



An investigation of mathematics teachers' documentation expertise and its development in collectives: two contrasting cases in China and France

Chongyang Wang

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Madame Chongyang WANG

An investigation of mathematics teachers' documentation expertise and its development in collectives: two contrasting cases in China and France

Une expertise documentaire des professeurs de mathématiques et de son développement dans des collectifs: deux études de cas contrastées en Chine et en France

数学教师文献纪录专长的中法案例研究：构成及其在集体工作中的发展

Devant le jury composé de :

M. Jiansheng BAO	Professeur, ECNU, Chine	Rapporteur
Mme Ghislaine GUEUDET	Professeure, Université de Bretagne Occ.	Rapporteuse
M. Lianghuo FAN	Professeur, ECNU, Chine	Examineur
Mme Birgit PEPIN	Professeure, Eindhoven University of Technology	Examinatrice
Mme Sophie SOURY LAVERGNE	MCF HDR, ENS de Lyon	Examinatrice
M. Luc TROUCHE	Professeur, ENS de Lyon	Directeur de thèse
Mme Binyan XU	Professeure, ECNU, Chine	Co-tutrice de thèse

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“Once the storm is over you won't remember how you made it through, how you managed to survive. You won't even be sure, in fact, whether the storm is really over. But one thing is certain. When you come out of the storm you won't be the same person who walked in. That's what this storm's all about.” I would like to express my appreciation to those people who support and accompany with full spiritual encouragement, and make me finally, rush through this storm, and reborn as a stronger me.

Abstract

An investigation of mathematics teachers' documentation expertise and its development in collectives: two contrasting cases in China and France

In a time of fast technology development and frequent curriculum reform, the abundance of instructional resources brings teachers both chances and new complexity in working with resources and working in collectives. Teachers have to develop and improve a set of competencies for facing such a situation. Focusing on mathematics teacher professional development, this PhD research aims at exploring mathematics teachers' expertise required for, and developed in, interacting collectively with resources. The research is designed as case study in two contrasting contexts (China and France), because a body of researches on expertise agree that expertise is a practical knowledge in action, which is contextualized, value laden and culture-bound.

Taking Documentational Approach to Didactics (DAD) as the main theoretical framework, this study is dedicated to explore the expertise aspect of this approach, and proposes the new notion of Documentation Expertise (DE) to refer to teachers' expertise in documentation work, namely the expertise in interacting with resources. Key notions of DAD, documentation work, resource system and scheme are retained for studying the components of DE in depth.

Three questions are explored:

1. What DE could be found in mathematics teachers' documentation work? What are the components of DE and the corresponding performances of experienced teachers?
2. How DE could get developed through teachers' collective work? What are the factors that could be supportive for DE development?
3. Through two contrasting cases, what are the similarities and differences? What could be borrowed and adapted for a mutual benefit?

Two theoretical frameworks, Cultural-historical Activity Theory (CHAT) and Anthropological Theory of the Didactic (ATD) are also combined and coordinated with DAD. The activity system of CHAT is used for analyzing the individual teacher's roles and labor division; the hierarchy levels of co-determination in ATD are used for making contrasting analysis.

The study is based on the methodology of reflective investigation from DAD. Special tools for this research are also developed: Inferred/Reflective Mapping of Resource System, Reflective Investigating-Box, Documentation-Working Mates (DWM, meaning regular partners in documentation working), and daily resource usage logbook.

The cases chosen for are: One experienced teacher and her two less experienced DWMs who work as her apprentices in the Chinese case; two experienced teachers work as each others' DWMs in the French case.

To propose a model for describing the components of DE, two steps are proposed: a first DE model based on literature review and a pilot study in China, a refined model after two contrasting cases analysis. For refining this model, the study follows three perspectives: The DE perspective of naming systems, the DE perspective of viewing the resource system, its content and structure, and the DE perspective of analyzing schemes of documentation work.

- The analysis of teachers' naming systems gives a lens for capturing the important elements of the resource system, and main resources used, through the word frequency in teachers' interview transcriptions. Three indicators are considered for studying these resources: (1) Their content; (2) Their position in the resource system (their links with other resources); (3) Their activeness (the frequency they are used and the way they are managed).

- Six views are proposed for capturing the complexity of resource systems: mathematics; didactics; curriculum, didactics; collective; student; and a design view. A view means a lens seeing the resource system with a given perspective, for example, the ‘student’ view refers to what teachers’ resources are for and from students;
- Five schemes are proposed and considered as basic schemes in documentation work: searching for resources; selecting resources, adapting resources; accumulating resources; and reflecting on documentation work. They are intertwined in activities, and not necessary happened in order. The schemes are analyzed from the rules of action and operational invariants.

The cases study brings some main results, taking into account, of course, that some elements of DE properties are linked to the teachers’ profiles and/or to the different cultural/linguistic/institutional contexts:

- The need for deepening the naming system perspective by (taking better into account the cultural, linguistic and institutional components of DE);
- The current six views needs to be refined with extra views considering the cultural contextual characters, such as a school view, an usage view, and an exam view for the Chinese case, a research view and critical view for the French case. Meanwhile, the articulation between these views are very important, and flexibility of passage between the views may constituting a critical feature of DE;
- The number of schemes needs to be extended, and they have to be crossed with the views of resource system; schemes should be considered by involving more situations.

Articulating these three perspectives leads to a new model, unifying the static and dynamic perspectives to study the components of DE.

The two case studies showed that the collective work supports the DE development from two aspects: (1) the resources provided by the collectives, such as the brochures from IREM/APMEP and the school lesson plan repertoire (in the French case), or the exercises and information shared instantly in the WeChat group chatting (in the Chinese case); (2) the opportunities to exchange the experiences (including the resource usage and what need to be avoid during the usage), which could considered a kind of social resources or human resources. The collective problem-oriented exchanges, especially in the Chinese MOKE activity, are crucial for the novice teachers to intensively experience the whole lesson design process including preparation, implementation and reflection.

This study confirms the relevance of the concept of DE in analyzing teachers’ documentation work, as well as its development in collectives. To confront teachers’ view, the tool of Documentation-Working Mates helped to obtain more complete information on the main teacher’s documentation work; the method of taking teachers’ naming system to see through their resource system brings also interesting findings.

Finally, this study raises new theoretical needs, such as in the scheme analysis, how to take the inferences components, how to obtain more precisely the operational invariants; it also question the “broad collection of resources”, and its analysis, especially the videos of teachers’ documentation work and their notes. It also opens new perspectives:

- New perspectives of research of naming systems: analyzing verbs that teachers use in dealing with the resources; deepening the data analysis by enlarging the cases from more contexts (see Chinese-Mexican, and Chinese-Ukrainian cases, in progress);
- New perspectives of development for teacher education in a time of digital metamorphosis: towards a repertoire of models of collective documentation work, to be adapted with respect to cultural and institutional conditions.

Une étude de l'expertise documentaire des professeurs de mathématiques et de son développement dans des collectifs :

Deux études de cas contrastées en Chine et en France

À une époque de développement technologique rapide et de réforme fréquente des programmes, l'abondance de ressources pédagogiques offre aux enseignants à la fois des chances et une nouvelle complexité de travailler avec des ressources et de travailler collectivement. Les enseignants ont alors à développer et améliorer un ensemble de compétences pour faire face à une telle situation. Centrée sur le développement professionnel des enseignants de mathématiques, cette thèse de doctorat vise à explorer l'expertise des enseignants de mathématiques requise et développée pour interagir collectivement avec les ressources. La recherche est conçue comme une étude de cas dans deux contextes contrastés (la Chine et la France), car un ensemble de recherches sur l'expertise s'accorde pour dire que l'expertise est une connaissance pratique en action, contextualisée, chargée de valeurs et liée à la culture.

Basée sur l'approche documentaire du didactique (ADD), cette étude se consacre à l'exploration de l'aspect expertise de cette approche et propose la notion d'Expertise documentaire (ED) pour désigner l'expertise des professeurs à l'œuvre dans leur travail documentaire, c'est-à-dire dans les interactions avec les ressources de leur enseignement. Les notions clés de l'ADD, à savoir le travail documentaire, le système de ressources et les schèmes sont retenus pour une étude approfondie des composantes de l'ED.

Trois questions sont explorées:

1. Quelle ED apparaît dans le travail documentaire des professeurs de mathématiques? Quelles sont les composantes de l'ED et les performances correspondantes des enseignants expérimentés?
2. Comment l'ED pourrait-elle être développée à travers le travail collectif des enseignants? Quels sont les facteurs qui pourraient soutenir le développement de l'ED?
3. Quelles sont les différences et les similitudes de l'ED dans les deux cas? Que pourrait-on emprunter et adapter pour un bénéfice mutuel?

Deux cadres théoriques, la théorie de l'activité historico-culturelle (CHAT) et la théorie anthropologique du didactique (ATD) sont également combinés et coordonnés avec l'ADD. Le système d'activité de CHAT est utilisé pour analyser les rôles et la division du travail des enseignants dans les collectifs. Les niveaux hiérarchiques de codétermination dans ATD sont utilisés pour effectuer une analyse contrastée.

L'étude est basée sur la méthodologie d'investigation réflexive de l'ADD. Des outils spécifiques sont également développés pour cette recherche: cartographie inférée / réflexive du système de ressources, boîte d'investigation réflexive, partenaires de travail documentaire (PTD, qui signifie développer un travail documentaire commun sur une base régulière) et journal de bord d'utilisation des ressources.

Les choix réalisés pour les études de cas sont les suivants: une enseignante expérimentée et ses deux PTD moins expérimentés dont elle assure la formation dans le cas chinois; deux enseignants expérimentés travaillant comme PTD dans le cas français.

Pour proposer un modèle permettant de décrire les composantes de l'ED, l'étude est faite en deux étapes: 1) un premier modèle d'ED basé sur une revue de la littérature et une étude pilote en Chine, 2) un modèle raffiné après deux analyses de cas contrastées. Pour affiner ce

modèle, l'étude suit trois perspectives: l'étude de l'ED à partir des systèmes de dénomination, l'étude de l'ED à partir des systèmes de ressources, leur contenu et leur structure, et l'étude de l'ED à partir des schèmes de travail documentaire :

- L'analyse des systèmes de nommage des enseignants permet de saisir les éléments importants du système de ressources et des principales ressources utilisées, par leur fréquence dans les transcriptions des entretiens avec les enseignants. Trois indicateurs sont considérés pour l'étude de ces ressources: (1) leur contenu; (2) leur position dans le système de ressources (leurs liens avec d'autres ressources); (3) leur mobilisation (la fréquence à laquelle ils sont utilisés et la façon dont ils sont gérés).
- Six vues sont proposées pour rendre compte de la complexité des systèmes de ressources: mathématique; didactique; curriculum, didactique; collectif; élèves; et conception (design). Une vue signifie une loupe qui voit le système de ressources dans une perspective donnée. Par exemple, la vue 'élèves' réfère aux ressources des professeurs qui sont pour les élèves, ou produites par eux;
- Cinq schèmes sont proposés et considérés comme des schèmes de base dans le travail documentaire: recherche de ressources; sélection des ressources ; adaptation des ressources; accumuler des ressources; et réflexion sur le travail documentaire. Ils sont étroitement liés dans les activités et ne sont pas nécessairement chronologiquement ordonnée. Les schèmes sont analysés à partir des règles d'action et des invariants opérationnels.

L'étude de cas donne quelques résultats principaux, en prenant en compte, bien sûr, que certains éléments des propriétés d'ED sont liés au profil des enseignants et / ou aux différents contextes culturels / linguistiques / institutionnels:

- La nécessité d'approfondir l'analyse des systèmes de dénomination en (prenant mieux en compte les composantes culturelle, linguistique et institutionnelle de l'ED);
- Les six vues doivent être affinées en prenant en compte des caractères culturels contextuels, telles qu'une vue 'école', une vue 'usage' et une vue 'évaluation' pour le cas chinois, une vue 'recherche' et une vue critique dans le cas français. L'articulation entre ces vues est très importante et la souplesse de passage entre les vues peut constituer une caractéristique essentielle de l'ED;
- Le nombre de schèmes doit être étendu et leur étude doit être croisée avec les points de vue du système de ressources; les schèmes devraient être envisagés en impliquant davantage de situations.

L'articulation de ces trois perspectives conduit à un nouveau modèle, unifiant les perspectives statiques et dynamiques pour étudier les composantes de l'ED.

Les deux études de cas ont montré que le travail collectif soutenait le développement de l'ED sous deux aspects: (1) les ressources fournies par les collectifs, telles que les brochures de l'IREM / APMEP et le répertoire des plans de cours de l'école (dans le cas français), exercices et informations partagées instantanément dans le groupe de discussion WeChat (dans le cas chinois); (2) les opportunités d'échange d'expériences (y compris l'utilisation des ressources et ce qu'il faut éviter lors de l'utilisation), qui pourraient être considérées comme une sorte de ressources sociales ou humaines. Les échanges collectifs axés sur les problèmes, en particulier dans l'activité MOKE en Chine, sont cruciaux pour que les enseignants débutants puissent expérimenter de manière intensive tout le processus de conception d'une leçon, y compris la préparation, la mise en œuvre et la réflexion.

Cette étude confirme la pertinence du concept de l'ED dans l'analyse du travail documentaire

des enseignants, ainsi que de son développement dans des collectifs. Pour confronter le point de vue des enseignants, l'outil « partenaire de travail documentaire » a permis d'obtenir des informations plus complètes sur le travail de documentation de l'enseignant étudié; l'exploitation des systèmes de dénomination des enseignants pour comprendre leur système de ressources a apporté également des résultats intéressants.

Cette étude soulève de nouveaux besoins théoriques, tels que dans l'analyse des schémas, comment prendre en compte les inférences, comment repérer plus précisément les invariants d'ouverture; cela questionne également «la collection large de ressources», et son analyse, en particulier les vidéos du travail documentaire des enseignants et leurs notes personnelles.

Cela ouvre aussi de nouvelles perspectives:

- Nouvelles perspectives de recherche sur les systèmes de dénomination: analyse des verbes que les enseignants utilisent pour gérer les ressources; approfondir l'analyse des données en élargissant contextes (travaux en cours: Chine-Mexique et Chine-Ukraine);
- Nouvelles perspectives de développement pour la formation des enseignants à une époque de métamorphose numérique: vers un répertoire de modèles de travail documentaire collectif, à adapter aux conditions culturelles et institutionnelles

数学教师的文献纪录专长的中法案例研究： 构成及其在集体工作环境下的发展

在科技迅速发展，课程改革频仍的时代，教学资源被极大丰富令教师的资源整合和集体工作更为复杂，教师需要某种专长来应对这种机遇与挑战并存的情境。本研究关注数学教师专业发展，旨在探索集体工作环境下，数学教师在资源工作中所需和所发展而来的专长。研究认为，专长具有情境性，是一种有文化价值烙印的实践性知识。因此，本研究选择案例研究法通过中法两组案例进行探索，旨在提出并构建此种专长的成分模型，并探索其如何在集体工作中得到发展。

本研究主要采用教学文献纪录法（DAD）作为主要理论框架。为探索并发展此理论中的教师专长一面，本研究提出了数学教师文献纪录专长（DE）的概念，意为数学教师在与资源互动中所需和所发展的专长。本研究保留了教学文献纪录法中的文献纪录工作、资源系统和应用图式等概念，作为深入分析文献纪录专长的切入口。

研究问题有三：

1. 何为文献纪录专长？数学教师文献纪录工作中有哪些表现可视为文献纪录专长？经验型教师的表现中印证了哪些文献纪录专长的成分？
2. 文献纪录专长怎样在集体工作中得到发展？有哪些促进发展的影响因素？
3. 通过中法案例研究，文献纪录专长有哪些异同？在该专长的获得与发展方面可以为双方带来哪些启发？

除了教学文献记录法，本研究还采用了文化活动理论（CHAT）和教学人类学理论（ATD）。文化活动理论的活动系统模型被用于分析个体教师在集体活动中的角色和分工，以及从集体的演进和发展视角看该个体的专长发展和变化。教学人类学理论提供了多层决策模型，为如何对背景迥异的双案例研究提供了描述和分析框架。

本研究教学文献纪录法中提出的反思性调查法作为主要研究方法，具体研究工具包括：资源系统的推断图/反思图，反思性调查工具箱，文献纪录工作伙伴（日常资源工作交流最密切的同事），以及资源调用日志。

案例研究所选案例中法各一：中方案例三位同校教师，一位经验型教师和她指导的两名徒弟；法方两位同校教师，均为经验型教师。

研究工作分两步进行：通过文献梳理和一项在中国进行的预研究提出初步的文献纪录专长模型，再通过中法案例对初步模型进行修正补充。案例分析从“命名系统，资源系统和图式”三个角度进行。

- 教师资源的命名系统分析是指通过对访谈数据中教师对其资源的描述对话进行词频统计，筛选出教师所强调的资源要素（资源所含内容）和重要具体资源。对具体资源的分析包含三项指标：资源内容，该资源在资源系统中的地位和与其他资源的联系，该资源的活跃程度。
- 文献纪录专长可从静态和动态两个维度进行调查和表征：静态维度指资源系统的结构和成分，该专长主要体现在教师在教学资源的有意设计、组织、整理和积累中综合考量数学学科、教学法、课程和学生等要素；动态维度包括资源系统的管理维护，资源工作过程中对资源的开放式搜索、批判性选择、灵活修改与应用，以及自动化的资源归纳与积累习惯。
- 集体工作有助于文献纪录专长的发展，尤其在集体备课活动中，针对具体情境下所需资源和应用图式的头脑风暴式讨论对参与教师获益均甚。

中法案例对照下，也有一些针对制度环境的启发，例如中国案例中的教师集体工作制度系统，以及法国案例中的高质量网络资源建设。

文献纪录专长可从静态和动态两个维度进行调查和表征：静态维度指资源系统的结构和成分，该专长主要体现在教师在教学资源的有意设计、组织、整理和积累中综合考量数学学科、教学法、课程和学生等要素；动态维度包括资源系统的管理维护，资源工作过程中对资源的开放式搜索、批判性选择、灵活修改与应用，以及自动化的资源归纳与积累习惯。

- 集体工作有助于文献纪录专长的发展，尤其在集体备课活动中，针对具体情境下所需资源和应用图式的头脑风暴式讨论对参与教师获益均甚。
- 中法案例对照下，也有一些针对制度环境的启发，例如中国案例中的教师集体工作制度系统，以及法国案例中的高质量网络资源建设。

Table of contents

Introduction.....	1
Chapter 1 Setting the scene.....	1
1.1 Mathematics education and curriculum reforms.....	1
1.1.1 From mathematics to mathematics education: a historical view.....	1
1.1.2 The mathematics curriculum reforms: trends and structures.....	5
1.1.3 Conclusion.....	11
1.2 Supports for teachers' resource work.....	12
1.2.1 Curricular supports to teachers' resource work.....	12
1.2.2 Technological supports, digital resources and online resources.....	14
1.2.3 Institutional supports for teachers' resource work.....	16
1.2.4 Conclusion.....	19
1.3 Supports for teachers' collective work.....	19
1.3.1 Collective working culture and TRG in China.....	20
1.3.2 Pedagogy freedom and AeP at FIE in France.....	24
1.3.3 Conclusion.....	27
1.4 Research questions and the practical values expected.....	28
Chapter 2 Literature review and theoretical frameworks.....	29
2.1 Teacher expertise and its links to teachers' resource work.....	29
2.1.1 The concept of expertise.....	29
2.1.2 Expertise in teacher education.....	34
2.1.3 Teacher expertise and teacher resource work.....	41
2.1.4 Teacher expertise and teacher collective work.....	44
2.2 Documentational approach to didactics (DAD).....	45
2.2.1 The origin and main ideas of DAD.....	45
2.2.2 Scheme: origin and definition for analyzing documentation work.....	47
2.2.3 Collective dimension of documentation work.....	53
2.2.4 A discussion on scope and category of resources.....	55
2.3 Cultural Historical Activity Theory (CHAT).....	57
2.3.1 The origin and main ideas of CHAT.....	57
2.3.2 Two key concepts in CHAT and DAD: system and collective.....	59
2.4 First approach to Documentation Expertise (DE) and questions of research.....	60
2.4.1 Preliminary ideas on the nature of DE.....	61
2.4.2 Research questions and structure of the thesis.....	65
Chapter 3 Methodological design.....	67
3.1 Research design as contrasting case studies.....	67
3.1.1 The choice of conducting case studies.....	67
3.1.2 Contrasting analysis dimensions.....	69
3.1.3 A pilot study based on the research proposal in 2014.....	72
3.1.4 A reflection from the pilot study to the DE model.....	76
3.1.5 A conceptual model of DE.....	77
3.2 Methodology and tools.....	80
3.2.1 Main principles of Reflective Investigation grounding the methodology.....	80
3.2.2 Static dimension: From Schematic Representation to Inferred/Reflective Mapping of teacher's resource system.....	82
3.2.3 Dynamic dimension: RI-Box, interviews, observation and videos.....	83
3.2.4 Collective dimension: Documentation-working Mate.....	85
3.3 Cases design.....	86

3.3.1 Project background for the research.....	86
3.3.2 Criteria for the case choice (teacher, school, teaching contents).....	87
3.3.3 Tools designed and prepared for the Chinese case data collection.....	89
3.3.4 Tools designed and prepared for the French case data collection.....	90
3.4 The procedure flow of the whole research.....	91
Chapter 4 Case study in China.....	93
4.1 Chinese case: setting the scene.....	93
4.1.1 Gao and her two Documentation-Working Mates (DWMs).....	93
4.1.2 The context of Gao's school.....	97
4.1.3 Mathematics teachers' documentation work support.....	98
4.1.4 Collective supports for mathematics teachers' documentation work.....	100
4.2 Data collection strategy.....	101
4.2.1 Organizing the follow up.....	101
4.2.2 Organizing the analysis.....	103
4.3 DE evidenced through teacher's naming system.....	103
4.3.1 Analyzing teachers' naming system.....	104
4.3.2 Analyzing Gao's resource system from her key resources.....	106
4.4 DE evidenced through teacher's resource system.....	113
4.4.1 Accessing the structure of resource system.....	113
4.4.2 Bridging the six views on resource system.....	119
4.5 DE evidenced through schemes in documentation work.....	120
4.5.1 Schemes related to searching for resources.....	121
4.5.2 Schemes related to selecting resources.....	122
4.5.3 Schemes related to adapting the resources.....	123
4.5.4 Schemes related to accumulating (and sharing) resources.....	125
4.5.5 Schemes related to reflection on the documentation work.....	127
4.6 Conclusion and referring to the research questions.....	129
4.6.1 DE and its relation with Gao's profile.....	129
4.6.2 DE and its relation with the Chinese situation.....	131
4.6.3 Enlightening the research questions and the DE model.....	132
Chapter 5 Case study in France.....	139
5.1 French Case: Setting the scene.....	140
5.1.1 Anna and her Documentation-working Mate (DWM) Cindy.....	140
5.1.2 The context of Anna's school.....	143
5.1.3 Mathematics teachers' documentation work support.....	144
5.1.4 Collective supports for mathematics teachers' documentation work.....	146
5.2 Data collection strategy.....	149
5.2.1 Organizing the follow up.....	149
5.2.2 Organizing the analysis.....	151
5.3 DE evidenced through teacher's naming system.....	152
5.3.1 Analyzing teacher's naming system.....	152
5.3.2 Analyzing Anna's resource system from her key resources.....	156
5.4 DE evidenced through teacher's resource system.....	159
5.4.1 Accessing the structure of a resource system.....	159
5.4.2 Bridging the six views on resource system.....	168
5.5 DE evidenced through schemes of documentation work.....	170
5.5.1 Schemes related to searching for resources.....	171
5.5.2 Schemes related to selecting resources.....	173
5.5.3 Schemes related to adapting resources.....	174
5.5.4 Schemes related to accumulating (and sharing) resources.....	175

5.5.5 Schemes related to reflection on the documentation work.....	176
5.6 Conclusion and referring to the research questions.....	177
5.6.1 DE and its relation with Anna's profile.....	177
5.6.2 DE and its relation with the French situation.....	178
5.6.3 Enlightening the research questions and the DE model.....	179
Chapter 6 Contrasting the case studies, discussion and perspectives.....	181
6.1 Related to research question 3: Contrasting the two cases.....	181
6.1.1 Seeing from the naming system.....	181
6.1.2 Seeing from the resource system.....	182
6.1.3 Seeing from the schemes.....	185
6.1.4 Conclusion.....	188
6.2 Related to research question 1 and 2.....	188
6.2.1 Research question 1: components of DE.....	189
6.2.2 Research question 2: the role of collective work in DE development.....	189
6.2.3 Refining the DE model.....	191
6.3 The relevance of theoretical and methodological choices.....	194
6.3.1 Reflecting from the PhD process, theoretical issues.....	194
6.3.2 Reflecting from this PhD process, methodological issues.....	197
6.4 Perspectives.....	199
6.4.1 Programs of research taking advantage of the linguistic diversity.....	199
6.4.2 Programs of development taking advantage of the collective potential.....	201
6.4.3 A final reflection.....	202
References.....	205

Introduction

This section introduces the genesis of the research questions. With an interest on teacher professional development in the field of mathematics education, this study takes the lens of ‘resources’, and pays an interest on the ‘expertise’ shown in teachers’ interactions with resources, and how it is developed through collective work.

The research interest starts from a cautious on information literacy (Marchionini 1999), which was raised as merely a kind of computer literacy or information processing capability at the beginning of 1970s. Then with the efforts of information scientists, the concept of information literacy got developed rapidly in 1980s, and proposed as some “should have” citizen literacy by the national level (American Association of School Librarian 1989). In 1990s, information literacy became a requirement of the professional positions, including teachers, as the premise of lifelong learning (Ren 2001). These trajectories remind a fact: along with the transition in technology development, teachers, including mathematics teachers, have to adapt to and benefit from the huge amount information and technologies, and the expertise of adaptation could be a lens to see through their professional development.

The second interest comes from the collective aspect of teacher work. Cooperation among teachers is considered as a crucial dimension for teacher’s professional development (Hargreaves 1995; Rao & Zhang 2007), because cooperating with other teachers cannot only improve the individual’s teaching, but also the long-term teacher’s professional development (Lavié 2006).

The third interest is making case studies in two contrasting contexts (China and France), since comparative studies can identify and explain differences of homologous phenomena in two or more contexts (Artigue & Winsløw 2010). China and France are both countries with “centralization in education”: the governments hold the control of the unified national curriculum program, influencing the teaching resources environment for the teachers. However they hold quite different features, such as the unified textbooks and rich learning-aid materials in China, and the pedagogy freedom with rich textbook choices in France. Inspired by Chevallard (1985), comparative studies can be conducted considering levels of didactical determination, mathematical praxeologies realized in school, and the knowledge of students related to the taught mathematical organizations.

Opportunities can also be found in the curriculum reforms in France since 2016, and in China since 2017. What’s more, the research interests also is being concerned by several projects, such as the national project ReVEA in France (Trouche, Trgalova, Loisy, & Alturkmani 2018), and the MaTRiTT project (Trouche 2018) cooperated between China and France.

The following chapters successively set the scene (Chapter 1); propose a literature review, a theoretical framework design and introduce the research questions (Chapter 2); situate the methodological design (Chapter 3); and analyzes Chinese and French case studies (Chapters 4 and 5). Chapter 6, finally, contrasts these two cases, allowing to enlighten the questions of research, and to propose perspective for further work, both practical and theoretical.

Before that, I would like to insert a joint point of view written with another PhD student, Katiane Rocha: from the beginning to the end of our PhD, our collaboration played really a critical role, and the insertion of this joint point of view makes justice to this fruitful interaction.

Twin trajectories of two PhD-working mates

Katiane Rocha and Chongyang Wang, February 22nd

In March 2015, we (Chongyang and Katiane) arrived at Lyon the same time as two PhD students working with Luc Trouche. We had obtained both full scholarships from our own countries (China and Brazil) after a series of competitive selections: from Chinese Scholarship Council (Chongyang), and from the National Council for Scientific and Technological Development (Katiane). Four years later, in 2019, our defenses happen in April (Chongyang), and June (Katiane). Actually our trajectories of research have shared a number of events and resources.

To know better the French education system and adjust our research proposals, we spent our first three months in France in following together a mathematics teacher, Anna, who later became our common research case. We observed collectively her classroom teaching and professional activities, particularly her work on/for resources in various collectives. Through our own lens of culture and context (for example middle school teachers have 32 teaching hours per week with students in Brazil, while the Chinese teachers have only 10 to 12 hours), the contrasting observation always brought us some unexpected points for discussing. Meanwhile, through the follow-up of Anna, we were allowed to observe her close interactions with another teacher in her school, and this situation inspired some of our theoretical propositions, especially the collective aspect of teacher professional development.

We were involved in a same laboratory, S2HEP, a same research team, EducTice. We have shared the same office during four years. In many occasions during these years, we were roommates when attending diverse conferences. We attended together ICME-13 in Hamburg (2016), and wrote each of us a chapter in the same book (Rocha 2018a; Wang 2018a); we attended together ICMT-2 in Rio (2017) and wrote a contribution for its proceedings (Rocha, Trouche & Gueudet 2018; Wang, Trouche & Pepin 2018). We worked as local volunteers and presented collectively for ICTMT-13 in Lyon (2017) (Rocha, Wang, & Trouche 2017), and for the Res(s)ources 2018 International Conference in Lyon (Rocha 2018b, Wang 2018b). We situated our data collection within the framework of the French national project ReVEA¹ and data analyses on the AnA.doc platform².

We appropriated a common theoretical framework (Documentational Approach to Didactics) with different but close research interests on mathematics teachers' documentation work: *experience and trajectories* for Katiane, and *expertise* for Chongyang. We tried to propose theoretical as well as methodological contributions for developing this framework, for example the concept of *Documentation-Working Mate* for Chongyang, and the concepts of *Reflective vs. Inferred Mapping* for Katiane, and we take profit each of us of the contributions of the other one.

Of course, beyond these commonalities, our PhDs are very different: Chongyang is contrasting a Chinese and a French case and writing in English, while Katiane is contrasting two different French cases and writing in French. During the four years, we wrote papers and made presentations in four languages: English, French, Portuguese (for Katiane) and Chinese (for Chongyang).

Coming from two contrasting cultures (Eastern vs. South America), we both have very distinctive cultural imprints and personal characters, one is more introverted and conservative,

¹ <https://www.anr-revea.fr/>

² <https://www.anr-revea.fr/anadoc/> (need a password, to be asked to the researchers involved)

and the other one is more outgoing and adventurous. We explored in and tried to adapt to the French culture together, we influenced and got influenced through the mutual helps, and finally we see another world in the window of each other. In one expression, we consider ourselves as two PhD-working mates and close friends. We would like to take profit of it and integrate our experiences here in our own PhD thesis, for memory of the direct link between Brazil-France-China, and also for our friendship and cooperation. We also wish that we could continue our exploration together after our graduation.

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Chapter 1 Setting the scene

This chapter aims at presenting the background information of this PhD research, including where this research is situated, what is already known, what should be explored, and what the issues this research will address.

As mentioned briefly in the section of ‘introduction’, it is a time of transition with fast development of technology and Internet, and deep curriculum reforms. Teachers are facing both opportunities and challenge for their working manners and professional development. They seem have faster access to richer available resources due to Internet, but actually the more choices, the higher requirements on the ability in resource working, such as the resources selecting and managing, because storing resources is no more crucial as before due to the born of cloud-drive technology. This research will explore teachers’ necessary abilities to adapt and get professional development in such a time of transition.

In this way, situations including culture, history and institution factors related to mathematics education and teachers’ working conditions, will be described in the following: mathematics curriculum reforms from the movements, trends, characters and current structure (1.1); supports for teachers’ resource work, mainly from the curricular aspect, technological supports, and institutional supports from teacher education, in-service training and other professional organizations (1.2); the institutional supports and conditions for/from teachers’ collective working (1.3); the research questions and expected values for this research (1.4). The previous three sections will start from a general description, and followed by the conditions in China and in France respectively.

1.1 Mathematics education and curriculum reforms

This section presents the background information of mathematics curriculum reforms trends in the two contexts, so that we could have a map of the new requirements and challenges to the mathematics teachers. The information of the two countries are following after an international context: a historical view on mathematics education (1.1.1); the trends of mathematics curricular reforms and the current structure of mathematics curriculum (1.1.2), a conclusion on the characters of mathematics curricular conditions in the two contexts, and challenges that mathematics teachers of the two contexts are facing (1.1.3).

1.1.1 From mathematics to mathematics education: a historical view

This section presents the development of mathematics education, in a general level, then respectively in China and France from a view of culture and history.

Mathematics education was built as a subject far later than mathematics. As an academic subject, mathematics can be traced back to the quadrivium of Plato’s academy (arithmetic, geometry, music and astronomy) or even the Sumerian and Babylonian scribal schools (Davis & Hersh 1981; Høyrup 1994). While the subject of mathematics education was established in the academy filed since 19th century, both more recently and less firmly (Kilpatrick 2008). Throughout that period, the modern scientific disciplines were emerging in higher education (Kilpatrick 1992), and during the second half of the 19th century, mathematics succeed in becoming an autonomous discipline in German universities (Schubring 1989). Teacher education was treated as a separated academic field during the last decades of the 19th century and early decades of 20th, when it began to move into institutions of higher education in various countries (Kilpatrick 2008). Since then, school mathematics was gradually becoming an object of scholarly study, not anymore just a field of practice (Jahnke 1986; Schubring 1988). By the end of the 19th century, secondary teachers for mathematics were being

prepared in universities, pedagogical seminars, and normal schools, but in that period, these preparations consisted almost entirely of lectures in mathematics with little or no instruction in teaching. With the efforts of Felix Klein, deeper reforms in teacher education were pushed, and curricula of teacher education were developed (Kilpatrick 2008). In 1905, the attention to mathematics teaching was proposed as an addressed question on pure mathematicians teaching in higher education (Smith 1905) in the Third International Congress of Mathematicians (ICM). In the fourth ICM in 1908, a wider scope of studies of “a comparative study on the methods and plans of teaching mathematics at secondary schools” (Lehto 1998, p. 13) was involved, which expanded to all types of schools, including primary schools, vocational schools, and universities. As for the practical part, when the national school systems were established, a larger supply for teachers with a professional education was required. Throughout the 20th century, many of the special schools for training elementary or secondary teachers either became part of a university or attained university status for themselves, which led to great differences across countries in the way teacher preparation is handled. By the 1930s in the United States, most former public normal schools had become teachers colleges, and by the 1950s they had become departments, schools, or colleges of education in universities. It was said, according to Kilpatrick (2008), in some less economically developed countries, prospective teachers still receive only a short training course at the level of secondary education to prepare them to teach large classes of young children, while in some economically developed countries, most teachers are university graduates who began their teacher preparation after finishing secondary school.

Kilpatrick’s description reveals one reason that leads the gap of teacher quality (also the requirements of teacher employ): level of economical development. While in China, due to the vast territory, multi-nationality and the ravages of wars, teacher quality gap is not only between the different economical developed areas (western and eastern, northern and southern parts), but also between the different generations of teachers, which results in the teacher education reforms and the fast economic and technology development during the latest decades.

Mathematics and mathematics education in China

China has a long history of mathematics since the existence of *The Nine Chapters* (Chemla & Guo 2004) in Zhou Dynasty (1046-256 BC), but a short history of modern mathematics education system.

Mathematics was not quite emphasized by the governors before the modern time. In China, the exam culture can be traced back to 587, the Sui Dynasty (581-619), improved and built systematically in Song Dynasty (960-1279), namely the traditional Imperial Examination System (科举制度, Kē jǔ zhì dù), settled for selecting intellectuals and state officers. It is considered as an important political system in ancient China, with giant influence on Chinese culture and society for more than 1300 years (this issue is also re-discussed in Chapter 4 and Chapter 6). Although this examination pays more attention on literacy, the skills of practical mathematics were still encouraged to be learned due to the necessity of national management affairs such as tax planning or making calendars etc. Chinese mathematics got developed during 3rd century to 13th century, with particular advantages in algebra problems. In 16th century, an Italian missionary named Matteo Ricci (1552-1610) arrived in China and brought the western mathematics (Katz 2004). Since then, Chinese mathematics gets influenced deeply by the western mathematics (Zhang 2002), also affected is the mathematics education.

Mathematics was settled as a subject along with the construction of modern education system. The first Chinese modern education system was put into force in 1904 (Qing Dynasty), which was the so-called “中体西用 (Zhōng tǐ xī yòng)”, with the meaning that it was based on the

tradition of Chinese culture to train students to become loyal to the existing feudal system, and at the same time draw experiences from western countries, and the literacy, moral education, as well as practical education were emphasized. Moreover, subjects in science and humanities, such as physics, chemistry, foreign languages, gymnastics, drawing and handicrafts were introduced in primary and secondary schools. The issue of the 1904 school system led to the termination of China's long historical tradition of examination-based education and official selection system, and marked the establishment of the modern Chinese school system. However, as announced above, the Imperial Examination System has already become part of culture. The end of the system did not immediately change the tacit value orientation on education at schools, either for parents, teachers, and students or for the whole Chinese society. In 1907, the first Ministry of Education (established in 1905) proposed a national educational reform. This inferred a new age of modern school system based on the Western model started, and the more than 1000-year-old history of emphasizing on literary examinations without universal education and school system was ended: "Confucian learning was no longer privileged, and new field of learning were introduced with compulsory mathematical curriculum at all levels of education." (Bréard & Horiuchi 2014, p. 154).

The construction of Chinese mathematics education system was influenced deeply by two camps of the Cold War: United States and Soviet. After 1911, the outbreak of the Xinhai Revolution ended Qing Dynasty. China became a republic, and a new guiding principle of school system was carried out in 1913, which aimed at establishing a modern school system compatible with the new democratic and republic system. This 1913 school system was upgraded in 1922 based on an American model, and the 1922 school system was a result of China's attempt to modernize its education system by borrowing experience from developed countries, especially from the United States. John Dewey's ideas and progressive education were very influential in many schools and teacher training institutions in the country (Wang 2009).

In the 1950s, as a result of the Chinese revolution and the policy of Western countries of isolating China, China chose to adopt the Soviet model for its educational development. In December 1949, the same year when the new regime was built, chairman Mao proposed to build a new education based on the previous experiences, and from the Soviet Union. Then in 1953, with an upsurge of "learning from Soviet Union throughout the country", Chinese education stepped into "Soviet" mode, including the subjects setting, the teaching contents, the curriculum management system, the textbooks as well as the education theories and ideas (Wang 2013b). This period gave China rooted influences because it was a post-war reconstruction period. Soviet experts of each field were invited to China, and Soviet texts were translated or edited to provide textbooks in almost each field of knowledge. Kairov's theories had a particularly strong influence in the field of education, his pedagogy was published in Chinese in 1950, and educational circles studied it systematically and at length, taking it as the bible for educational theory and for standards of criticism. However, when relations between China and Soviet Union deteriorated later, Kairov's theories were repudiated. During the Cultural Revolution, they were subject to thorough criticism, which had a strong political bias. But the related academic issues were blurred.

Reflecting on the various education reforms after 1949, Chinese education reforms "conformed excessively" to the politics and pay less on education localization (Wu & Yu 2011), for example, in 1950s totally denying the idea of Dewey, which had been tried out for decades before, meanwhile totally imitating Soviet Union (Wang 2013b). After 1960s, when the Sino-Soviet split, the upsurge of learning from Soviet turned into an upsurge of criticizing it (Gu 2004), but the influence from Soviet remains a lot even till now, for example the "double basic education (basic knowledge and basic skills)" has been improved and became a

character of the localization of Chinese mathematics education. There is a mixed phenomenon that lots of Chinese universities are using American education system, but the newly edited textbooks are still using the Soviet textbook compiling.

This section has presented the Chinese mathematics education in China. Some characters could be seen: China has a long history origin of exam culture, which remains deep influences nowadays; After the end of Qing Dynasty, due to the historical and political reasons, Chinese mathematics education was influenced deeply by two different camps: United States and Soviet, which caused a swing between Soviet and American education ideas, such as emphasizing the basic knowledge and basic skill in mathematics, which is so called “双基 (shuāng jī) (double base)” (Zhang 2005), exams and exercises, and the teaching procedures in classroom. In Chinese culture, even teaching has been recognized to be a profession since the born of The Teacher Act in 1994, but it is still believed that the knowledge for teaching can be developed “from examples and by doing” (Li, Huang, Bao, & Fan 2011). This may echoes what Wang (2013) had said, university is the best place for learning advanced mathematics content, the core purpose of teacher preparation is to learn subject knowledge because prospective teachers can develop their pedagogical knowledge from their future teaching practice.

There is one sentence from one of the most famous Chinese mathematics educators, Zhang Dianzhou, who passed away in the end of 2018: seeing from the history, the countries who were powerful in economy and military, must also ranked at the top in mathematics (Zhang 2002). France also has the glory times on mathematics.

Mathematics and mathematics education in France

The French mathematics could be traced back to the period of the renaissance, when it got fast development along with the requirement of commercial economy, with the popularization of printing, absorbing the ideas from Italy and other European countries, as well as some Islam mathematics (Katz 2004). In 18th century, the French school of mathematics became the center in Europe since the period of Napoleon Empire, and it kept her position with German till the beginning of 20th century (Zhang 2002), and the French school of mathematics kept, till now, a strong position in the world.

Mathematics was proposed as a subject to be learnt at school since 1808. It was the time of Napoleon, the creation of Imperial University provided the base of French modern education system: from primary schools, middle schools (collèges) to high schools (lycées) and then facultés as the peak. This system was established to educate its future leading administrative and military officers. Comparing this with the Chinese Imperial Examination System, they seems share a similar aim: select (China) and cultivate (France) human resources for the government. The difference is that “mathematics remained molded by its central role in the examinations for entering the professions of military engineers under the Ancien Régime (the political situation of France, with its feudal structures, before the Revolution)” (Gispert 2014, p. 230). But the position of mathematics was a bit awkward, like sciences, it was not counted as supreme as the humanities classes of lycée, even it was taught as an incidental subject, the teaching contents still only focused on the abstraction and rigorous reasoning. This might be the second difference: the Chinese Imperial Examination System takes the practical applications, while the French Imperial University system keeps the non-practical part. This could influence mathematics teacher’s conceptions on “which aspect of mathematics should be taught to students”, doing exercises to consolidate the “double basics” (Zhang 2005) or acquire some thoughts (this will be re-discussed in the two case studies in Chapter 4 and 5).

“Swing” can be used to describe the changes of mathematics education in France: France changes along with the world. A reform in 1902 restated further the educational importance of

mathematics and science, as well as the importance of the experiences for learning mathematics and connecting them to sciences. This reform was considered by Gispert (2014) as being inspired by the German model of the Realschule to the detriment of the specificity of a “French spirit”, which was based on Latin and the classical humanities. In 1923, a new reform was voted to revoke the 1902 programs and principles, with a result that secondary instruction, including mathematics, was again dominated for decades by a theoretical and abstract conception. In the end of 1930s, contrary evolution happened under the left-wing regime of the Popular Front (Trouche 2016a). In December 1966, the French National Education Ministry gave into the demands of mathematics teachers, and created a commission to work out new guidelines for teaching mathematics in primary and secondary schools. In the field of mathematics education, with the influence of “New Maths” from USA and from the elaboration of the Bourbaki school in Europe, a deep reform named “modern mathematics” was conducted in 1969. This reform was for the whole country, and concentrated far more than education or mathematics education, but the whole society: to be modern, to be in line with the development of science and to be democratic. It led to a very abstract teaching of mathematics and got abandoned ten years after. During these upheaval education reforms, mathematics teaching becomes and remains as the heart of the education debates in France (Trouche 2016a).

This section briefly presents the history of Chinese and French mathematics education. Like the history of Europe, French mathematics has a multi-source mathematics ideas from both European nations and Islam world. Its frequent exchanges with other countries is not the case of Chinese mathematics and mathematics education. Taking the history as a mirror, China has a long history of exam culture but short history of modern education system and mathematics education, and holds a practice orientation on mathematics; France has a profound foundation of modern mathematics and modern education system with an orientation of taking mathematics as a thought. Besides, a very special feature of French education is the “two separate systems”: the secondary system of the lycée reserved for a narrow social elites (for future *Grandes Écoles*) and a primary system for the people, and mathematics holds a crucial place in the specialized courses that were offered by the private institutions, and these courses were used to prepared for entering the *Grandes Écoles* (Gispert 2014). This leads also to a differentiation in teacher education and teacher qualification systems between the two contexts in China and in France. Specific curriculum reforms related to mathematics in the two contexts will be presented in the following section.

1.1.2 The mathematics curriculum reforms: trends and structures

Curriculum reform is a fundamental factor for pushing forwards educational development (Wang, Liu, Du, & Liu 2018). This section draws the main mathematics curriculum changes along with the education reforms in the late decades, especially since 1980s, from general elements on the international mathematics curriculum reform trends, to the specific actions in China and France.

Mathematics education research, as Fried and Amit (2016) argued, no matter in theoretical or in practical, is never far from the efforts to reform mathematics teaching and learning. The results carried out in the actual reforms, and provide researchers the feedback meanwhile on their proposals’ quality and the nature and processes of reform. For reforming any situation, it requires three conceptual levels: a criticism of the status, a vision of what is desired, and a theory of change by which the transformation from one situation to the other can be accomplished (Robinson & Aronica 2015).

In many national education systems, curriculum is a state-based document approved by educational authorities, and curriculum administration is symbolic, concealing complex power

relations and struggles over the distribution of knowledge between dominant forces, both insiders (e.g. the state, curriculum developers and professional associations) and local players (e.g. school boards, parent associations and unions) (Kirst & Bird 1997; Westbury 2008). Curriculum making is a social process that determines and legitimizes what knowledge, skill and dispositions are distributed through education and how, with the state as principal regulator (Law 2014, p. 334). Curriculum plays also different roles in different education systems. France has a national curriculum for many years: this is not usual if comparing with other Western contexts like United Kingdom and United States, while it is similar with China (Leung et al. 1999).

Since 1980s, many countries around the world started to think about improving mathematics literacy as part of citizenship education (Dong 2006), which arose a trend of new mathematics education reform, such as the *National Curriculum* in Great Britain (Cockcroft 1994), *Principles and Standards for School Mathematics* in the United States (National Council of Teacher of Mathematics NCTM 2000), *The 21st Century Revival Action Plan in Education* in China (Ministry of Education of the People's Republic of China 1999), and the foundation of French *National Commission for Reflection on the Teaching of Mathematics* in 2002, for rethinking the teaching of mathematics for the new century (Kahane 2002). In the following sections, details about the mathematics curriculum reforms in China and France will be presented specifically.

Mathematics curriculum in P. R. China

This section presents the history of Chinese mathematics curriculum reforms after 1949, the current mathematics curriculum structure and changes, and then concludes on the character of Chinese curriculum and its requirements and challenges to the Chinese mathematics teachers.

Since the founding of the P. R. China, the regulation of school curriculum in all majors areas are controlled by the central government, such as school syllabus, the allocation of school hours, textbooks, etc. The centralized nature of school curriculum development contributed to the reconstruction of school curriculum in the post-war period, but also has some negative impacts such as the over-convergence of school curriculum across the country, the lack of flexibility, diversity, and individuality, the disconnection between policy-making process and the daily classroom operation in schools (Wang 2009). These problems nourished the new curriculum reforms since 1990s.

As mentioned in section 1.1.1, after the establishment of the People's Republic of China in 1949, Chinese mathematics curriculum evolved from learning from the Soviet Union to exploring to build its own system according to Chinese situation, with the promulgation of Syllabus of Full-time School Mathematics in May 1963 as a milestone. During the ten years (1966-1976), China's education was almost destroyed by the "Cultural Revolution". Having recovered from the trauma, mathematics curriculum for basic education resumed its momentum in 1977, and underwent several rounds of changes/reforms in the following twenty years. It is considered that there are three stages for mathematics curriculum reforms in China since 1978, after the Culture Revolution, and the education started to recovery.

- Early Stage (1978-1985): The restarting phase after the Cultural Revolution.
- Principle Stage (early 1990s- 2001): This stage laid the major foundations for the curriculum reform and led to experimental curriculum standards (Law 2014). During 1986-1988 the Secondary School Mathematics Instruction Professional Committee of Chinese Society of Education (CSE) spent three years to take a national survey about basic mathematics knowledge and skill for economic and social development. With the survey results, the teaching syllabus (教学大纲, jiào xué dà gāng) for compulsory

education stage was formed in 1988 and announced in 1992, then later revised in 1996 and 2000, which was considered as the first local mathematics teaching program.

Chinese education or curriculum reform generally adapts a “top-down” approach (Wang, Liu, Du, & Liu 2018). During 1996 to 1997, the Ministry of Education in China organized a national survey for investigating the status of the implementation of compulsory education in all subjects, including mathematics. The data and facts collected showed that the curriculum used at that period achieved some goals (such as the basic knowledge and basic skill), but many problems were also identified: the curriculum was characterized as complex, difficult, partial, and old; students suffered from memorization and drill practice; teachers struggled with “draining students with the sea of problems” (Liu 2009). This arose also some reflections on Chinese mathematics education. Zhang (2009) pointed out that what should be changed in Mainland China was the recognition of mathematics and school mathematics: from the traditional methods of mathematics teaching and learning to the modern methods, from the traditional assessment to the modern assessment, but the teaching and learning in mathematics classroom were still tradition in nature. There may be some cultural reasons (will also be discussed in Chapter 4 and 6):

“Chinese traditional culture made teacher as the bearer of knowledge, Official-Oriented-Mentality as the core value ruler lead to the inequality relationship between teachers and students, understanding the mathematics as absolute truth made negotiating, persuading, and compromising unnecessary and reasonless, and examination culture led to score-centered learning” (Wang, Liu, Du, & Liu 2018 p. 5313)

- Fine-tuning Stage (1999-now): This stage refined the standards and gradually implemented them. In 1999, the Ministry of Education started to conduct a new curriculum reform, and proposed the new curriculum standard (课程标准, kè chéng biāo zhǔn) for each discipline after 2001.

In March 1999, the Ministry of Education called for a mathematics standard research team (consisted by 70% members from higher education institutes and 30% members from public schools) to explore a national curriculum standard for mathematics ahead of other disciplines. The curriculum standard was designed separately in compulsory level (grade 1-9) and high school level (grade 10-12). This standard played an important role in that round of curriculum reform in fundamental education, for it provided the ideas of basic value the mechanism of implement, and the way to develop standards for other disciplines (Wang, Liu, Du, & Liu 2018). The curriculum content contained four main sections: Number and Algebra, Space and Figure, Statistics and Probability, and Practice and Synthetic Application. There are several changes in this version (Ministry of Education of People’s Republic of China 2001):

- (1) The old teaching syllabus (教学大纲, jiào xué dà gāng) (Zhang & Song 2004) contains only the brief description of teaching content and objectives, and most of the descriptions of teaching objectives were included in the textbooks. While the new curriculum standard (课程标准, kè chéng biāo zhǔn) changed both the scope and depth by providing more descriptions of learning content, learning process and teaching recommendations. It also provided a standard of developing textbooks, which makes the one single national textbook policy transforms into diver textbook policy, different versions of textbook following the requirement of the curriculum standard can be allowed and authorized by the national committee.

- (2) It proposed a basic idea of “Mathematics for all”, everyone can learn valuable mathematics; everyone can learn the necessary mathematics, different people benefit from different mathematics development.
- (3) It inherited the qualities from traditional Chinese mathematics education of emphasizing the training of “basic knowledge and basic skills” (双基, *shuāng jī*, The Two Basics) (Zhang, Li & Tang 2005), and added mathematical thinking ability, problem solving skills, attitudes towards mathematics, and the appreciation of mathematics.
- (4) It defined mathematics as a language to describe the real world. It emphasized the cultural value of pure mathematics and applied mathematics, real world application of mathematics, the technical attributes of mathematics, and the connections between mathematics and calculators and computers. Mathematics was considered as a process of theory abstraction from nature using qualitative/quantitative methods to solve real world problems.

This curriculum reform was considered as greater than all previous ones; it brought also greater challenges and difficulties in the implementation (Wang et al. 2018), that is to say, to the teachers.

To support the implementation, the state launched an institutional system, and the central part of the support system was teacher professional development, which included centralized large-scale teacher training, school-based teaching, research activity, and online training as a high-efficient supporting system (to see more detail in section 1.2.3).

Nowadays, based on the national curriculum, there are three levels of curriculum (also for mathematics): the national level, the local level (generally on province level or city level), and the school based curriculum (see Figure 1.1).

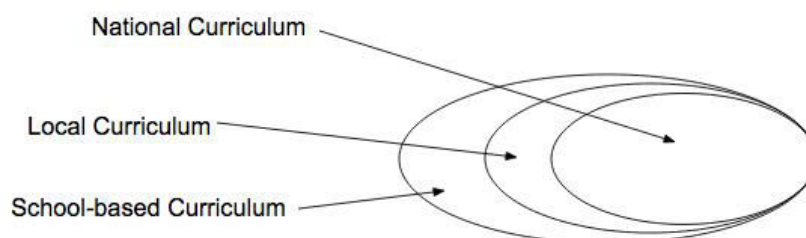


Figure 1.1. National School Curriculum Plan Framework in China (Zhong, Cui, & Zhang 2001)

The local and school-based curricula enriched the curriculum, which echo the idea of “mathematics for all”, and make the “mathematics culture” and “real world application of mathematics” be possible, since China is a multi-nation country and the areas of eastern and western are in quite different levels in economic development.

There are some characters could be summarized from Chinese mathematics:

- (1) A more restricted conception of curriculum. In China, education reform, instruction reform and curriculum reform are deeply interrelated: education reform aims at changing the education policy, system, content and methodology; instruction reform is more on a level of pedagogy for promoting and improving the teaching quality; while curriculum reform is theory-based actions with clear aim and planning for some specific curriculum conceptions or developing systems (Gu 1998). That is to say, the concept on curriculum is also different from the curriculum in Western contexts: their curriculum includes the whole curriculum scheme, evolving the curriculum designing, aims, contents, learning

activities and scales, which means the curriculum reform includes the education and instruction reform (Qu 1998).

- (2) “Top-down” approach lead by the state. In China, the curriculum reform is often a main human capital development strategy for coping with the challenges of the 21st century, and the state plays an important role in the curriculum-making mechanisms (Law 2014).
- (3) Emphasizing The Two Basics (basic knowledge and skills) (Zhang, Li & Tang 2005).
- (4) Emphasizing the examination (Liu 2009; Zhang 2009).

This section presented the Chinese mathematics curriculum reforms, especially the one in 2001. Although experienced a swing between Western and Soviet at the first decades, there is some fundamental change in Chinese education reform, such as “re-oriented its curriculum making from a state-dominated model to one that is state-lead, expert-assisted and evidence-based.” (Law 2014, p. 332), and keeping space with the international trends but combining the Chinese reality and characters. There appears some tensions during the curriculum implementation, for example the problem of exam emphasis, the ministry of education is trying to control such a reality, it is forbidden to hold national competition for students, it is obligation to reduce students’ homework, but on the same time, the way of university enrollment still remains the same as before. Details will be discussed more in the case study (Chapter 4).

Mathematics curriculum in France

Continued from the development of French mathematics education in section 1.1.1, this section mainly focuses on the French mathematics curriculum reforms, especially the current mathematics curriculum structure and changes (based on the new curriculum in 2016), and ends with a conclusion on the new curricular requirements to the French mathematics teachers.

The history of French curriculum reform is considered as tumultuous and sensitive to scientific, social and political tensions (Gueudet, Bueno-Ravel, Modeste, & Trouche 2017). It was also influenced by the international curricular reform trends, such as “Modern Maths” in 1970s. This section presents the crucial time points of French curricular reforms.

1802: Napoleon’s ordinance in December 1802 placed the importance of mathematics as Latin in secondary schools, “In placing mathematics at the same level as Latin in the male secondary curriculum, [this ordinance] took into account the new situation following the French Revolution, in which mathematics had become *a core aspect* of an intellectual education *combining theory and practice*” (Gispert 2014, p. 230)

1902: The French Parliament reasserted the importance of mathematics education in the new reform: “It was, for a time, the end of the monopoly on classical humanities by the *Lycées*, through the creation of a modern curriculum that was on par – at least in theory – with the classical curriculum. It also furthered the development of new disciplines such as the languages, sciences, and mathematics” (Gispert 2014, p. 233).

1950s: After the Second World War, under an intellectual and scientific pressure, and influenced by the Bourbaki group of mathematicians, the position of mathematics teaching was emphasized: “the new mathematics and its structures were recognized not only by mathematicians but even by scholars in other fields, in particular in the humanities, as a language and scientific tool that were essential for having access to any knowledge” (Gispert 2014, p. 236)”. This later led an international trend of deep reform of mathematics education, the so-called “modern mathematics”.

1980s: After the modern mathematics, the French math educators tried to find the balance between the systematic mathematics and the problems solving oriented mathematics. With considerable discussions, enlisting a large part of the society, the ambitious reform was abandoned but mathematics remains as “the decisive discipline discriminating between student academic orientations, a true subject of selection” (Gispert 2014, p. 237). Mathematics education since then started to go back to the activity-oriented teaching.

2002: The commission of CREM (National Commission for Reflection on the Teaching of Mathematics) was appointed in 1999 by the French Education Ministry, for rethinking mathematics teaching for facing the new century. In 2002, the report from CREM situated mathematics among the other sciences, and stated that “Mathematics is the most ancient science, whose values are the most permanent and stable.” (Kahane 2002).

2006: Since 2006, the common base of knowledge and skills for the compulsory school in France (from grade 1 to grade 9) was released. This reform aimed at fixing the tensions between disciplinary knowledge and competencies, and between “national perspectives” and “local effective practices”.

2012: With a mission of formulating answers to institutional questioning or to self-questioning, the higher council for teaching programs (Conseil Supérieur des Programmes, CSP) was created by the law of *re-grounding the republican school*. The team of CSP is composed of scholars, experts of educational issues, representative of the nation and the society. This is a turning point that the French curriculum program started to transfer from a tumultuous period of “each new government wants its own curriculum”, into a more stable professional period.

2014: The national syllabus was rethought to be designed in five domains: language, methods for learning, becoming a person and a citizen, natural and technique systems, representing human activities and the world.

2016: a newly proposed curriculum reform started since September 2016. There are three main changes in this new reform:

- (1) A statements form of the curriculum program. Firstly the new curriculum is not organized by discipline and individual grades anymore, but on the Common core state standards (2012), based on three-year cycles (e.g. program for cycle 3, which contains grade 4 to grade 6) (See Figure 1.2).

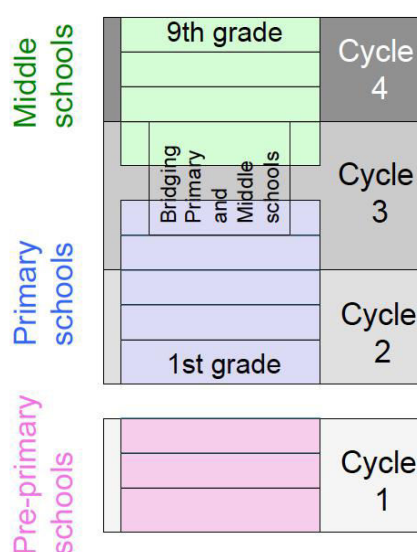


Figure 1.2. The structure of the program describing in cycle-based

Such a new organization is proposed for giving more flexibility for teachers because the learning process and needs of each student is different, and such a three-year statement could be more manageable, but on the other hand, teachers are also facing a confusion on what they should teach in their grade, thus “such a yearly division of the curriculum is very likely to be soon available on the Internet” (Gueudet et al. 2017, p. 49). Once in a middle school mathematics teacher training session, I talked to one of them, and the teachers said they were still using the old curriculum program (edition 2008) (to be re-discussed in Chapter 5).

(2) Using technology in Mathematics in Primary School.

Integrating new technology tools in mathematics classroom (from grade 1 to 6) is clearly written in the program, “numbers and calculation” and “space and geometry”. While in the old one, calculators are only mentioned as “concerned” tools since grade 3. The usage of calculator used to attract lots discussions and arguments in the topic of “mathematics learning and using technologies”, some teachers considered that the calculators and other technologies could damage students’ calculating skill, while others thought that a better design could be beneficial (Trouche 2016b) (will be discussed more in section 1.2.2).

(3) New content of algorithmic appeared first time in middle school teaching. Before 2016, algorithmic was only the teaching content in high school (grade 10-12) since 2009. The position of it was special: it must not be taught as a course chapter like functions, but should be integrated into other chapters. While in the new curriculum, it is suggested to start in grade 1 to 9.

Gueudet, Bueno-Ravel, Modeste, & Trouche (2017) considered such orientation was a sign of focus on language activities and programming, which would strongly influence mathematics teachers’ design on instructional activities (specific discussion will be continued in section 1.2.2 and Chapter 5).

(4) The interdisciplinary teaching practice. In the end of each cycle, there is a section with specific suggestions for making interdisciplinary teaching practice (in French, *enseignements pratiques interdisciplinaires*, EPI). Such practice is not compulsory, but is encouraged to be hold in schools. It needs the cooperation between teachers from different disciplines to develop new courses.

These are all challenges for the French mathematics teachers, on one hand, they are already used to work independently even in the same discipline, now they have to explore the potential ways of cooperating with teachers from the same discipline (for labor division within the cycle), and from different discipline (for EPI). Meanwhile, as what Gueudet et al. (2017) argued, these controversies demonstrated the need for teaching resources in a time of strong evolution on mathematics content, teaching environments and the frontiers of mathematics. But, for those who want more cooperation with others, the new curriculum provides a good chance.

1.1.3 Conclusion

The section 1.1 has presented the context information on mathematics, mathematics education and mathematics curriculum reforms, from the international level, in China and in France. The review on the history and development of the three issues provides both the different phenomenon between the two contexts, but also reveals the reasons behind these phenomenon, this is what we often say in comparative education, “through contrasting, we identify”.

A reform movement is a phenomenon that necessarily takes in the whole complex of students, teachers, researchers, parents, and politicians; it is motivated by societal, scientific, and technological needs, as well as by research in mathematics and general education, and it is

inescapably a phenomenon connected with values. It must take into account the social and historical nature of reform, its local and global aspects, its response to changing technologies and changing interests in mathematics and science (Fried & Amit 2016). This reminds the necessity of holding a cultural-historical view when seeing teacher's work (will be addressed more in section 2.3).

Both China and France are using a unique national curriculum program. The difference is Chinese curriculum reforms performs as more continuous and stable due to the single-party system, which allows a long-term (10 or 20 years) reform stable implementation possible; while the French curriculum has often to experienced changes almost each tenure of president, but the construction of higher council for teaching programs (CSP) could fix this swing reform conditions.

In both contexts, curriculum reforms are involved in the international reforms trends, and holding the remained influences. In China, there is a mixed influence from Soviet and United States, but since 2001, China has stepped into a period of keeping the international trends with the Chinese mathematics education traditions and advantages.

In both contexts, curricula are trying to adapt to the new requirements of the world and society, meanwhile proposing requirements to students and teachers. This is particular a case in integrating technologies and other available resources into mathematics teaching and learning. Meanwhile, the corresponding development of instructional resources, and supports for teacher training are also need to be considered urgently. Because “in order to teach conceptual mathematics, teachers need to learn concepts. In order to use technology effectively for mathematics, teachers need to learn to do mathematics using technology” (Shumway 1989, p. 288). In the two following section, these two issues, resource (1.2) and collective (1.3) will be addressed.

1.2 Supports for teachers' resource work

The previous section presents the context information from a view of mathematics curriculum; this section will address the context from the view of resources, specially the resource work conditions (supports and deficiency) for teachers. Four sections are included: the curricular aspect including textbooks, curriculum program and the accompanying materials (1.2.1), the instructional technology aspect including the Information and Communication Technology (ICT) resources, e-textbooks, the digital resources and online resources (1.2.2), the institutional supports for helping teachers in dealing and using resources, including teacher education and teacher training (1.2.3), then a conclusion on the similarities and differences by contrasting the two countries (1.2.4).

1.2.1 Curricular supports to teachers' resource work

This section presents the curricular supports from three aspects: textbooks, curriculum program and the accompanying materials available for teachers.

Curriculum resources were defined by Pepin and Gueudet (2018 online first) as “all mathematics resources that are developed and used by teachers and students in their interaction with mathematics in/for teaching and learning, inside and outside the classroom”. They also distinguished the resources into text resources (e.g. textbook, teacher curricular guidelines, websites, worksheets, syllabus, tests), other material resources (e.g. manipulatives, calculators), and Digital-/ICT-based curriculum resources (e.g. interactive e-textbooks). Inspired by this definition and resource category, this section presents a discussion mainly focus on the textbook, and also the available resources related to curriculum resource.

Textbooks, in China as well as in France, are a very crucial resource for mathematics teachers. A great dependence upon textbook is “perhaps more characteristic of the teaching of mathematics than any their subject” (Robitaille & Travers, 1992, p. 706). In China, the choice and usage of textbooks are controlled by the nation. Even though it was encouraged to use local curriculum and school-based curriculum, the percentage of such local resources is under a serious control. In October 2014, The Ministry of Education of People’s Republic of China issued the “(Temporary) Measurement for textbooks choice and management”. In 2015, the Ministry proposed that based on the thoroughly national investigation in the universities, the use of western textbooks should be controlled. In September 2018, the Ministry made a thoroughly national investigation in compulsory education stage, and proposed that “the primary and secondary schools should select the curriculum textbooks from those who had been examine and approved by the Ministry, and can not modify it without the permission of Ministry”, and “to maintain the authority and seriousness of the textbooks, it is forbidden to replacing the national curriculum textbooks with the school-based textbooks and overseas textbooks” (Beijing Youth Daily)³.

Along with the textbooks, the learning-aid materials market in China is very large, which provides many choices for teachers and students. Some schools with higher students performance were encouraged to develop their own school-based developed curriculum resources. School-based curriculum development (Wang 2009) is a product of the introduction of new basic education curriculum reforms in 2001, a result of school curriculum decentralization in which the government devolved some of the curriculum powers to the individual schools.

While in France, teachers have more choice in textbooks, because the publication of textbooks in France is a commercial activity. Due to the development of technology and economy, the French teachers have access to an abundance of online resources. Along with the new curriculum reform in 2016, the online resources for curriculum could be more enriched, since the development of online resources for teachers is largely encouraged by the state (Gueudet, Bueno-Ravel, Modeste & Trouche 2017).

France has also “a strong national instructional guidance, with a national curriculum complemented by additional commentary and advice published in ‘curriculum guides’. But the ministry does not control the textbook market, and a great variety of textbooks exists” (Gueudet & Trouche 2009, pp. 203-204). The mathematics curriculum is interpreted in different formats: curriculum program, accompanying resources and textbooks. The program generally starts with an introduction of general principles and objectives, and then gives details about four different domains (Functions, Geometry, Probability and Statistics). The content of each domain is in a table with three columns (content, expected skills, and comments). The accompanying resources are written by experts like inspectors or teacher educators, mainly aiming to support teachers in designing their lessons. But for most of the teachers, they do not seem to use these accompanying texts, due to the complexity, and the textbook authors find them useful and take almost all the examples of mathematical situations proposed in these resources and transformed them into accessible activities for students (Gueudet, Bueno-Ravel, Modeste, & Trouche 2017).

Conclusion

There are some similarities about the curriculum supports between China and France: in both countries, the curriculum program is organized, proposed and controlled by the nation,

³ Retrieved on 20th February 2018, <http://edu.people.com.cn/GB/n1/2018/0920/c1006-30303946.html>

textbooks are designed according to the curriculum program, and are considered as a critical resource for mathematics teachers. There are also several differences between them:

1. The number of textbook, in China, is limited (3 main ones) throughout the whole country, while in France, there are diverse choices;
2. The mode of publication and approval is more strictly controlled in China, and in France, the publication is free and decided by the market;
3. The option of textbooks for the teachers, in China it is decided by the city or province, while in France teachers and the schools can decide to use which kind of textbooks;
4. In China, teachers are more strictly required to follow the textbooks, while in France, teachers don't need to follow and they are encouraged to design.
5. The number of exercises in the Chinese textbook (a few) are less than in the French ones (hundreds), that infer perhaps the French teachers have to *select* exercises while the Chinese teachers have to look for *supplementary materials*, or/and to *design variations* of the textbook exercises.

Along with the development of technology and Internet, the curricular resources are also enriched in both form and contents. The following section will draw the technological supports for teachers' resource work.

1.2.2 Technological supports, digital resources and online resources

This section discusses the supports from the instructional technology level, including the digital, online resources and e-textbooks. Curriculum resource is different from instructional technology (like geometry software):

“Digital curriculum resources make use of these other types of tool and software: indeed, what differentiates them from pre-digital curriculum programs is that they are made accessible on electronic devices and that they often incorporate the dynamic features of digital technologies.” (Pepin, Choppin, Ruthven & Sinclair 2017, p. 647)

In this way, instructional technology can be considered as a technical resource, without the content of curriculum. However, sometimes, the contents and technology are involved together. This section will not draw their differences particularly, but the category of resources in academic field will be discussed in the end of section 2.3, and the category of resources by teachers will be explored in Chapter 4 and 5.

The technology supports for teachers' is sometimes driven by the requirements of the curriculum. As what Fried and Amit (2016) announced, technology is an unavoidable and welcome aspect of the modern world. There had been a large body of researches evidencing the necessity of adapting information and communication technologies into education and discipline teaching, such as calculators and computers in mathematics curriculum, to meet the new challenges of the information age (Trouche, Drijvers, Gueudet, & Sacristan 2013).

However, the world changes much quicker than the speed of research publication, new technologies and software and information was released every moment. The technique situation keeps changing. As Wong (2003) introduced, since late 1970s, with the invention of floppy disks, the popularization of desktop computers and the personal computers make technology shift from teaching aids to learning ones. Abundant Computer Assisted Learning (CAL) products were born in 1980s, including mathematics education games, which was distinguished by into “content games” and “process games” (Olds, Schwartz & Willie 1980); improved traditional teaching instrument with high-tech functions, such as the interactive whiteboard, projector, or whiteboard; software for graphing and spatial learning, such as Computer Assisted Design; algebra and mathematical word processors like the “formula editor” of micro soft word; dynamic geometry; pocket calculators. The use of these

productions has aroused many arguments in both the academic field and teachers' practice, especially the usage of dynamic geometry and calculator, which influences also teachers' decision in using technology or not (will be evidenced in Chapter 4). Besides the resources development, actually exam orientation has a great influence on technology use. At a certain time in Hong Kong, calculators were not allowed in public examinations for secondary school students, and for this reason, no calculators were used in mathematics classroom for learning and teaching (Fried & Amit 2016). Till now, digital tools are far from being an ordinary component of mathematics education (Trouche 2016b).

Pepin, Gueudet, Yerushalmy, Trouche, & Chazan 2015) used to distinguish the types of e-textbooks based on their development process and function: integrative e-textbook, evolving or "living" e-textbook, and the interactive e-textbook.

In France, the most representative e-textbook is Sésamath (also discussed in section 1.3.2). Sésamath is actually a mathematics teachers association, starting from 2001 to design online mathematics exercises, then mathematics e-textbooks, free for every visitor, no matter teachers, students, parents or researchers (<http://www.sesamath.net>). It offers a complete platform with sub sections for its users, for example, Sesaprof supporting teachers collaborative design work, and LaboMEP for organizing students' work (Gueudet, Pepin, Sabra, & Trouche 2016).). This e-textbook is interactive and living.

In China, efforts were also made, such as the "digital school bag projects" in 2010s (Zhu & Yu 2011) aiming at building a personal digital learning space for students combining e-Classroom, e-School, e-Home, e-Museum, e-library and e-Lab, where e-textbooks were involved. Due to the copyright and the cost, not each school is able to build or access to the ready digital school bags. There are some websites⁴ with free e-textbooks (in different versions from publishing houses) to download, but most of them are in pdf format, and just a digital version of the paper textbooks, the users can read, but not in any interactive way.

In our pilot study (see in section 3.1.3) conducted in February 2014, the three experienced teachers were still using QQ groups⁵ for exchange resources and information with colleagues inside and outside their school (Pepin et al. 2016). While in the case study, which started in November 2015, the teachers started to use WeChat⁶ group. What has been changed is not only the name of application. Both QQ and WeChat are products of Tencent, but WeChat gets more popular along with the popularization of smartphones, which makes the mobile office work possible. People can exchange resources anytime anywhere, and work on their cellphone. The popularization of QQ and WeChat is along with the mobile phone and mobile Internet (Wang 2006).

From the mid-1980s, the first generation of mobile was offered commercially based on an analogue system. Along with the cheaper handset and call prices, mobiles were more widely adopted, and became an important feature of technologically mediated communications. Mobiles could be associated with an individual person, and allowed people to make calls where they were able to find reception and network availability (Ling 2004). Then through 1990s, second generation mobiles were developed based on a digital standard with an extended range of features, such as storage of message and phone numbers, and call number display (Lindholm et al. 2003). In this period, text messaging was widely adopt since 1993,

⁴ One example of the website for downloading the textbooks (recommended by the teachers in the case study) <http://www.dzkbw.com>

⁵ More information on Tencent QQ on Wikipedia https://en.wikipedia.org/wiki/Tencent_QQ

⁶ WeChat is a Chinese social communication messaging app developed by Tencent, firstly released in 2011, and become one of the world's largest standalone mobile apps by monthly active users for its multi-functions, including group chatting and official accounts subscription. See more on <https://en.wikipedia.org/wiki/WeChat>

which brought another form of writing and text, electronic mail over the Internet (Goggin 2009). As what Katz (2004) predicated, tomorrow's mobile technology may be the perfect tutor in the local/global bio-machine that many futurologists anticipate. "In the years ahead, it is very likely that mobiles will take center stage for using Internet and online communications" (Goggin 2009, p. 65)

The use of WeChat in China in the working occasions is also a result of culture, which could be traced back to the Confucianism. In China, the social media is not only used among families and friends, but also used in business professionals to establish and maintain the relationship with their peers (Keith et al. 2016). Up to 2015, 90.7% of 1.29 billion mobile phone users have social-messaging applications, and WeChat was used to build and maintain these relationships (CINIC 2015). WeChat is considered as low anonymity, high privacy and closed community, which makes it as appropriate for developing social interactions.

Another factor influencing teachers' resource usage is the *quality* of resources. Teachers also count the cost of adapting resources. For those new technologies, teachers prefer not to touch if they think learning to use this technology is time consuming, and the effects might be not worth their time and efforts.

Conclusion

There are some similarities about the technological supports between China and France: in both countries, social medias are more and more used; e-textbooks and the online resources are encouraged to be explored and used.

There are also several differences between them:

- The technology equipment and balance for teachers. In China, teachers who work in the big cities in developed areas and the small towns in undeveloped areas have very different resource working conditions. In big cities like Shanghai, each teacher can have their own working space and computers. While in France there is not such much differences, as a developed country, the schools are generally equipped with computers connected to the Internet, and most of the teachers also have one or several computers at home.
- The digital curriculum resources: in France, the e-textbooks are richer and better designed than in China (taking the Sésamath textbook as an example, teachers are the designers of the textbook, and it is totally available online).

1.2.3 Institutional supports for teachers' resource work

Using technology for solving problems is a requirement for both students and teachers, or for learners when we consider teachers as lifelong learners. This section presents the requirements for teachers in technology usage, and the conditions of technology education, namely what have been prepared for teachers' using technologies in pre-service learning and in-service training, firstly from the trends of the world, and then in China vs. in France.

Technology is a requirement for mathematics teachers. In 2000, the National Council of Teachers of Mathematics (NCTM) released their *Principles and Standards for School Mathematics*, technology was cited as one of the six principles to guide mathematics teaching in the new millennium. Common core state standards for mathematics, which is considered as containing "varieties of expertise that mathematics educators at all levels should seek to develop in their students" (Common Core State Standards Initiative 2012, p. 6), the fifth requirement is "use appropriate tools strategically", the students are sufficiently familiar with tools appropriate to make sound decisions about when each of these tools might be helpful,

recognizing both the insight to be gained and their limitations, they need to know the technologies helpful for their teaching.

Learning environments have changed significantly in the past decades, highly due to the inclusion of emerging ICT (Information and Communication Technology, ICT), both hardware and software. Since 1990s, the education literature was flourishing and was excited to report on capabilities and advantages of integrating technology in education, and the promise of making education available at anyplace, anytime, anywhere (Tucker & Morris 2011). Since then, ICT has been increasingly strengthening its position as a vital component of both learning and teaching, which effectively led to new and enhanced mode of learning (e.g. e-learning, MOOCs, mobile-learning), various technologies have been used to enhance and assist learning experiences.

After the concept of lifelong learning was proposed (Department of Education Science 2000), teachers' in-service learning calls attention. For the learners, technology and mobile applications have been their primary source of information, knowledge, and social discourse. However, on the side of the classroom, a vast majority still bear a very close resemblance to that of the past: lecture format, long hours, text-heavy, in-authentic assessment, and rote-based learning: the positive attitude that ICT could contribute to relevant and effective learning outcomes is still hold by the mainstream section, such as UNESCO (United Nations Educational, Scientific and Cultural Organization, UNESCO) (Singh, & Hassan 2017).

However, there are also the voices with doubts on the value of ICT. What is driving the development of technology education is technology, not education anymore (Wu 2017). Toyama (2011) proposed four ideas to state that "there are no technology shortcuts to good education": (1) The history of electronic technologies in schools is fraught with failures; (2) Computers are no exception, and rigorous studies show that it is incredibly difficult to have positive educational impact with computers. Technology at best only amplifies the pedagogical capacity of educational systems; it can make good schools better, but it makes bad schools worse; (3) Technology has a huge opportunity cost in the form of more effective non-technology interventions. (4) Many good school systems excel without much technology.

In China, for the bachelor study of normal university students (such as mathematics education), the first year they will learn general basic knowledge and skills for computer work, such as making PPT slides, mainly via Microsoft applications. While in the third year of their study, they will be arranged some courses for learning the software for mathematics teaching, such as GeoGebra. The question is, in the teacher enrollment, not all mathematics teachers are graduated from mathematics education, some of them may come from mathematics application, or physics etc. The different areas have different levels of requirements, taking the Shanghai city teacher recruitment (for 2019)⁷ as example, to apply a position of mathematics teacher in primary and secondary school, the native applicants of Shanghai can apply with a bachelor diploma, while the non-native applicants need to have a master diploma, the requirement of major is "relevant", either mathematics or mathematics education, no matter which major the employee did in his/her bachelor study. That is to say, probably the teacher was not major in mathematics education and received nothing about using technology for teaching mathematics. In 2004, the Ministry of Education in China published the "standards of education technology competence for primary and secondary teachers" (Ministry of Education of People's Republic of China 2004), aiming at building a national network for in-service teacher training on education technology competencies. Although it required adapting one standard for the whole country, it also encouraged adjusting the measures to local conditions especially in the central and western regions (He 2005). This

⁷ <http://www.shehr.cn/home/cn/index.php?akm=main&aka=display&id=1012556>

makes it possible that the courses for in-service teacher training vary a lot in different regions and depend largely on the level of economic development. For example, in Shanghai, teachers can receive training on how to integrate Ipad to classroom teaching (for example the digital school bag introduced in section 1.2.2), while for the teachers from less developed cities, they might just start to use computer and projector in classroom teaching.

Since 2013, the national examination for teacher qualification had been established (Chen & Yu 2015), the examinations has no special requirements in technology multiplication. But there is another aspect for the Chinese teachers to accumulate resources, not relying too much on technological ways. In Chinese schools, students are organized by age into grades, and study three core subjects: the Chinese language, the English language, and mathematics. Unless the West, Chinese students form class cohorts that stay together in the same classroom throughout the day, visited by their various teachers. Most of the Chinese teachers that teach the core subjects generally only teach one subject two or three times a day, and they are all full time service teachers in school. This allows the Chinese students be taught with one set of teachers during their whole middle school study, and meanwhile for the teachers, resource accumulation can be conducted in a more material way.

While in France, as introduced in the French mathematics education and curriculum reforms in section 1.1, France is one of the first states to modernize its educational system. The ten years' Revolution witnessed the process of replacing the old Collèges with the Ecoles Centrales. Mathematics started to play an important role in the new schools. However, there was no systematic and coherent education for the mathematics teachers, they were mixed: some of them were from the old Collèges, some of them attended the lectures given by the Ecoles Centrales. Then after the Restauration, these schools were replaced by lycées, and the future mathematics teachers could only learn mathematics in their final grades (Schubring 1988). In France, till now, to become a mathematics teacher, the "concours"⁸, a very competitive examination, is still the only way. The students need to prepare this exam after their third year of bachelor study.

As discussed in 1.2.2, the new curriculum reform needs and encourages more resources to be developed, and

"The teachers are more expected to act as designers of the mathematics courses, including new computer science and interdisciplinary aspects. At the same time, little in service teacher education is offered." (Gueudet, Bueno-Ravel, Modeste & Trouche 2017, p. 65)

Too many choices is no choice. There is now nearly unlimited access to resources online, teachers are often at a loss to choose the most didactically and qualitatively suitable resources for their mathematics teaching. Hence, the study of resources and mathematics teachers' interaction/work with those resources has become a prominent field of research (e.g. Pepin, Gueudet, & Trouche 2012), not least because curriculum reforms in many countries go through the provision of reform oriented curriculum materials that are seen to help teachers enact the curriculum suitably and aligned with the reforms.

This provides a chance for the research on seeing teacher expertise: when teachers meet new situations with challenges that need them to act with conscious, their expertise started to work (see more discussion in section 2.1).

⁸ The national exam for public school teachers recruitment, see on website from the Education Ministry on <https://www.fonction-publique.gouv.fr/score/concours>

Conclusion

There are some similarities about the technological supports between China and France: In both countries, technology use is closely linked to teachers' technology using habits, no matter professional software for mathematics teaching like GeoGebra (mentioned by both the Chinese teachers and French teachers in the following case studies in Chapter 4 and Chapter 5), or some general software for supporting their teaching, either for teachers' personal resource management habits (such as the Dropbox⁹ used by teachers in the French case, Chapter 5), or for their social communication (such as WeChat for the teachers in the Chinese case, § 1.2.2).

There are also several differences between them: the technology equipment and balance for teachers. In China, teachers who work in the big cities in developed areas and the small towns in undeveloped areas have very different resource working conditions. In big cities like Shanghai, each teacher can have his/her own working space and computers. While in France there is not such much differences, as a developed country, the schools are generally equipped with computers connected to the Internet, and most of the teachers also have one or several computers at home.

1.2.4 Conclusion

This section presents the supports for teachers' resource work in each context from the curricular, technological and institutional aspects.

For the curricular supports, both contexts adapt the national curriculum program with accompany materials and textbooks designed for interpreting the national program, but the choice, the exercises quantity, the role of textbooks are different for teachers due to the differences of textbook publication and approval mode, the position of textbook and the expected roles of teachers in implementing the textbooks.

For the technological supports, both contexts have the mathematics teaching software, the e-textbook and diverse online teaching resources, but as for the quality, the French online resources (especially the e-textbooks) are globally better organized than the Chinese ones; the difference on technological equipment condition is larger in China from different regions than in France, which makes the diverse competency level in technology usage among Chinese teachers.

For the institutional supports, both contexts have the national system for teacher education and teacher qualification. But the French teacher education system and teacher certification system was built since 1980s, and the Chinese started after 1990s till now. This makes diverse qualification levels of teachers with different ages and service years.

1.3 Supports for teachers' collective work

This section presents the context information for teacher's work from a collective aspect: the cultural origin for teachers' collective work and the institutional supports or obligation for teacher's collective work. The whole section contains: a subsection for Chinese collective working culture and Teaching Research Group (TRG) system (1.3.1), a subsection for French individual working culture and collective working environments like Associated educational

⁹ Dropbox is a file hosting service operated by the American company Dropbox, offering cloud storage, file synchronization, personal cloud and client software. It can create a special folder on the user's computer, and the contents can be synchronized to Dropbox servers and to other computers and devices where the user has installed Dropbox, keeping the same files up-to-date on all devices. See more on https://www.dropbox.com/zh_CN/

Places (AeP) (1.3.2), and finally a conclusion on the similarities/differences on teachers' collective working by contrasting the two contexts.

Collective work is not only a beneficial mechanism for teachers' professional development, but also an important resource (Pepin, Gueudet, & Trouche 2013a). Cooperation among teachers is considered as a crucial dimension for teacher's professional development (Hargreaves 1995; Cui & Zheng 2008), because the cooperation with other teachers cannot only improve the individual's teaching, but also long-term teacher's professional development (Williams, Prestage, & Bedward 2001; Lavié 2006). Besides the considerations on the benefits from collective to teachers, it is also considered as an important resource for mathematics teachers. As what Pepin and Gueudet (2018, online first) admitted, there existed other "nonmaterial" resources used by teachers for their resource work, such as social resources (e.g. direct and/or web-based conversations with colleagues) and cognitive resources (e.g. conceptual frames that are used in professional development sessions to develop some competencies). The specific usage needs specific case study; the following sections will discuss it mainly from general institutional levels.

1.3.1 Collective working culture and TRG in China

This section focuses on the Chinese collective working contexts (Wang 2015, 2017) from four parts: what are the Teaching Research Groups (TRG)? What are the cultural and institutional supports for TRG? Where does TRG come and how it is developed? What activities are there in TRG?

What are the Teaching Research Groups (TRG)?

With the frequent good performance of Chinese students achieved in several international tests, Chinese mathematics education has attracted much attention from the world. Compared with teachers in developed countries, Chinese mathematics teachers lagged far away in terms of academic qualifications. As a national survey (Ding 2010) about teacher professional development in primary and secondary schools showed, among the huge quantity of teachers, only 0.8% of Chinese teachers have a master degree, while in United States, it is 50% (Wang 2013a), 55.7% of the teachers have university diploma, but only 17.3% of them have the bachelor degree, which means almost 2/3 teachers gain their university diploma via in-service training but not formal and full-time higher education. Although after having received compensatory education and achieved higher academic credentials, Chinese mathematics teachers still lag behind their counterparts in developed countries in terms of academic qualifications. However, several studies showed that, Chinese teachers' good performances are quite close with some efficient school-based means (An, Kulm, & Wu 2004; Li & Huang 2013). They gain a deep understanding of basic mathematics through the activities of Teaching Research Group (TRG), which help them obtain practice knowledge and achieve in-service professional development (Yang, Li, Gao, & Xu 2013). "A Teaching Research Group is an organization to study teaching. It is not an administrative department. Its task is to organize teachers to do teaching research...to improve the quality of education, but no to deal with administrative affairs." (Ministry of Education of People's Republic of China 1957). This collective has been evidenced as an essential source for teachers developing their expertise, even for experienced teachers (Pepin, Xu, Trouche & Wang 2016).

What are the cultural and institutional supports for TRG?

In East Asian region, including China, it is believed that all teachers can teach if they are properly trained and guided (Lee 1998), which is quite similar to the Chinese ideas in an old saying goes "diligence can remedy mediocrity" (勤能补拙, qín néng bǔ zhuó). Working collectively, in China, is a culture, which can be traced back to Confucius: "Whenever

walking in a company of several persons, there among them must be someone worth learning from” (“三人行，sān rén xíng, 必有我师,bì yǒu wǒ shī). From the view of culture, the school level working culture in China has been described as collective (Yang 2014).

TRG could also be considered as a result of the influence of the former Soviet Union, which was based on the common model, with an emphasis on enhancing school-based teachers’ professional development through collective effort (Lin 2008). In the western countries, the prototype of the teacher is a person with individual responsibility to teach a number of classes (Winslow 2012), culturally to see, Chinese teachers welcome visitors to their classrooms, and they regard it as an honor to present an open class (Wang 2013a), working collectively has been described as a working culture and atmosphere in China; while institutionally to analysis, Chinese students form class cohorts that stay together in the same classroom throughout the day, visited by their various teachers, since most of the Chinese teachers of mathematics, Chinese or English teach only one subject twice or three times a day, these core-subject teachers easily organize into subject-specific TRGs. A mathematical TRG therefore exists in every school. Figure 1.3 shows the structure of current teaching research system. In 1956, Teaching Research Office started to be established at the district/county, city, and provincial/municipal levels under the corresponding government education departments (Lin 2008; Yang & Ricks 2013). TRG is a basic unit for teachers’ activities. In most middle schools, especially large-size ones, Lesson Preparation Group (LPG, see following section) appears as sub-organization of TRG, in which teachers can study the curriculum materials, make lesson plans together and share teaching experiences (Yang & Ricks 2013).

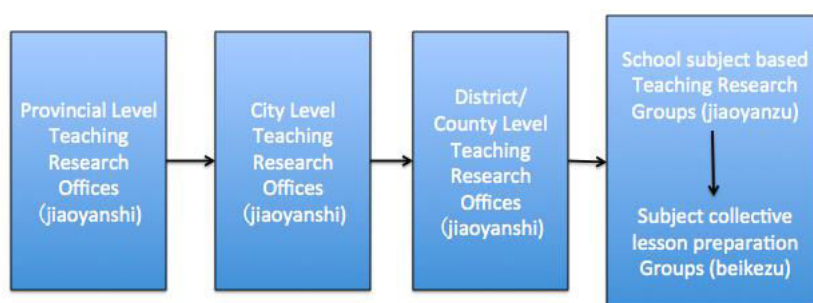


Figure 1.3. Structure of teaching research system in Mainland China

The main functions of this teaching research system is to help education department at the various levels to enact relevant policy documents, organize seminars for teachers from the district to learn the curriculum framework and teaching syllabus, to study teaching material and teaching methods, and to exchange teaching experiences. What’s more, the TRGs also organize regular subject-based teaching contest, which are well-organized formal professional activities (Huang, Peng, Wang, & Li 2010), for in-service teachers and novice teachers, providing them a “concentrated opportunity to learn” and a chance to work on “basic teaching skills” (Paine, Fang & Wilson 2003).

Where does TRG come and how it is developed?

Chinese educational system was influenced greatly by Soviets since 1950. The word of “TRG” was firstly announced in 1952, “teaching research groups should be set up in all subjects in secondary schools”, with the duty of “to study and improve the way of teaching”, cultivating large amount of teachers to meet the demand of rebuilding schools after wars. As the rule-books emphasized by the China ministry of Education (Ministry of Education of People’s Republic of China, 1957), TRG is not an administrative department, the leader of TRG is not an administrative responsible, and the task of TRG is organizing teachers to do teaching research, and improving the quality of education. But the property of TGR has

remained arguable for a long time: due to the unbalanced development of schools and teachers in different regions in China, TRG was actually being set in a condition which has very limited resources to set up such a professional principle-based teaching and research organization. At the beginning of People's Republic of China, in many primary schools, one teacher in charge of several classes or grades was a quite a frequent phenomenon. So the TRGs always shared responsibilities for some administration work. With the rapid development of the population after 1990, especially in large cities, TRG began to be much more formal and normative. Since TRG is a basic unit for teachers' collective work, once a teacher start to work in a school, she will belong to a specific TRG in the discipline she teaches. As the division of labor subdivided, within each TRG, specific groups named "Lesson Preparation Groups" which consist of teachers from the same discipline in the same grade, focus more on affairs about daily teaching. Meanwhile, the administrative works of TRG begin to be moved to "Grades Group", which contains all teachers come from the same grade. Grades Group born as an administrative organization, and Head teacher Committee which was formed by the head teachers who are in charge of classroom management work also spared some trivial stuffs from TRG. Figure 1.4 shows the school administrative structure since 1980s.

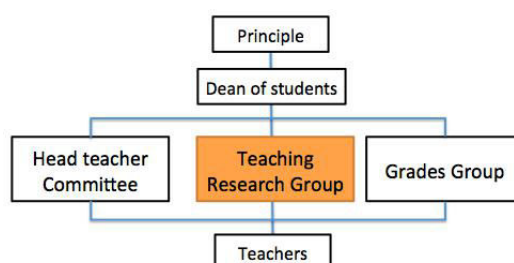


Figure 1.4. Structure of the school administrative graph since 1980s

From the 1980s, a trade that teachers from primary and secondary schools participate in education research raised throughout China. The education administration department built a set of education research management system, including a management procedure of "selecting topics, proposal, project approval, medium-term inspection, final project report, expert review and education research achievements evaluation" (Chen 2006).

Since 1990's curriculum reform, TRG began to the responsibility of carrying out post-1990 curriculum reform, "Teaching research units of schools need to center on the basic education curriculum reform, fill its functions of researching, guiding, and serving " (Ministry of Education of the People's Republic of China 1990).

In 2001, "the TRG at all levels should actively participate in editing textbooks and conducting teaching experiments of basic educational reform, to learn from other nation's experience, and to promote the excellent experience on teaching in basic educational reform" (State Council, 2001). By encouraged to participate into the curriculum reforms, the work of TRG slowly gained the research part. But most of the school-based TRGs still focus on school-based teaching research activities and serve as China's conduit for helping teachers to efficiently implement educational reform (Yang & Ricks 2013). During 1990s to 2000s, school-based TRGs focused on school-based teaching research activities and serves as China's conduit for helping teachers to efficiently implement educational reform.

In 2003, the Basic Education Division of Ministry of Education start a program called "School-based Study" to improve the traditional research and engaging the teachers into curriculum reforms. From 2004, with the selection and guidance of the program's Expert Group (formed with participation from 30 provincial education research centers and 16 normal universities), the first 84 school-based study sites were approved and specific program

plans were made. During the following years, the number of school-based study sites greatly increased with, at all levels, the supports of TROs (Teaching Research Office, instance of the local Department of education). TROs are hosting Teaching Research Officers, who are generally considered as part of the teacher developing mentors (Gu 2017): they instruct the teachers and many of them are selected from the experienced teachers from the schools. Since then, the School-based Study program has been promoted all over the country, and a more formal, professional relationship between schools and universities formed (Wang & Gu 2007).

Originally envisioned as a collaborative means to improve teaching, the School-based TRG System has gradually evolved over its history into a powerful school based form of professional development for implementing curriculum reform (Yang 2009). The new approach of the school-based TRG system has greatly influenced traditional TRG activities in recent years.

What activities are there in TRG?

Up to now, the main jobs of TRG can be separated into two parts: the regular work as before, including knowledge and professional learning, collective lesson preparation and Chinese lesson study; and the various education research projects and studies. In detail, the current school-based study activities include: (1) helping teachers move from skill-based lecturing pedagogies to a more cultural, ecological pedagogy; (2) shifting attention from textbooks and traditional instruction approaches to teacher-student interaction and verifying student learning in the classrooms; (3) creating a learning atmosphere in the classroom instead of preparing for examinations with routine lesson activities; and (4) promoting collaboration beyond sharing teaching experience to emphasizing new study ideas and methods (Yang 2009).

- **Collective lesson preparation and open class**

Lesson preparation generally infers that teachers prepare lessons individually. Due to the historical reasons, collective lesson preparation appeared in order to make advanced teachers mentor those teachers who need help. In this way, collective lesson preparation, to some extent, improves communications and exchanges among experienced teachers and novices, which is considered as a core activity in TRG. Open class appeared to be example lessons in 1950s, namely teachers give lessons in public, aiming to provide models for teacher students or in-service teachers. When adding the parts of evaluation and comments on lessons after class, open class becomes a lesson study, which contains giving lessons, lesson observation and lesson discussion seminar after class.

- **Research projects and special topics seminars**

According to the documents in 1957, TRG was set as a teacher collective learning organization to improve teaching quality, which has very few “research” elements. The exchanges and communications among teachers mainly based on teaching experiences, which relies much on individual feels and shortage of subjective evaluation standards and theoretical reflections. Since 1990s, impacted by the trends of the new curriculum and education researches, research projects demand teachers to summarize some ideas or value orientation from their teaching experiences, conduct the project in an established research procedure which demands for theories to guide the research process and support the research results, and meanwhile instructed, supervised and motivated by the research management institutes, the whole process “at least, providing teachers some training in research” (Chen 2006).

The operation mode of TRG in China was influenced deeply by the Soviet Union. The activities in TRG can be sorted into two types: task-based activities and diagnosis-based activities.

Task-based activities hold a main part of TRG activities, such as collective lesson preparation and open class, which contains “tasks assigning - preparing separately - combining collectively - tasks accomplish”, as shown below in Figure 1.5 (Hu & Wang 2014). Most of task-based activities are presented through a set of teaching management methods, which means although there are some study and discussion elements, task-based activities turn to be more administrative and instructional. Accomplishing tasks collectively is the main advantage, as well as the arguable part, of task-based activity. It focuses on the tasks and objects, but ignores the individual ideas and preparations.

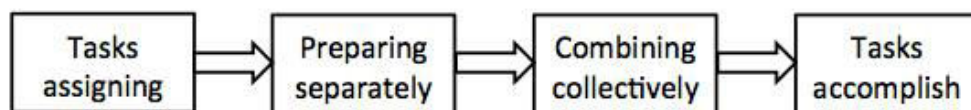


Figure 1.5 Operation mode of task-based activity

Diagnose-based activities are not so widespread in TRG practice, but it is quite beneficial for teacher teaching practice. “Diagnose” comes from the medicine field, focusing on specific problems. The procedure can be seen in figure 1.6.

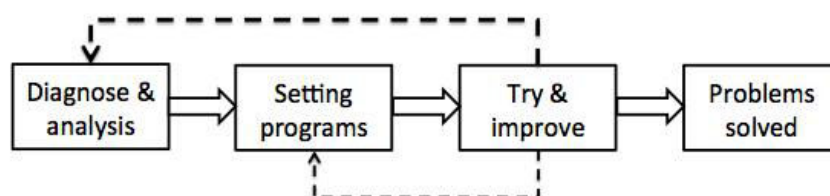


Figure 1.6. Operation mode of diagnose-based activity

• MOKE

MOKE (磨课, mó kè) activity can be considered as a typical diagnose-based operation mode activity. The detailed process of MOKE is: (1) a teacher communicates in TRG about a problem rising from her teaching practice; (2) with the help of colleagues, the teacher gets the preliminary problem solving programs; (3) the teacher applies the program into reality; (4) with the carried out results, the teacher reports and discusses with his colleagues again; (5) they diagnose the result and make a new improved program; (6) the teacher carries out the new programs in practice... There is no ending until the problem solved. During the process of diagnose-based activities, what TRG focuses most are the problems raising from teaching, the object is finding the reasons and the methods for the problem, and getting reflective ideas in the end (further case will be presented in section 4.3).

This section presents the Chinese collective working conditions. With an influence of collective benefit philosophy, Chinese people hold a collective working culture, which makes them working collectively in a regular way. Meanwhile, for the teachers, the school-based TRG system makes collective working as a compulsory work, which is closely related to their working performance, evaluation and promotion. Such a collective working system and mode is considered as beneficial to both novices and experienced, question about “how” to benefit should be addressed within case study in Chapter 4. Next section will present the conditions in France.

1.3.2 Pedagogy freedom and AeP at FIE in France

This section presents the collective working context for mathematics teachers in France. Four parts are addressed: firstly the ordinary conditions a teachers’ collective work in France; secondly a specific national mathematics collective network, IREM and its structure; thirdly

an online collaboration working team, Sésamath; and then the Associated education places to the French Institute of Education, which shares some similarities with TRG.

The ordinary conditions of teachers' collective work in France

In France, teachers have the freedom of teaching ('la liberté de l'enseignement'), which means that compared with the Chinese teachers, they are not obligated to work collectively, that means: no rooms, no time, dedicated to teachers' collective work in schools. Actually seeing from the various unions in France, the French (including French teachers) emphasize the force and power from collectives. In the field of education, the origin of teachers' collective work could be traced back to 1990s. As the French Dictionary of Pedagogy (Buisson 1911) saying: "Teaching is collaborating." Even if there is no specific prescription and no specific means, when considering in depth the ordinary work of French teachers, the collective dimension appears clearly as important when interacting with resources (Gueudet, Pepin & Trouche 2013). And it is all the more true if we consider the advanced settings developed for teacher education (Gueudet & Trouche 2011). Regarding mathematics education, the IREM network constitutes also an advanced example of teachers' collective work.

IREM (Institute for research on mathematics teaching)

The IREM (Institute of Research in Mathematics Education) network, consisted by researchers and mathematics teachers (from primary schools to university level) working for mathematics education, was existing since 1968. Before IREM, there was APMEP (Association des professeurs de Mathématiques de l'Enseignement Public) (The association of Mathematics Public School Teachers), which was born in 1910. It is considered (Trouche 2016a) that the born of IREM is the result of a social movement, a result of social pressure, with the continuous efforts of APMEP, by asking budgets for creating the following IREM step by step.

The creation of IREM could be traced back to the Modern Math Reform period (see in section 1.1.2), for constituting new institutes for mathematics education. Different from APMEP, it is a network of institutes in each university. The local IREM is generally associated with schools and institutes for teacher education, which makes it as "an incubator for a new field of research" (Trouche 2016a, p. 229). IREM gathers different level teachers, make researches arose from teachers' practice, and build the close links between the academic world and schools, classes, and the teachers.

This working mode of IREM is considered as an exceptional conjunction of phenomenon and leads the emergence of French didactics of mathematics with some French specificity: among all disciplines, there exist an association like IREM only in mathematics; both the scale and diversity of members are remarkable; what's more, the mathematical Bourbaki context where IREM was born make it more theoretical structured (Trouche 2016a).

Sésamath

Another specificity in the field of mathematics education, Sésamath arose in the thread of digitalization, at the beginning of the XXIe century. Already introduced in section 1.2.3), it will be addressed here in a teacher collective perspective.

Created since 2001, Sésamath is an association of mathematics teachers in France. Members of this association are mainly secondary school teachers. The initial aim of Sésamath was to design and publish free resources for mathematics teaching and learning. They have a website (<http://www.sesamath.net>) with "more than 15 million hits each year, around 20, 000 teachers

subscribe to the teachers' websites, Sesaprof, and more than 1 million students are subscribe to LaboMEP" (Gueudet, Pepin, Sabra, & Trouche 2016).

For the teachers' part, Sésamath involves (only) teachers to design the resources. The Sésamath association creates a platform for teacher to contribute to the re-design of each existing and widely used e-textbook. Different from the common digital version textbooks, Sésamath is lived: it is interactive, and enriched continuously. The creation is a collective design on the textbook and related teaching resources through platforms or other digital means, via Skype meetings, or emails, and also the regular face-to-face discussion. As Gueudet, Pepin, Sabra and Trouche (2016) introduced, the initial plan of Sésamath team is to build a toolkit with the help of the new technologies. The toolkit contains the multiple different pathways for the specific topic area, but the results show that not all pathways are relevant, teachers had their own conviction on what should be learnt and taught. "The way these (selected structures) were put together in the learning trajectory/ies were nevertheless shaped by the teachers' didactical understandings of learning" (Pepin, Choppin, Ruthven & Sinclair 2017, p. 654).

AeP at FIE in France

Not specific for mathematics education, is the AeP network associated to FIE¹⁰. AeP stands for "Associated educational Place" (in French, "Lieux d'éducation Associés", LéA). It is a network of schools, each of them being associated to a team of research on education. FIE works as a "hub" between the schools and research institutes, to gain resources and better understanding from the interactions among the teachers and the researchers. Started since 2011, AeP is created for conducting collaborative researches for teaching practice problems raised by teachers. As what stated on the website¹¹:

"Theses places created to meet educative challenges gather a set of conditions: questions raising from actors supported by the place managing staff (school directors, local authorities...), involvement of an FIE research team and joint construction by all the actors of a long-term project designed to find answers to these questions."

As a structure, AeP is coordinated by a scientific committee (for developing this network and calling for research projects) and a management team (for interacting with other educational partners such as Ministry of Education, Ministry of Agriculture, local authorities...).

To become a member of AeP, the school needs to have a project gathering three conditions: to be strongly carried by a team of teachers; to be strongly supported by its administrative staff; and to meet the interest of a team of research (Chabanne, Monod-Ansaldi & Loisy 2015). Once the school, named middle school A for example, becomes a member of AeP, its name inside this network will be changed into "AeP A". On the website of AeP, each institution (member) has its own space where the specific information is shared, including the main events of AeP, and the collaborative work of the corresponding school.

On the side of schools, the network covers the primary schools, network of primary schools, lower and upper secondary schools, vocational and agricultural upper schools, networks gathering lower and upper secondary schools dedicated to different research issues, for example, mathematics teaching, reflective thinking, education games etc.

On the side of research teams, AeP is open for the involvements of institutions (in France or abroad) for the collaboration on teacher education, or education issues of higher education,

¹⁰ FIE stands for the French Institute of Education (Institute Français de l'Éducation, IFÉ in French).

¹¹ <http://ife.ens-lyon.fr/lea>

and non-academic associations, such as cultural or scientific associations or associations for health education.

The researches conducted in AeP pay a great attention on the collective aspects of learning and teaching process, and correspond a metamorphosis of educational research. Sharing experiences, designing common tools, making educational experiments are crucial aspects of the program. Besides the experimental field, it also raises new questions for education research, on method level and foundation level: what is learning/teaching, how does the individual and social part going during the process of learning/teaching?

As a formal program, there are two seminars held each year in AeP: a national conference in spring (generally in May), and the other one in autumn (generally in November). The seminars in autumn are mainly dedicated for a better integration of new members, thus the topics presented during these seminars are mainly about the research experiences of the specific projects being conducted. As for the national conference, it is open to any educational actors, with an aim of disseminating the resources, tools and research results produced by AeP. The topics presented in these annual conferences pay an attention on the global view of the network on a more academic level.

To summarize, seeing from the three organizations, IREM, Sésamath and AeP at FIE in France, some characters could be identified. The French teacher associations are not a top-down construction action lead by the state, but some results pushed by the needs of research institutes and teachers, this makes the format of teacher collective work diverse and rich. Secondly, the French teachers work collectively in a more flexible working way by profiting the digital and online technologies. Lastly, some associations may lead by the research institutes (IREM), some conducted only by teachers (APMEP and Sésamath), some are coordinated by research institutes between school teachers and pure research teams (AeP at FIE). Compared this with the Chinese TRG, which has a strong institution-led, The French teachers have more freedom to choose, that is to say, for those who want to join in collectives, there are rich possibilities, but for those who prefer not, there is no obligation, all these may lead to a differentiation on teacher development. Behind the phenomenon, there are the reasons of culture (such as the collective working philosophy), the reason of history (such as the social movements making the born of IREM), and the reason of technology development (such as the online resources construction, and people's technology usage habits). All these need to be discussed in specific case studies in Chapter 4 and 5.

1.3.3 Conclusion

This section presents the collective working supports for teachers' work from the cultural influences and institutional view. In both contexts, collective work for teachers is emphasized from a professional development consideration, and nowadays, different institutional systems and collectives are prepared for supporting teachers' collective work, and the cooperation between schools and research institutes/universities (the affiliated schools in China, and the AeP at FIE network in France) is encouraged and built since long time. But the cultural orientation and the way of running the collective institutions are very different, which also indeed influence teachers' collective working. The French teachers hold their pedagogy freedom, and critical thinking, in this way they have the non profit teacher organization (APMEP) working like a labor union, for giving out the voices and appealing of teachers, they have the research institute (IREM) organized by university involving school teachers cooperation. While the Chinese teachers share the cultural value of collective working, and under the influences from the ex Soviet Union, they have the school-based collective working organization (TRG and LPG) within a teaching research system, where regular collective working is compulsive.

1.4 Research questions and the practical values expected

This section comes back to the research questions that this research wants to address. In the previous three sections, the requirements for teachers were seen from the background of mathematics education and curriculum reforms (1.1), the conditions of teachers' working with resources (1.2) and working with resources (1.3), were reviewed. The research interest of this research is: in such a transition context, how teachers will react and what expertise can be evidenced from their interactions with resources? How teachers get professional development through their resource work in collectives? And what lessons can be learnt if crossing the two contexts?

There is a common belief among practitioners that academic studies are irrelevant for educational practice (Bromme & Tillema 1995). Teacher expertise takes different forms in different cultures and teachers' working conditions have a powerful influence on the development of their expertise (Berliner 2004). Therefore, teaching expertise and the conception of expert teacher are not universal, but culturally and contextually dependent (Berliner 2001). As a country with more than five thousand years of history, education in China has its own characteristics and traditions (Gu 2001, 2006).

No matter China (with a population of about 1.4 billion) or France (with a population about 67 million), they both have their own characters in educational issues, with unique advantages and hurdles or challenges. Thus a mutual understanding could not only offer a chance to learn the experiences from each other, but it is also the precondition for international exchange and cooperation.

China and France share a common interest for mathematics and mathematics education, and for developing education and then teacher education. The conditions of teachers' collective work are quite different in the two sides. Then we could expect some results from contrasting the two situations.

After setting the terrain, we need now to set our theoretical background allowing us to develop our research.

Chapter 2 Literature review and theoretical frameworks

This chapter is dedicated to design a conceptual framework to support the exploration of mathematics teachers' expertise in interacting with resources (which will be named as documentation expertise). It is structured in five sections: Section 2.1 reviews the literature on expertise, teacher expertise and the links with teacher's resource work in the mathematics education field; Section 2.2 presents our main theoretical framework, the so called Documentational Approach to Didactics; Section 2.3 presents the second theoretical framework Cultural-historical Activity Theory and how this research benefits from these two theoretical frameworks; Section 2.4 introduces a first conceptual framework of Documentation Expertise (DE) based on the literature review, and the research questions with the structure of the whole thesis.

2.1 Teacher expertise and its links to teachers' resource work

This section aims at presenting the literature review on teacher expertise, and the position of resource work in teachers' expertise development, in four sections: the concept of general expertise and the ways for studying it (2.1.1); teacher expertise in mathematics education (2.1.2); teacher's resource work and its links to teacher expertise (2.1.3); teachers' collective work and its function in teacher expertise development (2.1.4).

2.1.1 The concept of expertise

Expertise is a key research field in cognitive psychology and cognitive science. The study of teaching expertise is considered as drawing from the studies of expertise in other professions (Tsui 2003). In this way, before starting teacher expertise (2.1.2), this section shall review on the existing studies on expertise in a general level, from its definition, origin and development, the approaches for studying it, and the frequently results, followed by some questions reflecting on this PhD research.

Expertise is often defined along with the notion of expert, for referring to the characteristics, skill and knowledge that distinguish experts from the masses (Ericsson 2006a). In the Webster's New World Dictionary (1968), expert was described as "one who is very skillful and well-informed in some special field" (p. 168). When we mention expertise, there appear several synonyms like literacy, capacity, competence, skill, ability or proficiency. According to the online Oxford Dictionary, literacy is "competence or knowledge in a specific area", while the competence is defined as "the ability to do something successfully or efficiently", then ability means "possession of the means or skill to do something", or "talent, skill, or proficiency in a particular area", then the proficiency refers "a high degree of skill" or "expertise", and finally the definition of skill comes back to "the ability to do something well" or "expertise".

Seeing from the notions as well as their definitions above, expertise holds the meaning of "expert skill or knowledge in a particular field". Researchers choose their own preference to name the expertise or related terms, but seldom researches try or succeed to distinguish the differences among the terms. In some researches in education field, these terms were mixed used, for example, the researches on Pedagogical Design Capacity or Instructional Capacity (to be discussed more in section 2.4), the capacity is inferred as more than a function of the knowledge that teachers have, but as their ability to accomplish new things with that knowledge (Ball & Cohen 1999), it is an individual teacher's ability (Brown 2002), or an area

of knowledge and ability (Remillard 2005). In this research, I choose the term of expertise instead of the terms discussed above, there are the considerations on the nature of expertise and the nature of teachers' work, especially their work with resources (see more in section 2.1.2).

The history of research on expertise is short. The study on expertise was initiated earlier, in the field of chess playing in 1960s due to the development in Artificial Intelligence (AI) and cognitive psychology (Chi, Glaser, & Farr 1988). While "the topic of expertise first appears in major textbooks in cognitive psychology in 1985, in John Anderson's second edition of *Cognitive Psychology and Its Implications*" (Glaser & Chi 1988, p. xvii). The comparison between the strong chess players and weak ones showed that the stronger are able to recognize and reproduce large patterns quickly and accurately, rather than search more deeply or broadly (de Groot 1965; Chase & Simon 1973), and specialized structures of knowledge maybe strongly implicated, but the nature of the knowledge and of its interactions with general heuristic processes required further studies (Chi, Glaser, & Farr 1988). Then in 1970s, studies on experts start from chess playing to other fields like medicine, law, radiology (e.g. Dreyfus & Dreyfus 1988), nursing (e.g. Benner 1984), physics problem solving (e.g. Chi, Feltovich & Glaser 1981), dance skills (Solso & Dallop 1995) or music appreciation and performance (Sloboda 1991). The researches on expertise start to nail down into "specific area" in different professions.

The studies on expertise mainly concern three aspects (Tsui 2003): the characteristics of experts' performances; the critical features that distinguish experts from the non-experts; and how to acquire and maintain the expertise. The approaches to study expertise, especially for the first two aspects were categorized by Chi (2006) into "absolute approach" and "relative approach".

Absolute approach: Who are experts and how do they excel?

The "absolute approach" is a way to choose some truly exceptional people (so called experts) with the goal of understanding how they perform in their domain of expertise, which can be called absolute expertise.

In his later work, Chi (2011) divided the studies with absolute approach on expertise into four further types: (1) studies describing how experts went about making their discoveries through studying their *notes or diaries*, trying to capture the circumstance where their discovery was made and how their cognitive processed; (2) studies looking at the societal and environmental conditions that may lead to their superiority (Lehman 1953); (3) studies investigating their cognitive structure with an assumption that greatness may lead by some innate talent of mental capacity (Simonton 1977), such as larger memory capacity (Pascual-Leone 1978); (4) studies looking at how exceptional individuals perform in the tasks they excel.

There remain some risks in the absolute approach.

On the one hand, studying expertise from the "exceptional individuals" means there is a tacit assumption: these individuals have some greater minds, or to say the "global qualities of their thinking" might be different (Minsky & Papert 1974, p. 59). However, in some fields, genetic inheritance does seem to be a relevant component for expertise, such as someone naturally endowed with greater memory capacity (Pascual-Leone 1970), some greatness or creativity may arises from chance and unique innate talent in music and sports (Simonton 1977).

On the other hand, how to identify the experts out of the masses needs to be solved by the studies that use the "absolute approach", which is quite problematic. Chi (2006) summarized three methods to figure out the experts: one is retrospective, determining an expert or non-expert by looking at his/her outcomes or products, such as how often his/her music was

broadcast for an expert composer (Kozbelt 2004); a second method is concurrent measure, such as rating system in the tournaments results like chess (Elo 1965), or examinations (Masunaga & Horn 2000); a third method is using some available independent index, such as the time it takes to complete some specific tasks. However, there still remain problems even if there are some performance indicators to figure out the experts, for example, how to prove that these measurements exactly reveal the expertise we want to investigate? Then, if we succeed in selecting the individual experts, how to finger out the expertise from their performance? Here comes the second relative approach by making comparisons.

A relative approach: What differs experts from non-experts?

The “relative approach” consists in studying the experts with respect to the novices. This relative approach holds an assumption that expertise is a level of proficiency and it can be archived by hard working of the novices. Along with this assumption, the experts are often defined as the more knowledgeable group, and from novice to expert, there exist several generic notions referring to the non-experts, represented by the five stages from novice, advanced beginners, competent, proficient to expert (Dreyfus & Dreyfus 1988). The proficiency level can be more fine-grained further is necessary, assessed by measures like academic qualifications, seniority or years performing the task, consensus among peers, or some domain-specific knowledge or performance tests (Chi 2006).

The studies using the “relative” approach can be less precise about how to identify expertise, since experts are defined as relative to novices on a continuum. These studies can describe and identify the ways in which experts excel, and help us to understand how experts became that way so that we can learn to become more skilled and knowledgeable. But the problem is: do experts always excel better than novices in every aspect? Most of the research has focus on how the experts excel, but “knowing both how they excel and how they fail will provide a more complete characterization of expertise” (Chi 2006, p. 23), he generated seven manifestations of experts’ skills and shortcomings (see Table 2.1)

Table 2.1. Manifestations of experts’ skills and shortcomings (adapted from Chi 2006)

Seven ways in which experts excel	Seven ways in which experts fall short
1. Be more opportunistic in using available resources and sources of information when solving problems (Gilhooly et al. 1997).	1. Expertise is restricted to a specific domain.
2. Be better at choosing appropriate strategies, not only better for a situation, but also be more likely to use those have been more frequently proved to be effective (Lemaire & Siegler 1995).	2. Within the domain of expertise, experts rely on contextual cues. Exemplified by diagnosis in medical domain (Feltovich & Barrows 1984), tacit enabling conditions of a situation like age, sex, previous diseases, occupation, drug use are information that experts use to find their patients’ problems (Hobus, Schmidt, Boshuizen, & Patel 1987).
3. Spend more time in analyzing problems qualitatively, developing problem representations, balancing with the domain-specific and general constrains (Simon & Simon 1978).	3. Overly confident in judgments related to their expertise field (Oskamp 1965).
4. Can detect and see features that novices cannot, perceive the “deep structure” of a problem or situation (Chi, Feltovich, & Glaser 1981).	4. Bias and functional fixedness, which could be seen as a mindset box of greater domain knowledge.
	5. Glossing over, and fail to recall the surface features and overlook concrete

5. Can generate the best solutions, and success faster and more accurately (Klein 1993).	6. Inflexible when their familiar contexts change, even research (Hatano & Inagaki 1986) claims that experts adaptive. Exemplified by the Brazilian street mathematics (Schliemann & Carraher 1993).
6. Have more accurate self-monitoring skills in detecting errors and their own comprehension, such as judging the difficulty of a problem in physics domain (Chi, Glaser, & Rees 1982), predicting accurately their following moves, for better entire position control in chess domain (Chi 1978).	7. Inaccurate prediction and judgment when the experts predict the novices' performance, which could cause the fail in taking the novices' perspectives accurately. Exemplified by students are far more able to incorporate feedbacks from their peers than from their expert instructors (Cho 2004)
7. Less cognitive efforts in retrieving relevant domain knowledge and strategies (Alexander 2003), executing skills automatically (Schneider 1985), controlling their performances (Ericsson 2006b).	

The manifestations listed could be more than seven if studies involved more domains or professions in depth. Gathering the features of experts' performances is still on a descriptive level that maybe an endless work, and it is hard to enter the question on how to acquire expertise. Then what is the nature of expertise?

The nature of expertise and the way to acquire it

No matter using an absolute approach or a relative approach, there are three divergences on what is expertise and how to acquire it, exemplified by the work of Dreyfus and Dreyfus (1988), Glaser and Chi (1988), Bereiter and Scardamalia (1993) and Sosniak (2006).

To go against the proposition, from the field of artificial intelligence, that intelligent practice is the mere application of knowledge and rules to instrumental decision-making, Dreyfus and Dreyfus (1988) proposed that the core of human expertise is "knowing how", but not "knowing that":

"Human understanding was a skill akin to knowing how to find one's way about the world, rather than knowing a lot of facets and rules for relating them. Our basic understanding was thus a knowing how rather than a knowing that." (Dreyfus & Dreyfus 1988, p. 4)

For them, expertise is (1) embedded in expert's action rather than in a body of propositional knowledge that can be separated from action, which echoes Schön's (1983) "tacit knowing-in-action" (p. 49); expertise is (2) automatic and non reflective, because experts are so skilled that conscious deliberation is no need for decision-making or problem solving, they just do what normally works based on their working experience, because the expertise is already part of them. Experts engage in conscious work only when the situation is novel, or the decisions are important and the time is enough; expertise is (3) intuition, experiential and tacit which cannot be articulated (Polanyi 1966), marked by effortless and fluid performance guided by intuition (knowing how), which is gained through years of experience. Their second idea of "conscious deliberation" and "analytical thinking" only occurs conditionally reminds me that, even when studying the work of expert teachers, it is necessary to pay attention on the types of teachers' specific tasks and the situations. The experience is undoubtedly a crucial factor to

acquire expertise, but it does not necessarily result in acquiring and developing expertise. Experience only contributes when the practitioners are capable of learning from it. This echoes the idea of Bereiter and Scardamalia (1993) that comparing experts with novices cannot help in identifying expertise, but with experienced non-experts can, and what differs experts from novices is the combination of highly motivated learning and the ability to reflect on experience (Berliner 1994).

Different from this “intuition (knowing how) and tacit knowledge” view, Chi and his colleagues (Glaser & Chi 1988; Chi 2006) teased expertise as a thought of cognitive psychological process of the mind: expertise is consist by different skills in processing (see the list in the left column of Table 2.1), with a hard work to do (conscious deliberation) with the structurally organized knowledge base. This knowledge-base view entails three fundamental theoretical assumptions (Chi 2006): the experts are people with more knowledge in a domain (Ericsson & Smith 1991; Hoffman 1998), and this knowledge is well organized or structured (Bedard & Chi 1992); between experts and non-experts, the fundamental capacities and domain-general reasoning abilities are identical; the different performance between experts and non-experts are determined by the differences of how their knowledge is represented. The differences between experts and non-experts are much related to their fast access to the related knowledge (Chase & Simon 1973; Ericsson & Smith 1991). This knowledge, either of conceptual or procedural, can be acquired with “superior monitoring and self-regulation skills” (Glaser & Chi 1988, p. xxi).

Besides, the view of Glaser and Chi (ibid.) proposed the importance of conscious deliberation (including self-monitoring and self-regulation), which was emphasized by Eraut (1994) as the ability to cope with difficult or ill-defined problems, and “the essence of professional expertise” (p. 152). Tsui (2003) considers this as a conflict on expertise should be “automatic and non reflective” or be “conscious deliberation” with reflection.

I do not think there exists conflict: Dreyfus and Dreyfus (1988) was using “automatic and non reflection” to describe the working state of experts, while Glaser and Chi were proposing “conscious deliberation” as the way to acquire the expertise. But when turning back to the profession of teaching: About the approaches in studying teacher expertise, do we face the same problems as the general human expertise in other professions? About the way of cultivating expertise, are the suggestions in developing general expertise also beneficial in developing teaching expertise? About the performance characters of expert teachers, are they always better than the non-experts? Are there any qualities that are extraordinary innate gift (nature) that is considered to be an expertise can be achieved by incredibly hard working (nurture)?

Besides the absolute and relative approaches Chi (2006) discussed above, there was a third consideration of taking the expertise not as the characters or states of expert teachers, but a process from novice to experts.

As something specific to a domain, Berliner (1988) and Bereiter and Scardamalia (1993) consider expertise as “more a process than a state” (p. 161), they argue that comparing experts with novices is not a good way to address expertise, and suggest to compare the experts with the experienced non-experts, because *experience is not expertise*. They also point out that the abundant comparative studies show what expertise are like and the importance to work hard, but do not tell how to obtain it in details. They regard the development and maintenance of expertise also as a process in which experts continuously reinvest their resources, freed up by the acquisition of relevant knowledge through experience, in problematizing what is taken as routine, in reformulating problems and in solving them. This “process” perspective provides a view out of the two approaches discussed above by Chi: expertise is not a static state, but

something that the experts need to keep extending the upper edge of their competence by seeking themselves high standards and working hard for researching these standards. Like Sosniak (2006) said, “expertise is not an endpoint, it is a continuum” (p. 300).

This section presents the general human expertise from its origin and development, to the approaches to study it, and the discussions on the nature of expertise in some main researches. Meanwhile some reflections on the approaches were also made, including the criteria of choosing the object (expert), and the problems to be considered. I spend more than seven pages on these discussions, but it is necessary for preparing the following sections on teacher expertise (2.1.2) and the methodology issue is discussed further in depth in chapter 3. As the expertise in teaching profession, teacher expertise may share the common questions and draw insights from these discussions above.

In this PhD research, I would not discuss the boundary to distinguish the difference between expert (teachers) and ‘ordinary’ teachers; I would not either use only the interview (by what they say as the questions), or part of their actions (by observing some activities). But in a long-term follow up, with diverse methods that I can “see” their work, such as their group chatting messages, their emails, their collective activities and different meetings, as well as what they write like articles or some reflection reports. I also care their oral expressions, because how they named their resources in a different way as the researchers or the academic fields could reveal some invisible information, such as their attitude towards the resources and how they use it (see more development in Chapter 3 about methodological design).

2.1.2 Expertise in teacher education

This section presents mainly the researches on expertise in the field of teacher education, especially in mathematics teacher education, within five issues: the nature of teacher expertise; the characteristics of expert teachers; the issue of time; expertise as tacit professional knowledge in action; expertise and professional development stages.

The research of expertise is considered as a crucial aspect in teacher education, because learning directly from expert teachers is one popular approach used in practice to improve the quality of classroom instruction (Li, Huang, & Yang 2011), and such researches provide several things for us, such as the benchmark against less successful teaching by comparing with those non-experts, the information about teacher education programs design, the models of successful teaching for the novice teachers who may have lots difficulties, the route of novice teachers pass through as they acquire new knowledge and skills, and also the complexity of teaching (Tsui 2003).

The nature of teacher expertise: contextualized

As a branch of human expertise, teacher expertise shares the nature of it: “expertise is considered to be highly contextualized” (Berliner 1988, p. 6), the label ‘expert’ is value laden, and “judgments of expertise are culture-bound” (Schoenfeld 2011, p. 328). The criteria of expert teachers and the nature of teacher expertise need to be investigated in specific cultural contexts and education systems (Li & Kaiser 2011). This echoes Berliner’s (1988) idea that expertise “may not transfer from situation to situation very well” (p. 12), because new settings/contextes will demand teachers’ working hard to maintain their expertise (Bullough & Baughman 1995).

This reminds me that between China and France, I should pay an attention on the value orientation from culture and society on education, teaching profession and the roles of teachers. It is different to study the expertise and expert in Chinese context and in western context (such as France in this research). In China, expert teachers are officially conferred and socially recognized with teaching taken as a professional practice, and it is open to public

scrutiny and discussion (Li & Li 2009), while in the West, teaching is even not subject to public scrutiny (Kaiser & Vollstedt 2008). As discussed in section 1.3, Chinese teachers are involved strictly in a school-based teaching research system. Teachers' work accomplishment needs various examinations and assessments, and is formally acknowledged by rank and title according to several indicators, such as teaching experiences, teaching performance, teaching research outcomes, and levels of instructional leadership (Li, Huang, Bao & Fan 2011). While in France, teachers have more freedom in organizing their work, and do not have to join the collective activities or cooperative projects, or pass diverse competitions and examinations (see more details in section 1.3). In this way, it is unnecessary and unpractical to try to investigate a universal list of teacher expertise in this research, because one teacher performance may be considered as a kind of teacher expertise in one context maybe not in the other context, such as doing educational researches for being a Chinese expert teachers (Yang 2014), is not necessary in the French context.

Expertise is not owned only by expert teachers

How to identify expert teachers if it is hard to identify experts? As a question continued on the dilemma in identifying expert teachers out of non-experts discussed in section 2.1.1, there is an assumption that only through experts we can find the expertise. Since expertise is a process (Bereiter & Scardamalia 1993; Sternberg & Horvath 1995) and continuum (Sosniak 2006), teaching expertise should not only owned by expert teachers, but the discussions on how to identify an expert teacher still provide some information on the performance/achievement or the necessary condition for acquiring expertise.

There are several discussions on how do expert teachers show their expertise. Expert teachers have 'extensive pedagogical content knowledge, including deep representations of subject matter knowledge'; 'better adaptation and modification of goals for diverse learners and better skills for improvisation'; 'better perception of classroom events and better ability to read from cues from students'; and 'better monitoring of learning and providing feedback to students'. Perhaps more importantly, Berliner claims that in his research he found evidence that those identified as experts were able to increase students' learning skills and test scores (beyond that of non-experts) (Berliner 2004). Experts are "not consciously choosing what to attend to and what to do, they are acting effortlessly and fluidly, behaving in ways that are not easily described as deductive or analytic. "...When things are going smoothly, experts rarely appear to be reflective about their performance" (Berliner 1988, p. 12). For Ropo, "a person is an expert because he or she seems to understand the requirements of the situation better and is able to fit his/her own decision, action and interaction into the context" (2004, p. 163). However, using a sentence to define expertise or expert is far less difficult than investigating the complex categories and standards to distinguish it, thus, studies on teacher expertise are blooming.

Sternberg and Horvath (1995) proposed to take expertise as a prototypical concept, bounding "together by the family resemblance that expert bear to one another" (p. 16). They proposed "teaching expertise be viewed as a similarity-based category with something like a prototype as its summary representation" (p. 9), and as "a category that is structured by the similarity of expert teachers to one another rather than by a set of necessary and sufficient features" (p. 9). Yang adapt this prototype approach in studying the prototype of Chinese Mathematics expert teacher, he convinced that a prototype can represent the central tendency of all the exemplars in its category and can serve as a basis for judgments about category membership (Yang 2014, p. 13).

Identifying experts is problematic (Chi 2006, 2011), identifying expert teachers is more problematic, because unraveling what distinguishes an expert from a no expert teacher is very

difficult, and there is no commonly accepted criteria or methods for identifying expert teachers (Leinhardt 1990; Tsui 2003), and sometimes the terms of experienced teacher and expert teacher are interchangeably (Peterson & Comeaux 1987). Tsui (2003) generated some criterion for identifying experts (see table 2.2):

Table 2.2 Criterion for identifying expert teachers (adapted from Tsui 2003)

A review on the criteria cited in research studies

-
1. Teaching experiences (usually more than 5 years) (e.g. Peterson & Comaux 1987).
 2. Nominations or recommendations from school administrators (principles or the school district board) (e.g. Saberts et al. 1991), or supervisors and peers (e.g. Leinhardt, Putnam, Stein, & Baxter 1991).
 3. Students' academic achievement (Leinhardt & Greeno 1986; Yang 2014), for example, students' scores in the top 15% of the school for at least three years in the past five years (Tsui 2003).
 4. Have a master's degree (e.g. Swanson, O'Connor, & Cooney 1990)
 5. The roles that the teachers are playing, such as the cooperating teacher by universities, or reputation like mentor-teacher by the school district boards, (e.g. Westernman 1991).
 6. Rewarded or some honorary titles by outsides such as the state.
-

No criterion is without problems. Is experience proportional to expertise? How do the related judges make nominations and recommendations, what indicators do they refer to and are these indicators reliable (Olson 1992)? What about their personal preference and variation? If we use students' academic achievement, then is that the only representation of effective teaching (Shulman 1992) and what about the conditions of students? If we use teachers' diploma like master degree or doctoral degree, then is research competency directly indicating the level of teaching competence? If we use the awarded honors or titles, there will be the same problem like the nominations from the principles, or worse, because the judges are often from outside, namely untrained, inexperienced, and from professions other than teaching (Berliner 1986). Teaching performance is often linked with students' testing scores and recommendations of local educators or administrations such as the principle of the school. As discussed in the previous, identifying expertise is influenced by the context orientation. In different cultures or societies, the criteria for judging teaching expertise or identifying an expert teacher may vary. For example, in a very examination-oriented education system may take students' score in examinations as an important criterion for identifying expert teachers and teachers' expertise (Tsui 2003). Yang's study (2014) on Chinese expert teachers showed that an expert teacher in China needed also to be an expert in exams.

In this way, many researches trying to seek for what constitutes expertise in teaching tried to combine the criteria. This will also adapt such a combination method in the case choice (see more in Chapter 3, section 3.2). As a case study with two contextual cases, this PhD research is not aiming at finding a uniform standard or model for expertise in all contexts, but tries to tell two stories in different contexts, and show how they offer some possible suggestions that we can learn from these teachers. Three issues are coming in the following parts, the relationship between teaching experience and teacher expertise; the teacher expertise and the knowledge components; and the stages of teacher expertise in teacher professional development.

Time does not necessarily lead to either experience nor teacher expertise

As discussed in section 2.1.1, experience is the crucial factor for acquiring expertise, but needs deliberated conscious with practice and reflection (Glaser & Chi 1988), and the teacher expertise is considered as a kind of knowledge base (ibid) of “knowing how” (Dreyfus & Dreyfus 1988).

Long working time and long working experience is not the same thing. The term of “experience” and “expertise” shared the same root word, and an experienced person was usually considered with “a form of knowledge that was beyond that possessed by ordinary individuals” (Berliner 1994, p. 141), or “a person who is very knowledgeable about or skillful in a particular area”. Also, for Berliner (1988), “what looks to be so easy for the expert and so clumsy for the novice is the result of thousands of hours of experience and reflection”, which emphasized two factors: experience and reflection. Reflection is a key affiliated nature that decides whether experience must lead to expertise. Long teaching experience does not lead to high teaching expertise, even though distinguishing the two is difficult (Berliner, Stein, Sabers, Clarridge, Cushing, & Pinnegar 1988), and probably the growth of some teachers’ expertise stalled despite their continuing to accumulate teaching experience, till they retire (Berliner 1988). In the studies about expert teachers, the service year diverse a lot: “more than 5 years of teaching experience”(Carter, Cushing, Sabers, Stein, & Berliner 1988); “at least 7 years of classroom experience, including 3 years or more in the subject s/he now taught” (Moallem 1998); “at least 10 years of teaching experience” (Li, Huang & Yang 2011); “an average of 12.6 years teaching experience” (Lin 1999); or “at least 15 years of teaching” (Lian 2004, 2008). “The points of beginning teaching is the accumulation of experience...From that experience comes the ability to understand what individual differences look and feel like in the classroom, how creative lessons interact with other instructional goals, and how level of processing can be inferred from classroom cues” (Berliner 1988, p. 27).

“Experiences seems to change people so that they literally ‘see’ differently...In any domain of expertise one must learn through experience, perhaps thousands of hours of experience, what is worth attending to, particularly because of the severe biological limits humans have for processing information” (ibid, p. 24).

For the experts, they hold richer personal references, namely the events from their personal experiences can be recalled and brought to bear on the problems that they face, which allows experts make more assumptions, hypothesis, and predictions than others (ibid). The duration of time spent in a stage can be expected to vary widely, because “the more important question is whether the stages make sense, rather than whether the trip from novice to expert takes two years or five.” (ibid. p. 21).

For Berliner (1988), from novice (students and beginning first-year teachers) to advanced beginners, it took *often* 2-3 years’ teaching experience, then “if they have any talent and motivation whatsoever”, about 3-4 years, advanced beginners *may* become competent: “I am convinced that this stage of development can be achieved by the *vast majority* of graduates of our teacher training colleges.” (p. 8). While from competent to proficient, it takes *perhaps* around 5 years, and happens on *a modest number* of teachers. From proficient to the highest stage, expert, there are only few members can achieved. To summary, the different adverbs in italic fonts like “often”, “may”, “perhaps” reveals at least two facts: expert is few; *becoming an expert takes time, but not decided by time.*

Expertise as a kind of practical, tacit profession knowledge in action

“We can know more than we can tell” (Polanyi 1966, p. 4). The researches on expertise/knowledge experience a process of “divorcing” and “being together”. As discussed

in section 2.1.1, expertise is considered as “knowing how” and a kind of tacit knowledge (Dreyfus & Dreyfus 1988), but Ryle (1949) used to remind that distinction between these two knowing is a misconstruction of the nature of knowledge. Actually “knowing how” is not an application of “knowing that”. The intellectual and the practical kinds of knowledge do not exist independent of each other (Ryle 1949). Knowledge of theory cannot be established until it has been used to interpret experience, and true knowledge lies in the ability of using it (Polanyi 1966). Knowing and action are not two separate things but ones, knowing is in the action itself, knowing in action is intuitive and automatic (Schön 1983). Teachers’ action is informed by theory rather than divorced from it, and teacher knowledge is a function of teachers; response to the situation, which is oriented to a particular practical context and social context, and is highly experiential and personal (Elbaz 1983):

“This knowledge encompasses first hand experience of students’ learning styles, interests, needs, strengths and difficulties, and a repertoire of instructional techniques and classroom managements skills. The teacher knows the social structure of the school and what it requires, of teacher and student, for survival and for success; she knows the community of which he school is a part, and has a sense of what it will and will not accept. This experiential knowledge is informed by the teacher is theoretical knowledge of subject matter, and of areas such as child development, learning and social theory. All of this kind of knowledge, as integrated by the individual teacher in terms of personal values and beliefs and as oriented to her practical situation, will be referred to as ‘practical knowledge’ ” (1983, p. 5).

Along with Elbaz, Clandinin proposed also teacher knowledge as personal practical knowledge:

“It is knowledge that reflects the individual’s prior knowledge and acknowledges the contextual nature of that teacher’s knowledge. It is a kind of knowledge carved out of, and shaped by, situations; knowledge that is constructed and reconstructed as we live our stories and retell and rely them through processes of reflection” (1992, p. 125).

This idea was restated by Clandinin (2013) in his later work:

“This knowledge is neither theoretical, in the sense of learning, teaching, and curriculum, nor merely practical, in the sense of knowing children... A teacher’s practical knowledge is composed of both kinds of knowledge, blended by the personal background and characteristics of the teacher, and expressed by her in particular situations.” (Clandinin 2013, p. 67)

The practical knowledge view of Elbaz gives some components which could be a component of teacher expertise, which is also discussed in Shulman’s (1986) content knowledge category (see Table 2.3).

Table 2.3 Categories of teacher knowledge from Elbaz vs. Shulman

Elbaz (1983)’s five knowledge categories	Shulman and his colleagues’ seven knowledge category (Shulman 1986; Wilson, Shulman, & Richert 1987)
Knowledge of subject matter, including the teaching contents and theories for teaching and learning;	Subject matter content knowledge, including the knowledge of the content of a subject discipline, namely the major facts and concepts in the discipline and their relationship (Grossman 1990);
Knowledge of the curriculum, including the curriculum content and the students’ learning	Pedagogical content knowledge, including the representation of a subject to make it comprehensible to students, what makes a topic easy or hard for students,

<p>experiences;</p> <p>Knowledge of instruction, including the classroom routines and management, and students' condition;</p> <p>Knowledge of milieu of schoolings, including the social structure of the school and requirements or expectations from school and the surrounding communities;</p> <p>Knowledge of self, including the teacher's own characteristics like values, goals, attitude and habits etc.</p>	<p>what their preconceptions and misconceptions are, and what schemes can be effective to deal with these difficulties;</p> <p>Curricular knowledge, including the knowledge about the curriculum program and available materials designed for teaching;</p> <p>General pedagogical knowledge, namely the knowledge of principles and skills of teaching and learning that are generally shared by all subjects;</p> <p>Knowledge of educational aims, goals, and purposes;</p> <p>Knowledge of learners, including knowledge of learners' characteristics and cognition, their learning development and motivation;</p> <p>Knowledge of other content, namely the scope of the subject that they are teaching.</p>
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The skill of classroom management and knowledge on students are crucial for achieving the expected teaching results, which of course rely on several factors. For example, does there exist model lessons designed well, and with this, novice teachers can make excellent lesson? The answer perhaps is no. Before this, teachers and students need to get familiar with each other. In Berliner (1988), for experts, "my expectations when a kid comes into my classroom for math is that he has pencils and paper ready at all times because I make them take notes... they (the students who were not familiar for this teacher) have practice problems. And this is a kind of tough 'cause I don't know what was the routine these kids were used to." (Berliner 1988, p. 20)

For some good high schools in China, those graduates with diploma of pure mathematics or graduated from mathematics departments are more popular than those majored in mathematics education or graduated from teacher education schools. Berliner (1988) warned that "those who come into education through an alternative certification route... do not possess much pedagogical knowledge. The content knowledge that they possess will not help them much, particularly with hard-to-teach students or in tough teaching assignments." (p. 26)

The conception of reflective practice Schön (1983) provides a way of acquiring expertise: reflect-on-action, and reflect-in-action. Reflect-on-action often takes place in preparation work and on the practitioners' experiences. Reflect-in-action happens during the action, when the practitioners encounter situations that require their deliberate reflection.

Expertise and professional development stages

Expertise is assumed to have different states in teachers' professional development. In the field of teacher professional development, expert teacher was deemed as the final stage. The development of expertise in pedagogy (Berliner 1988) was built based on the general model of expertise by the philosopher Hubert Dreyfus and the computer scientist Stuart Dreyfus (Dreyfus & Dreyfus 1988).

Berliner (2004) proposed a heuristic five-stage model of teacher expertise development, and explained the characters of each stage:

- Novice stage (e.g. student teachers or first year teachers): "the behavior of the novice is usually rational, relatively inflexible, and tends to conform to whatever rules and procedures s/he was told to follow" (p. 206). The behavior of the novice is rational,

relatively inflexible, and tends to conform to whatever rules and procedures they were told to follow;

- Advanced beginner stage (e.g. 2nd & 3rd year teachers): they typically have “(practical knowledge) ... that is action-oriented knowledge and ... is generally acquired without direct help from others, ... ‘wisdom of practice’ (p. 206);
- Competent stage (3-5 years of teaching): they typically are “competent performers in their domain of interest”; they make “conscious choices about what they are going to do”, and they can “determine what is/is not important” (p. 207), in short they make rational choices based on their experience. Competent have rational goals and choose sensible means for reaching them, and they can determine what is and what is not important;
- Proficient stage (after ca. 5 years of teaching): This is the stage at which intuition and know-how become prominent and they have a “residue of experience (p. 207);
- Expert stage: “Expert teachers engage in performance in a qualitatively different way than do novice or competent performers” (p. 207);

Early training might better concentrate on (a) perceptual training-teaching the novice to see what teacher educators believes is important for later development; and (b) identifying instances of concepts-teaching the novice to classify things that teacher educators consider important for understanding what occurs when one is a classroom teacher (Berliner, 1988, p. 27). Teachers need to make efforts to maintain their levels of expertise. For individuals, if the situation changes, then some persons belonging to one stage may show characters of another stage (Berliner 1988).

Compare with the western partners, China emphasizes also the moral quality of teachers very much, which brings a personal attributes color on the idea prototype of Chinese expert teachers. Yang (2014) proposed the characters of expert mathematics teachers through deep interview, and he found that there are at least three dimensions of expert teachers (with varying nuances): knowledge; skills/abilities; and personal attributes (p. 31). In his final findings, the roles of an expert mathematics teacher should be perceived to play are: a researcher (to be able to conduct research and publish papers); a teacher educator (to be able to mentor (non-expert) teachers and help them to develop professionally); a scholar: to have a broad and profound knowledge base in mathematics, pedagogy knowledge and curriculum theories; an expert in examinations: to be able to develop questions/problems according to the curriculum; and an exemplary model for students and colleagues (to have a ‘noble personality’). This provides a “perfect” one with the sum of almost each good ability and quality. However, the special features of mathematics expert teachers are seldom discussed more precisely in most of the Chinese related literature.

Schoenfeld (1985) developed what proficiency in mathematical problem solving might consist of. Kilpatrick et al. (2001) offered a characterization of the dimensions of proficiency in school mathematics (conceptual understanding; procedural fluency; strategic competence; adaptive reasoning; and productive disposition). Then Schoenfeld and Kilpatrick (2008) appropriately modified their dimensions and developed a (provisional) framework for ‘proficiency in teaching mathematics’ (p. 2), with the following seven strands: knowing school mathematics in depth; knowing students as thinkers; knowing students as learners; crafting and managing learning environments; developing classroom norms and supporting classroom discourse as part of “teaching for understanding”; building relationships that support learning; reflecting on one’s practice.

About the factors for supporting the teacher professional development were also addressed to the social context. Teacher professional development is not only an individual issue. The growth of expertise also involved in a social-context, because the “cooperation” needs among teachers, and the social process offers the contexts support and constraints of teacher professional development.

This section presented teacher expertise and teacher knowledge based on the general human expertise discussed in section 2.1.1, teacher expertise is a practical knowledge, and teaching experience does not necessarily lead to expertise development, which followed by teacher professional development stages. Teachers’ specific expertise in working with resource is discussed in the next section.

2.1.3 Teacher expertise and teacher resource work

As proposed in both the introduction and the end of Chapter 1, the aim of this research is to see through teacher expertise in their resource work. Thus in this section, the discussion will focus on: In the existing researches, what expertise on teacher resource working has been revealed? Which phases of teacher resource work will be paid attention?

From Information literacy to expertise in teacher resource work

Teachers’ work from information literacy, a concept closely related to “resource”, teachers’ resource work environment and the necessity for studying their documentation work. Educational digital technology will not be effective without the effective teachers’ use of it (Alqahtani 2018).

Information literacy was firstly raised by Paul Zurkowski, an American information scientist, in 1974 (Marchionini 1999). Information literacy was used to represent the skill of using vast information in problems solving, which merely indicates a kind of computer literacy or information processing capability at the beginning. Since then, many information scientists showed their own views about it. Consequently, information literacy seemed more like computer literacy and emphasized the information processing capability. In 1980s, the concept of information literacy developed rapidly, both the connotation and the field. American Library Association (1989) proposed that a man with information literacy should be equipped with the abilities of searching, evaluating and using the information s/he needs. In 1990s, information literacy became a requirement for all citizens of society, because it is the premise of lifelong learning (Ren 2001). A man with information literacy should know that exact and complete information is the basic when making decision, which means he can make sure what problems to be solved, where are the resources and how to find them (Doyle 1992). With the rapid development of network, it was embraced as a necessary capacity for living into different field. From technology literacy to civic literacy, then to specific literacy in all walks of life, the information literacy has permeated through the field of education. Among the voices in 1990s, Drucker (1992) used to distinguish “data” and “information”: For raw material to become information, it must be organized for a task, directed toward specific performance, applied to a decision, and the data users have to decide what information to use, what to use it for and how to use it, namely what to know about their job and how to find that knowledge.

As for the Chinese side, information literacy was a hot spot in 2000s. After it was officially proposed as a crucial basic of *Educational Informationization* by Ministry Department of Education in China in 2002, discussions on it had the aspect of components (information consciousness, information knowledge, information ability and information ethics) (Zhang & Yang 2005); its functions on the professional development for pre-service teachers (Wang 2004; Zhao 2004; Liu 2008) and in-service teachers (Guo 2012), or even considered as the

core of teacher professional development (Wu & Liu 2004; Zhang 2011). Some studies paid attention on the comparison of information literacy cross the cities or areas (Zhang 2009; Sun & Tian 2007; Lin 2008), and announced that information literacy was more lack in the undeveloped areas, such as the cities in Western China (Yang 2007) and rural areas (Xie & Jiang 2004). However, most of these researches are from macro, official perspectives, and few concentrates on the individual and procedural cases with long-term follow-up. What's more, the word of "information" remains to be an abstract word, which makes information literacy focus too much on the inner side ability of processing information, but less the interactions with the contexts, such as exchanging information. The group activities and partnerships and more cooperation needed to be cared (Zhang & Li 2003).

As the rapid development of network technology, teaching resources of information society breaks the barrier of paper resources. The vast and quick access electronic resources enrich the teaching resources, but challenge the capability of teachers' retrieval as well, especially the information screening. Investigations about information literacy showed that resource paradox was quite normal and general. On one hand, teaching resources are emerging in large numbers, on the other hand, many teachers complain about the shortage of resources. Actually, for the novice teachers, what is in shortage is not the resource itself, but the approaches to get resources, which always make them confused when they are facing massive information. Teacher-resource relationship includes 'what' of the teacher resource interactions, and 'how' of the interactions. Inside the dynamic interrelationship between teacher and resource, teacher and resource are viewed as shaping each other, and they both shape the outcome of instruction (Stein & Kim 2009).

All these discussions provide a lens of resource for seeing through teacher expertise. For a further study, some studies focus on teacher cognitive processes in different phases, such as the proactive (lesson plan and teaching methods/materials evaluation) and interactive (lesson implementation and interacting with students), phase of teaching (Jackson 1968), and post-active phase (reflection on the lesson and the following plan) (Clark & Peterson 1986). This distinction do not aim at separating the design, implementing and reflection, because teaching itself is a continuous process of design and reflection could happen in the whole teacher activities. As what Tsui (2003) stated, the decision-making in the proactive and interactive phase of teaching are intertwined and it is not easy to distinguish them.

In the proactive phase of teacher work, making plan is considered as an essential lens to see how they conduct conscious deliberation.

"...Whether conscious deliberation is involved depends on the nature of the task. For tasks that are routine and repetitive, and where rapid interpretation and decisions are needed, the automatic intuitive performance of experts is what distinguishes them from novices. However, for tasks that are not routine, and sometimes even problematic, it is often the kind of analytical thinking that experts engage in and the deliberative decisions that they make that distinguish them from novices. " (Tsui 2003, p. 13)

As Dreyfus and Dreyfus (1988) argued, experts only use their deliberate conscious when facing new situations. While lesson design is often a new start of coping new situations, because "the process of planning seems to be more appropriately conceptualized as a problem-solving process" (Calderhead 1984, p. 74), teachers in this process have to combine several factors: the pupils' previous knowledge, interest and level, the requirements and supports from textbooks and the available resources, the syllabus, the time, the expectations of the curriculum makers etc. For example, when teachers plan a new lesson, they have to learn and evaluate the curriculum materials, and decide on their scheme of working for the

whole year or the following lessons, then this process they are very much involved in conscious decision-making.

“It is in planning that teachers translate syllabus guidelines, institutional expectations, and their own beliefs and ideologies of education into guides for action in the classroom.” (Calderhead 1984, p. 69)

Based on the researches about the experienced or expert teachers in lesson planning, the characteristics are summarized into four as below (Tsui 2003):

1. **Autonomy.** Not following the models, rules or guidelines laid by people with authority, but relying on their own judgment and exercise autonomy (making modifications on their students' need and their own goals), with more confidence than the novices (Borko & Livingston 1989). They know planning is one thing, and “the reality of how teachers think about their actual teaching” (Brown & McIntyre 1992, p. 88) is another thing.
2. **Efficient.** A comprehensive outlook on planning, namely a long-term planning on the lesson, the unit, the daily/weekly/term/yearly planning. Expert teachers plan in a systematical way, considering the overall curriculum till specific topics, and these designs and decisions are based on their experiences about how things went in the previous year (Yinger 1980; Borko & Livingston 1989). However, they are flexible at the same time, they plan long-term but not long-range (McCutcheon 1980), which means they are not strictly following the detailed planning, but adaptive to save space for their students' interests.
3. **Flexible.** The lesson plans of experts or experienced teachers are richer than what they write down, that means they plan lessons mentally, without the limits of working space and the format of the written detailed lesson plans. In some contexts (such as China), there exists the model with specific modules to fill and follow, but some experienced teachers said that they had the ready lesson plans in their head (Pepin, Xu, Trouche & Wang 2016, and also in the pilot study discussion in section 3.1.3).
4. **Rich and integrated base.** Drawing a wide range of knowledge during the lesson planning, including the knowledge on curriculum, for example the key points in the curriculum and the links among the knowledge points within the curriculum, their lesson planning fit into the entire curriculum, relate to the curriculum content already covered previously, and relate to the other subjects in the curriculum (Schram, Feiman-Nemser, & Ball 1989). Knowledge about the students' competencies and difficulties and the suitable strategic decisions prepared for them (Calderhead 1984), what they have learnt before (Leinhardt 1989).

Some special concepts were already proposed along with the representative researches, exemplified by Teachers' Pedagogical Design Capacity (PDC) (Brown 2002, 2009). PDC was proposed as teachers' unique skill of perceiving the affordances of a resource, the ability of creating “deliberate, productive designs” (Brown 2009, p. 29). PDC is different from teacher knowledge, that is, from pedagogical content knowledge (Shulman 1986), or subject matter knowledge. PDC is not what a teacher “has”, like knowledge, but characterizes a process by which the teacher utilizes their knowledge and other, a high PDC could be reflected by a deliberate use of the textbooks and an intimate relationship with the textbook. It is not only an appropriation of the affordances of curricular resources by the teacher, but also about the quality of opportunities for mediation of mathematics that the teacher creates. A further discussion on PDC and other related terms will be presented in section 2.4.

2.1.4 Teacher expertise and teacher collective work

This section presents the emphasis of collective working in teacher professional development.

Teacher learning is not limited to formal professional development only, but takes place in all the arenas that the teacher participates in, such as classroom, or the community of teachers/students, and also the school environment (Borko 2004).

Cooperation among teachers is considered as crucial dimension for teacher's professional development (Hargreaves 1995; Rao & Zhang 2007; Cui & Zheng 2008), because the cooperating with other teachers cannot only improve the individual's teaching, but also long-term teacher's professional development (Williams, Prestage, & Bedward 2001; Lavié 2006).

As for collective work, there appears the question of types or extents. Dillenbourg (1999) distinguished cooperation and collaboration: "in cooperation, partners split the work, solve sub-tasks individually and then assemble the partial results into the final output. In collaboration, partners do the work 'together'". In this study, due to the contrasting contexts, I use "collective" rather than others, for a consideration that collective work includes cooperative work and collaborative work.

Teacher involvement in collaborative design of curriculum is viewed as a form of professional development, in which teachers create new or adapt existing curricular materials in teams to comply with the intentions of the curriculum designers and with the realities of their contexts. Such collaborative process of design provides opportunities for teachers to reflect on the intentions and implications of the reform (Voogt, Lafferrière, Breuleux, Itow, Hichkey & Mckenney 2015). Teachers can benefit from each team member's personal knowledge and beliefs, practice and goals for student learning (Parke & Coble 1997; Schön 1983), and the interactions with peers or experts in the collective may deepen and challenge the teachers' reflections (Borko 2004).

Collective working cultural has a long history rooted in China (see more in section 1.3). With strong cultural and institutional support, the reality of collective working in China still remains lots of problems. Studies on teachers' cooperation show that the reality is not quite optimistic. Teachers' attitude toward cooperation can be concluded as two types: one is negative cooperation, which seems like teachers sit together but do unrelated activities and little mutual aid exists; the other is false cooperation, the so-called cooperation is almost daily and prescriptive work contacts, and no spontaneous and voluntary cooperation (Cui & Zheng 2008). It sounds like on one hand, teachers hold quite a negative attitude toward cooperation with their colleagues, on the other hand, they dependence on the subject experts excessively (Guo 2007).

This section has presented the notion of expertise and its components discussed in the previous researches. The nature of expertise (will be discussed again in section 2.4) implies that the study of expertise should be situated into specific contexts, with the considerations of institutional supports (such as the collective working mode for teachers), the social technology environments (such as the requirements to teachers along with the development of Internet and diverse teaching software), and also characters of teachers' personal study background and efforts. In the following two sections, two theories will be presented for studying teachers' expertise in their resources work within a collective working context.

2.2 Documentational approach to didactics (DAD)

This section presents DAD, the main theoretical framework grounding this PhD, in four parts: firstly its origin and main ideas (2.2.1); secondly a discussion on the concept of scheme (2.2.2); the collective aspect of documentation work (2.2.3); finally a discussion on scope and categories of resources.

2.2.1 The origin and main ideas of DAD

In this section, Documentational Approach to Didactics (DAD) (Trouche, Gueudet & Pepin 2018 online first) is presented from its origin to the main ideas with the related key concepts.

Origin

Proposed firstly in 2008 in French (*Approche Documentaire du Didactique*) (Gueudet & Trouche 2008), DAD is grounded in the French didactics of mathematics tradition (Trouche 2016a, Artigue et al. 2019). On the one hand, “didactics” comes from the notion of “*Didaktik*”, which is a common concept in continental Europe (Blum et al. 2019). On the other hand, the term of “documentation” was drawn from the French word “ingénierie documentaire”, with “literal English translation [...] ‘to work with documents’ ” (Gueudet, Pepin & Trouche, 2012, p. ix), intending to match the terminology of “document management research” (Gueudet & Trouche 2009, p. 205). It contains a French morphology: the notion of document holds a verb meaning of supporting something (e.g. teacher professional activity), as what Pédaque (2006, p. 12, our translation) stated, “a document is not anything, but anything can be a document, as soon as it supplies information, evidence, in short, as soon as it is authoritative” (cited from the translation in Gueudet & Trouche 2009 p. 205), while “Documentation refers to the complex and interactive ways that teachers work with resources; in-class and out-of-class, individually, but also collectively.” (Gueudet, Pepin & Trouche 2012, pp. ix-x).

DAD was mainly developed from the Instrumental Approach to Didactics (Guin, Ruthven & Trouche 2005), itself developed from the work of Rabardel (1995): according to him, an artifact is a cultural and social means provided by human activity, offered to mediate another human activity, including materials like computer, or a given language; while the instrument is built from the artifact by a subject through his/her goal-directed activity. For a given class of situations, the process of generating an instrument was defined as instrumental genesis, and a scheme (further description will be presented in section 2.2.2) of utilization of the artifact was also developed through this process. DAD keeps these ideas and structure, and deepens it with a broader view on resources from Adler (2000): thinking the resource as the verb *resource*, anything with the potential to source teacher's' activity again or differently. Resource in DAD is “not limited to curriculum material, but including everything likely to intervene in teachers' documentation work: discussions between teachers, orally or online; students' worksheets, etc.” (Gueudet & Trouche 2009, p. 200), or even “a discussion with a colleague” (ibid., p. 205), they “extend beyond basic material and human resources to include a range of other human and material resources, as well as mathematical, cultural, and social resources” (ibid., p. 210).

DAD was proposed initially as an empirical approach for studying mathematics teachers' resource work and professional development, bridging cognitive psychology (through the notion of scheme) and education (within didactics), technology usage (with resource and its utilization), document management (through the notion of document) (Trouche to be published). During 10 years' development since 2008, DAD has been applied in other disciplines such as physics and chemistry (Hammoud 2012), in different stages from

preschool (Besnier & Gueudet 2016) to university (Gueudet 2016), and expanded to explore the work of students (Kock & Pepin 2018).

Main ideas

DAD is an approach for looking how teachers develop professional knowledge through the process of appreciating diverse resources for teaching. Its main ideas are consisted by a series of key concepts: resource, document, scheme, documentation work, documentational genesis, resource system, documentation system, instrumentalization and instrumentation.

The creative work of mathematics teachers' interaction with curriculum and other resources in their daily work is coined as *teacher documentation work* (Trouche, Gueudet & Pepin, 2018 online first). The interaction is actually a process of appropriation and transformation on the resources, including selecting, modifying and creating new resources, by individual or by a group of teachers working together, in-class and out-of-class (Gueudet & Trouche, 2009). During the interaction with resources, teachers develop corresponding *scheme of usage* attached to these resources for the same class of situations across a variety of contexts, and generate a document as outcome:

$$\text{Resources} + \text{scheme of usage} = \text{document}$$

The *scheme* in the formula came from Vergnaud (1998), inferring an invariant organization of activity corresponding to a given class of situations, which could be used to differ the teachers' dispositions and knowledge when they use the same resources. Further discussion on scheme will be presented in section 2.2.2.

As Rabardel and Bourmaud (2003) claimed, the design continues in usage. A document developed from a set of resources provides new resources, which can be involved in a new set of resources, leading to a new document. Figure 2.1 shows the dialectical relationship between resources (set) and documents.

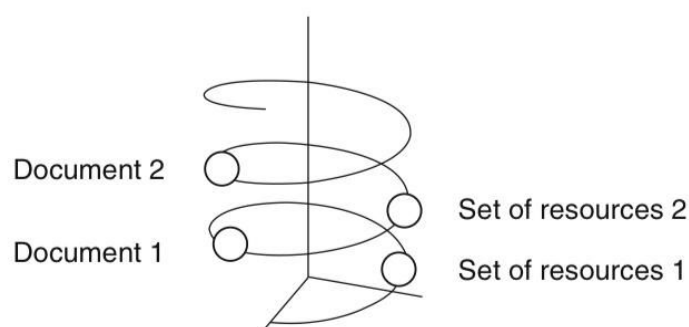


Figure 2.1. The resource/document dialectical relationship (Gueudet & Trouche 2009, p. 206)

A resource is never isolated, “each resource must be viewed as a part of wider ‘set of resources’, and forming a *resource system* with an a priori structure of the resource sets” (Gueudet & Trouche 2009, p. 200). Like a resource belongs to a resource system, a document belongs to a *documentation system*. The genesis from resources to document is named as *documentational genesis*, which is considered as central in teachers' professional development by DAD. Figure 2.2 below shows this interactive and potentially transformative process and the dialectic relationship between teachers and resources through instrumentation (the affordances of resources influence the teacher) and instrumentalization (the dispositions and knowledge of the teacher guide the choices and transformation of resources).

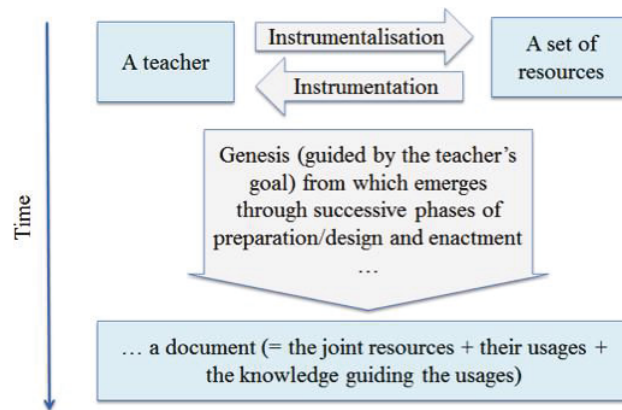


Figure 2.2. A representation of a documentational genesis (Trouche, Gueudet & Pepin, 2018 online first)

DAD, in a time of digitalization, has a particular interest in digital resources. As underlined by Gueudet and Trouche (2009), this interest “is not directed towards the promotion of such resources; it is meant to shed light on the use of resources as a whole, including digital and no digital pieces, and on teachers’ professional evolution” (p. 200), providing a lens of resource for tracing teacher professional development. In this way, an expertise perspective of documentation work draws the attention of researchers: in front of an immensity of potentially suitable materials (“a pile of bricks”), teachers need some *teacher design capacity* (Pepin, Gueudet, & Trouche 2017), a mindfulness or sensitivity of learning resources and the flexibility to use them, or *pedagogy design capacity* (Leshota & Adler 2018; Remillard 2005), or *documentation expertise* (Wang 2018) in this thesis, as one specific type of teacher expertise particularly needed and developed for/in documentation work (will be introduced in section 2.5).

2.2.2 Scheme: origin and definition for analyzing documentation work

This section presents the concept of scheme, emphasized as a central concept in DAD (Trouche, Gueudet & Pepin 2018 online first) from four parts: its origin; its definitions and components; the nature of scheme, especially its links with knowledge and competence; and the dialectical relationship between scheme and situation.

Origin

The term of scheme was introduced by Kant in his book “Critique of Pure Reason”, and mentioned by several philosophers of the 19th century, then introduced and developed by psychologists during the early decades of 20th century. Piaget (1952) provided concrete and convincing examples of the significance of scheme in his book “The origins of intelligence in the child”, since then the field of infant cognitive development was opened as a new research field. Jiang (2014) proposed four peculiarities of scheme by contrasting Kant and Piaget’s work: the structural nature, the dynamic feature, the subjectivity and the intermediary role. The intermediary role is the essential peculiarity of scheme. The structural nature and the dynamic feature allow the basic structure and mechanism of cognition to be understandable. The subjectivity can remove the obstacles for the unity of subject and object, and the subjectivity and the intermediary role can criticize and improve the traditional epistemology.

Based on the Piaget’s work, Vergnaud (1990), in his theory of conceptual fields, developed and re-defined the concept of “scheme”, as well as the components for analyzing it. He argued that “the main role of the schemes, according to Piaget, is to generalize efficient behavior to new objects. For Piaget, schemes are functional dynamic totalities.” (Vergnaud 1998 p. 228).

He considered the concept of scheme as important, because “it provides the essential link between behavior and representation.” (Vergnaud 1996, p. 189).

Definition and components

Vergnaud proposed two equivalent definitions of scheme, one as a general statement, and the other from its components/aspects.

The first definition of scheme is: “a scheme is the invariant organization of activity for a certain class of situations” (Vergnaud 2009, p. 88): “Schemes are adaptable resources: they assimilate new situations by accommodating to them.” (ibid, p. 88); “The invariant character of a scheme for an individual does not mean that schemes are stereotypes. What is invariant is the organization of behavior, not the behavior itself.” (Vergnaud 1998, p. 229); “A scheme is not generally a stereotype, but on the contrary an instrument for adapting activity and behavior to the specific values acquired by different parameters as the situation develops.” (Vergnaud 1996, p. 189).

The main characteristic of schemes is the operability: “they operate on situations and deal with them in order to overcome the difficulties, and organize progress in the managing or these situations. When our schemes fail, we develop cognitive activities to accommodate them to the properties of the situations that may have caused trouble. Even emotion is made of schemes. Emotional schemes are often seen as negative, but they may also be very positive and drive us to new ways of doing and representing.” (Vergnaud 1998, p. 235)

The second definition of scheme is based on its four components/aspects (Vergnaud 1996, 1998, 2009):

- Goal/sub-goals* and expectations, i.e. the intentional aspect. “A scheme always applied to a type of situation in which the subject can identify a possible target for his/her activity, and sometimes intermediary sub-targets too. In addition, certain side effects or phenomena may be anticipated.” (Vergnaud 1996, p. 189).

- Rules of action*. “They can be considered as the generative part of the scheme, the part that generate behavior as a function of some situation variables.” (Vergnaud 1998, p. 229), “engendering a series of activities aimed at transforming reality, seeking information and controlling the outcome of the activities; this makes it possible to ensure the success of the activity in a context that may be constantly evolving” (Vergnaud 1996, p. 189);

- Operational invariants*, i.e. the epistemic aspect. “The operatory invariants form the implicit, or explicit, conceptual basis which make it possible to select the appropriate information and, by inference based on that information and the target to be attained, to identify the most appropriate rules of action (Vergnaud, 1996, p. 189). “They consist mainly in *concepts-in-action* (to categorize and select information), and *theorems-in-action* (to infer, from the available and relevant information, appropriate goals and rules) (Vergnaud 1998, p. 229). “Their main function is to pick up and select the relevant information and infer from its goals and rules.” (Vergnaud 2009, p. 88).

- Possibilities of inferences*. “The computational aspect involves possibilities of inferences. They are essential to understand that thinking is made up of an intense activity of computation even in simple situations, and even more in new situations.” (Vergnaud 2009, p. 88). “These possibilities are essential since there is always some inference and computation in any activity.” (Vergnaud 1998, p. 229).

The four components make scheme analyzable. Vergnaud (2011) suggested to start the analysis of scheme from the rules of action, of gathering information and controlling, because

the rules of action constitute the generative part of scheme, which is immediately along with time and drive the activity, not only actions, but also gathering the necessary information for the activity, allowing the subject to control the activity by reflecting what has been done and what is to be done, ensuring that the activity is always on a track of making choice, even when the subject is not very conscious.

Among the four components, the operational invariants are emphasized most: “Operational invariants are the source of concepts and propositions.” (Vergnaud 1998, p. 231), it is “the keystone that makes the connection between practice and theory” (Vergnaud 1998, p. 230):

The main attraction of the scheme concept for theoreticians is that it provides the essential link between behavior and representation. It is in fact the operatory invariants which form the main linkage, since perception and information seeking and selection are based entirely on the system of the concepts-in-action at the disposal of the subject (objects, attributes, relations, conditions, circumstances, etc.) and the theorem-in-action underlying his or her behavior. (Vergnaud 1996, p. 189).

Why are operational invariants so crucial? Because practice is action; because action is always efficient under certain conditions; because action is driven by rules of the form 'if C1, C2, ... then Ak, ... , Aj'; and finally, because the possibility for such rules to emerge would not be understandable if there were no cognitive categories to analyze these conditions, to analyze the components of action, and to analyze the relationships between goals, conditions and actions. (Vergnaud 1998, p. 230).

Concepts-in-action differ from theorems-in-action, “a theorem-in-action is a proposition concerning reality which is held to be true; and a concept-in-action is a category of thought that is held to be relevant.” (Vergnaud 1996, p. 189). Vergnaud also made a clarification between concept and theorem: “A concept is not a sentence and therefore cannot be true or false, only relevant or not relevant. Another important point is that one may think a sentence is true that in fact is false; it is still a theorem-in-action.” (Vergnaud 2009, p. 88). The relationship between concepts and theorems is dialectical, “there is no concept without theorem, and no theorem without concept.” (ibid, p. 88).

The nature of scheme

To make the concept of scheme clearer, Vergnaud made several statements to distinguish its nature with those relative concepts like algorithm, competence and knowledge.

1. Scheme and algorithm

Algorithms are schemes, but not all schemes are algorithms. Scheme is not necessary to be effective and right, it could be wrong.

“Algorithm... is also an invariant organization of behavior for a certain class of situation. Both concepts are closely connected. But algorithms are schemes, whereas not all schemes are algorithms. Moreover, algorithms are effective (they provide the solution in a finite number of steps, if a solution exists), whereas most schemes are only efficient (and are only likely to lead to success). They may even be wrong. Even when students and adults are supposed to learn and use algorithms, they develop personal schemes: for calculations, for geometry, for algebra, for reasoning.” (Vergnaud 1998, p. 229).

Algorithms “often degenerate in personal schemes: most students, and even most mathematicians, do not follow the rules of the algorithm strictly. They have shortcuts - for better or worse!” (Vergnaud 1998, p. 233). Vergnaud thought this as worth analyzing. Thus it is interesting that the distinguish between algorithms and schemes turns into the differences between effective and efficient: effective (algorithm) stresses more the desired results can be

achieved, while efficient (scheme) puts more attention on the lack of waste (resources, time, effort or energy) in producing that result, which greatly depends on how the subject weighs the costs and benefits.

2. Scheme and competence

“The concept of scheme is essential to understand the cognitive structure of competences.” (Vergnaud 1998, p. 228); “Competences are composed of schemes aimed at facing situations.” (Vergnaud 1998, p. 230), and “rely heavily upon efficient concepts-in-action and theorems-in-action; that is to say, upon relevant categories from which to select the information available, deal with it, and generate from it plausible goals, sub-goals, actions and expectations.” (Vergnaud 1998, p. 228).

Vergnaud proposed the discussion on competence before scheme (Vergnaud 1996, 1998), in which he used two examples, “satellite expert” and “swineherd”, to emphasize that: (1) Some specific competences (similar like expertise to be discussed in section 2.5) could make someone irreplaceable, and differ between those who have such competences and those who have not; (2) They are probably not formed from books or reports, “there is no expert-system to replace this person; there is not even any younger engineer that would have been trained in times for the purpose of inheriting and capitalizing on that critical knowledge.” (Vergnaud 1998, p. 227); (3) They often consist of more than purely technical and scientific skills, also the “skills in managing affects and social relations which carry considerable weight.” (Vergnaud 1996, p. 190), and even social aspects, especially when “the solution may have involved a whole network of human and technical resources” (Vergnaud 1998, p. 227); (4) “Competences formed in practice concern all levels of children’s development and professional experience; at all levels of qualification. This is true even for scientists.” (ibid, p. 228).

The discussion on competences reminds the variety and multi-levels of scheme: “Schemes are appropriate for all the possible registers of behavior, including competences as different as physical gestures, intellectual scientific and technical activities, interaction with others, affectivity and the use of language. They may also apply to different levels of organization: the use of language, for example, will involve schemes for phonology, vocabulary, syntax, tone and discourse organization in a dialogue.” (Vergnaud 1996, p. 189). Besides, scheme is also a highly personalized and individualized concept, and could differ on different individuals.

3. Scheme and knowledge

“Schemes are the operational side of knowledge.” (Vergnaud 1998, p. 230). Vergnaud (2009) classified knowledge into operational form and predicative form: The two forms of knowledge are intertwined: the former consists in action in the physical and social world, while the latter consists in the linguistic and symbolic expressions of knowledge, “scheme...plays a crucial role in the analysis of the operational form of knowledge, as distinct from the predicative form.” (ibid, p. 84). In his work on professional didactics (Pastré, Mayen & Vergnaud 2006), the operational form of knowledge was explained as the *knowledge in action*, in a technical order, on and with the material world, in situation of communication, cooperation and conflict with others.

The relationship between knowledge and competence was also mentioned, but not discussed quite deeply: “Most of our knowledge consists of competences and these competences form, develop, are differentiated and improved, and possibly deteriorate during our life depending on the range of situations to which we are exposed.” (Vergnaud 1996, p. 188). Thus, in Figure

2.3, I use a Venn diagram to describe the relationship, as I understand it, between scheme, knowledge, and competence.

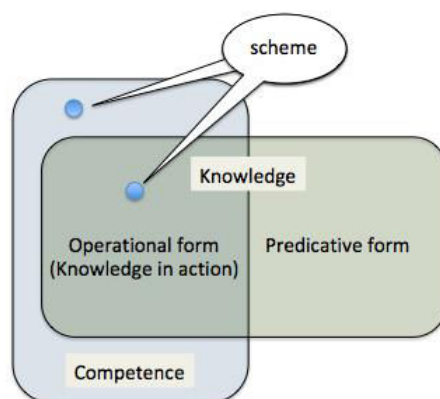


Figure 2.3. My interpretation of the relationship between scheme/knowledge/competence based on Vergnaud

This figure is drawn by me based on the literature review work of Vergnaud's papers discussed above. It shows that scheme concerns the operational form of knowledge, and also the competences (further discussion will be presented in section 2.5).

Dialectical relationship between scheme/situation

Vergnaud considered situation as an underestimated concept, which deserves more attention:

"Piaget attaches very little importance to the concept of situation; yet given the importance he attaches to the concept of scheme one wonders why he did not establish a close correspondence between these two concepts. In his operatory theory of representation: Piaget speaks of subject-object interaction, when he could have been more precise and spoken of the scheme-situation interaction. A theory of representation needs a theory of reference, and the reference, in the subject's representation of the world, does not consist only of objects and their properties but also of situations in which his or her activity is involved, and which provide him/her with the basis for organization of his/her activity." (Vergnaud 1996, p. 190).

On the one hand, schemes get developed through adapting to the situations. "Schemes have physical, linguistic and social components. Their main characteristic is their operability: they operate on situations and deal with them in order to overcome the difficulties, and organize progress in the managing of these situations. When our scheme fail, we develop cognitive activities to accommodate them to the properties of the situations that may have caused trouble." (Vergnaud 1998, p. 235).

On the other hand, situation is a key to understand and analyze scheme. "For the purpose of analysis, they must be related to the characteristic features of the situations to which they apply." (Vergnaud 1996, p. 188). He regarded "knowledge as a process of adaptation" as one of Piaget's most fundamental idea, then "to understand knowledge, one must study the way in which it develops." (Vergnaud 1996, p. 184). When "schemes assimilate new situations by accommodating to them, and concepts, to gain sense and operability, need to be contextualized and exemplified in situations" (Vergnaud 2009, p. 94).

Besides the importance of situation to scheme, Vergnaud (1998) also emphasized the classification of situations: "The analysis of schemes make it necessary to analyze and classify situations carefully so as to understand what is essential to be conceptualized in them." (p. 231). In his earlier work, Vergnaud (1991) categorized the situations into two classes based on the competences stored in the subject's repertory, which were explained as:

1. A class of situations where the subject can find and adapt the necessary competences in her/his repertory, and dealing with the situations with related treatments immediately;
2. A class of situations where the necessary competences are not ready in the subject's repertory, and needs the subject to reflect on and explore through her/her hesitations, attempts, trails and errors, leading to either success or fail.

Then in his later work, Vergnaud (1996) introduced a distinction of three types of situations made by Brousseau: "He draws a distinction (over-emphatically perhaps but usefully) between (a) situations involving action, aiming at performing a action successfully; (b) situations involving the formulation of ideas, aiming at producing a message and communicating; (c) situations involving validation, in which one must show that a particular sentence or theory is valid and enlist support for it." (p. 184).

Vergnaud regarded these three types of situations as both the source and the criterion of operational knowledge, but he didn't give further clear category of either scheme nor situation, even he used to consider situations as "problems to be dealt with" (Vergnaud 1998, p. 237). For him, the process of confronting situations is the process of developing schemes, and for the subjects,

*"...at any given moment in their development, [they] have a **repertory of skills** which enable them to deal successfully with a large number of situations and that they have therefore achieved a certain equilibrium between the complexity of their cognitive resources and that of the situations with which they are faced. When confronted with new situations which they are not yet able to control, they need to develop new resources, which will be the result on the one hand of adoption through accommodation of the resources already acquired, and on the other of the discovery of entirely new properties of reality."* (Vergnaud 1996, p. 185).

With some trial and error, and recomposing the existed schemes and adapting them to the new situation, the teachers progressively form a new class of situation/scheme. But when the situation is familiar, they just need to draw the necessary schemes from their repertoire to deal with the situation they have identified and recognized. When the situation is new, the teacher has to confront the with the situation she/he never met before, and do some trial and error, recomposing the existed schemes and adapt them to the new situation, which progressively form a new class of situation/scheme. The later configuration corresponds to the moments of learning and development.

Knowledge and schemes are developed through actions, personal experiences and reflections. "The progression of the pupils' knowledge is largely the result of their own action and personal experience and reflection." (Vergnaud 1996, p. 184), this works in the same way if we consider teachers as professional learners. Reflection (which will also be further discussed in section 2.5) here is important, because Vergnaud although admitted that "repetition is an important aspect of the formation of schemes, since it is the familiarity of the situations which make the most decisive contribution to the process. But repetition can be dangerous unless there is a degree of variation" (Vergnaud 1996, p. 190).

Back to DAD, the definition and components of scheme makes teachers' documentation work as well as the attached knowledge in action observable and analyzable. Scheme should be stable, shaped and verified in the previous situations. To emphasize the "invariant" (stable) aspect of scheme, Gueudet and Trouche (2009) used to distinguish further between usage and utilization: "A scheme of utilization of a set of resources entails both an observable part and invisible aspects. The invisible aspects are the *operational invariants*, the cognitive structure guiding the action. The observable part corresponds to the regularities in the teacher's action

for the same class of situations through different contexts. This part is what we call usages.” (p. 208). The difference between utilization and usage is: usage is more stable than utilization, which could be drawn by a teacher on resources few times without developing a stable behavior for a given class of situations. Due to the “invariant” property, to see the development and improvement of scheme, it takes time, and needs a long-term observation and case follow-up for the specific activities and situations.

Knowing situation can help us to analyze a scheme. As Vergnaud said, “the dialectical relationship between situations and schemes is so intricate that one sometimes uses an expression concerning situations to refer to a scheme, for instance high jumping, or solving equations with two unknowns, as well as an expression concerning schemes to refer to a situation, for instance rule of three situations (the rule of three is a scheme, not a situation).” (Vergnaud 2009, p. 88). In this section, the components and properties of scheme, classification of situation are emphasized, because they determine how to classify schemes, further the properties and classification of documentation expertise (further discussions will be presented in section 2.4).

2.2.3 Collective dimension of documentation work

This section presents the collective aspect of documentation work, from a theoretical level (the origins of DAD and properties of scheme), to the practice level (teacher’s work is often situated in collective contexts).

As claimed in the French Dictionary of Pedagogy (1911), “teaching is collaborating” (cited from Gueudet & Trouche 2012, p. 305). “Human work always takes place in an institution (Douglas 1986), encompassing a cultural, historical and social reality (Engeström 1987). The collective aspect of documentation work was emphasized since DAD was born (Gueudet & Trouche 2008), in the same paper, five theories were proposed for thinking on the collective aspect of documentation work: thought collective (Fleck 1934), the universe of practice (Bourdieu 1980), the activity theory (Engeström 1999), the theory of institutions (Douglas, 1986), and the communities of practice (Wenger 1998). Among these five theories, activity theory was mentioned as one of the sources of instrumental approach, which was further developed into DAD (stated in section 2.2.1). In the recent study (Trouche, Gueudet & Pepin 2018 online first), sociocultural theory (Vygotsky 1978) was announced to source DAD (further information will be presented in section 2.3). Besides the theoretical origins of DAD, the collective dimension is important also because scheme, the central concept in conceptual field of theory, was inspired by both Piaget and Vygotsky, “representing individual and social aspects of learning respectively, in constructing theory in mathematics education” (Presmeg 1998, p. 58), “he [Vygotsky] was also interested in the formation of concepts in daily life, through experience” (Vergnaud 1998, p. 231).

The importance of collective dimension of documentation work also comes from the requirements of teacher practice (general points of views were stated in section 2.1):

- Teachers work in a collective context. Teachers’ activity requires a consideration of their working environment (Cohen, Raudenbush & Ball 2003). “Teachers’ ordinary work comprises many collaborative aspects, and that the interactions with colleagues, often through resources, are crucial for teacher professional development [...] Teachers’ collective work uses and produces resource [...] resources also ‘produce’ collective work and professional development.” (Gueudet, Pepin & Trouche 2013, p. 1003);
- Teachers’ collective work is arising because of the new requirements by curriculum changes, such as interdisciplinary teaching practice (Gueudet & Trouche 2008);

- The form of teachers' collective working is getting richer due to the development of technology. "As the nature of resources changes, and their availability increases, so too do the possibilities of teacher collaboration with and via the resources: email and forums, for example, permit distant collaboration." (Pepin, Gueudet & Trouche 2013a, p. 929). The possibility of working with/as resource designers in potential communities is rising (Pepin, Gueudet, Yerushalmy, Trouche & Chazan 2015), and "[...] the easiness to communicate via the Internet leads this approach to take into account the emergence of a spectrum of various forms of teachers' collective work: networks, online association, communities more, or less formal." (Trouche to be published).
- Collective working is considered as beneficial for curriculum reform implementation. "Sharing artifacts and collectively developing utilization schemes in collaborative groups of teachers and researchers can be a more effective means to curriculum change. Cooperation around appropriately designed resources - be they materials and/or conceptual - can be a way to develop teaching and learning mathematics." (Straesser, in Gueudet, Pepin & Trouche, 2012, p. vii).
- Collective working itself is a source for producing resources. The beneficence between collective work and resources was announced as mutual (Gueudet, Pepin & Trouche, 2013): Teachers' collective work uses and produces resources. The collective interactions enriched the scope of resources more than material form: (a) interactions between teacher-students could "re-source" the teacher's documentation work decision, such as new forms of students' productions created, new mode of communication between teacher-students due to digitalization, or even the expressions on the face of the students in class; (b) interactions between teacher-colleagues bring the resources designed collectively, such as curriculum plans, lessons, new forms of communication, networking and association due to the digital means (Gueudet, Pepin, & Trouche 2012, p. ix). In the recent study of Pepin and Gueudet (2018 online first), curriculum resources contains also "non-material" resources including social resources (e.g. "direct and/or web-based conversations with colleagues") and cognitive resources (e.g. conceptual frames that are used in professional development sessions to develop particular competencies) (p. 2)

The collective dimension was developed along with DAD. The "collaborative documentation work" was explored in particular through innovative teacher training programs, within the communities of practice (Gueudet, Soury-Lavergne & Trouche 2009). Later, the "social aspect" of teachers' documentation work was deepened (Gueudet & Trouche 2012) with new terms such as "community documentation" and "community documental genesis" (Gueudet & Trouche, 2012, p. 309), which was paraphrased from community of practice. Then through a review work on literatures about mathematics teachers' work and interactions with resources from collective perspective (Pepin, Gueudet & Trouche 2013a) and specific empirical investigations within cases (Gueudet, Pepin & Trouche 2013), collective work with resources was proposed formally as an essential dimension of documentation work, by this moment, the collective aspect of DAD was formed within its own framework, with its own notions of resource system and the collective components in the system. Three levels of complexity in teachers' collective documentation work were presented: the complexity of the boundaries of each resource set (because resources are more or less shared within a given collective); the complexity of overlapping of collectives (diverse groups where a given teacher participates in); the complexity of time (collective working generally happened within schedule constraints) (Gueudet & Trouche 2012).

The definitions of collective work was also discussed, since “collective is everywhere in teachers’ documentation work and that it takes very different forms.” (Gueudet & Trouche, 2012, p. 320). A community of practice was defined as a group of people sharing an interest, a craft or a profession, with three conditions: mutual engagement (collaborative relationships), joint enterprise (common objectives) and shared repertoire (producing/storing resources for the whole group and its members) (Lave & Wenger 1991). The collective was proposed as “a group of person doing something together, each teacher takes part in a variety of collectives. Some... are institutional collectives that are compulsory (such as a school team), others are association, which can be large and open, or more restricted” (Gueudet & Trouche 2012, pp. 305-306). In “the ‘world’ of teachers’ work with resources, we regard ‘collective work’ as teachers’ work with colleagues in-school and out-of-school, with teacher educators in professional development, and also with pupils and parents in school.” (Pepin, Gueudet & Trouche 2013a, p. 930). In the same study, they also proposed some conditions for better collective work: particular resources and the corresponding supports to draw the participants together, the design and quality of resources, the particular supports for developing well functioning collectives (ibid.)

The types of teachers’ collective working diverse a lot in contrasting cultural contexts, such as the lesson study as a means for professional development of mathematics teachers in Japan, and Danish high-school teachers’ collaboration in the setting of multi-disciplinary modules (Winsløw 2012), the Chinese Teaching Research Group activity and the multiple independent choices for attending collectives under French Pedagogy Freedom (see more in section 1.3).

2.2.4 A discussion on scope and category of resources

In section 2.2.2, the definition of resource has been discussed. This section re-discusses resources concerned in this research from their scope and categories.

Before the discussion, I would like to refer these ideas to my pilot study (see more in section 3.1.3) for two necessary reasons:

(1) For collecting data. Language is a reason for distinguishing resources. Designed as case study with a Chinese case and a French case but written in English, there exists a problem of information entropy caused by the translation. According to Trouche (to be published), “explaining a definition in a very different language needs to deepen the corresponding concept, to give examples and counter examples. For example, in Chinese language context, resource (资源, zī yuán) is a more abstract term, which is not an oral term quite often used by the teachers. A Chinese teacher could give a very general description of his/her resources if she/he is asked what are his/her teaching resources (for further information in section 3.1.3 on the pilot study in China), while in France, teachers are easier to give out specific examples of resource they are currently using. This question attracted our attention since 2015, when was proposed the project named “Resources Naming Project” (Trouche, to be published) (sections 4.3.1, 5.3.1 and Appendix 1.8).

(2) For analyzing data. The way of denominating could reveal teachers’ personal conceptions towards what is a given resource, and how to use it. When studying resources from teachers’ view, it appears an issue of naming or denominating. Besides, resource system is an academic term to be studied in researches. As Rousseau and Morvan (2000) said, the process of denominating concepts is essential for a development of each scientific field. As a case study crosses three languages: one Chinese case and one French case analyzed and presented in English, it draws some issues due to the translation on specific resources from different contexts, all the more important when the distance is large between two thought – languages (Jullien 2015), what is the case for English (or French) to Chinese. Meanwhile, the

category of resources by the teachers echoes the fifth methodology principle (see more in section 3.2.1): taking the teachers' view.

What resources are concerned in this research?

The definition of resource by Adler (2000), anything with the potential to re-source teachers' activity, shows an open attitude towards resources. DAD kept the broad scope of resource. Cultural Historical Activity Theory (CHAT, to be presented in details in section 2.3) also shared a wide consideration on it, but in a different emphasize: Mediating artifacts in CHAT include material tools and psychological signs: "The tools' function is to serve as the conductor of human influence on the object of activity; it is externally oriented; it must lead to changes in objects. It is a means by which a human external activity is aimed at mastering, and triumphing over, nature" (Vygotsky 1978, p. 55).

I consider that to decide a thing is a resource or not, we could reflect it into a question: Is resource a kind of relationship, between thing and activity (DAD), or between human psychology and object (CHAT)? I assume that resource comes in pair with human psychology and object of activity: thing A could be a resource for subject B, but not necessary for subject C, here B and C may hold different knowledge and understanding on the usage of A.

As Pepin, Gueudet and Trouche (2013a) argued, "when appropriating resources, teachers adapt them to their needs and customs" (p. 929). Besides, when we say someone has expertise in integrating resources (defined as documentation expertise in 2.4), it infers that this person holds the knowledge and competence to recognize and adapt the potential things to fulfill his/her working tasks. In this way, there exist some boundaries of the scope of resources, and the boundary is decided by the teachers, and different individuals could differ, which in return works as a tool for the researchers to study teachers' knowledge and competence (documentation expertise in this thesis).

What is the relationship between technology and resource?

New technologies have broadened the types of subject and topic specific resources available to support school mathematics. "Educational suppliers now market textbook schemes alongside exercise and revision courseware, concrete apparatus alongside computer micro-worlds and environments, manual instruments along side digital tools" (Ruthven 2009, p. 136). Among these products for education, question of what is the difference between technology and resources may arise.

For the standard of Adler (2000), technology is a resource because it can help teachers to re-source their activities. But Pepin and Gueudet (2018 online first) distinguish between the two: "we distinguish digital curriculum resources including e-textbooks, from instructional technology (e.g., digital geometry software)":

It is the attention to sequencing—of grade-, or age- level learning topics, or of content associated with a particular course of study (e.g., algebra)—so as to cover (all or part of) a curriculum specification which differentiates Digital Curriculum Resources from other types of digital instructional tools or educational software programs... Of course, Digital Curriculum Resources make use of these other types of tool and software: indeed, what differentiates them from pre-digital curriculum programs is that they are made accessible on electronic devices and that they often incorporate the dynamic features of digital technologies (Pepin, Choppin, Ruthven, & Sinclair 2017, p. 647)

In the study of Yu and Golden (2019), they distinguished the technology into four categories: (1) cultural technology (referring to the devices and applications available, widely used and recognized in a cultural context, e.g. hardware like smartphones and computers, applications

such as cloud storage like Google Drive, social media like Twitter or Facebook); (2) educational technology (referring to those found primarily in educational environment or learning situations, such as a school management system, a formative assessment app or an interactive Whiteboard); (3) content specific technology (referring to those specific to the content field such as hardware like graphing calculators, software like GeoGebra); and (4) pedagogical content specific technology (referring to those designed specially for the teaching/learning in specific content area, such as some applets created with GeoGebra). Inspired by these discussions, here comes another consideration on resource (besides the assumption of relationship discussed above): it is necessary to pay attention on comparing the resource category of teachers and of researchers.

This section has presented the frame of DAD from its origin and key concepts of resource system and scheme, then discussions on the resources concerned in this study and the collective dimension were made. The following section will make a specific presentation of CHAT.

2.3 Cultural Historical Activity Theory (CHAT)

To better understand the collective aspect of teachers' documentation work, especially the influences of the social and historical aspects, this study takes CHAT as the second framework. In this section, CHAT is presented from its main ideas (2.3.1) and followed by a discussion on the key concept of *system*, crossing the notions used in CHAT and DAD (2.3.2).

2.3.1 The origin and main ideas of CHAT

CHAT is the third generation of Activity Theory, which roots in the classical German Philosophy of Kant and Hegel, emphasizing both the historical development of ideas as well as the active and constructive role of human. This philosophy provided the foundation for the more contemporary philosophy of Marx and Engels and the Soviet cultural-historical psychology of Vygotsky and Leonti'ev (Kuutti 1996), on which activity theory is based. It adopts Marx's dialectic materialist view of activity and consciousness as dynamically interrelated (Leonti'ev 1981), claiming that conscious learning emerges from activity, providing us an alternative way of viewing human thinking and activity. As a powerful socio-cultural and socio-historical lens, activity theory focuses on the interaction of human activity and consciousness within its relevant environmental context, and used as a framework for understanding the totality of human work and praxis (Bodker 1991), or serves as a "philosophical framework for studying different forms of human praxis as developmental process, both individual and social levels interlinked at the same time" (Kuutti 1996, p. 532).

The core basis of first generation of Activity Theory is the idea of "mediation", which is proposed by Vygotsky (1978), the founder of the Soviet cultural-historical school of psychology, sketched the idea of "mediation" between Stimulate (subject) and Response (object), which is known as his idea of cultural mediation of action (Figure 2.4).

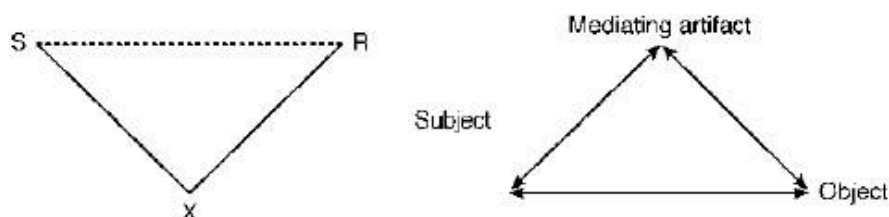


Figure 2.4. Vygotsky's model of mediated act and its common reformulation (Engeström 2001 p. 134)

The insertion of cultural artifacts into human action overcame the split between the Cartesian individual and the untouchable societal structure, which was considered as revolutionary: The

individual can not be understood without his/her cultural means; and the society can not be understood without the agency of individuals who use and produce artifacts. Objects are no longer raw materials but a cultural entity. The object-orientedness of action is the key to understand human psyche (Engeström 2001).

Vygotsky proposed the mediation idea but not the systematic activity theory, and the analysis unit still focus on the individuals. Then his student, Leonti'ev developed it and started to pay attention on the complex relationship between individuals and communities. But Leonti'ev did not graphically expanded out the second generation of Activity Theory, Engeström (1987) did it. After 1970s, the works on activity theory of former Soviet Union started to enter the western countries, and the most representative work comes from Engeström (1987). He generated the activity theory into graphs, and introduced three more mediating artifacts: rules, division of labor, and the mediation of artifacts (see Figure 2.5).

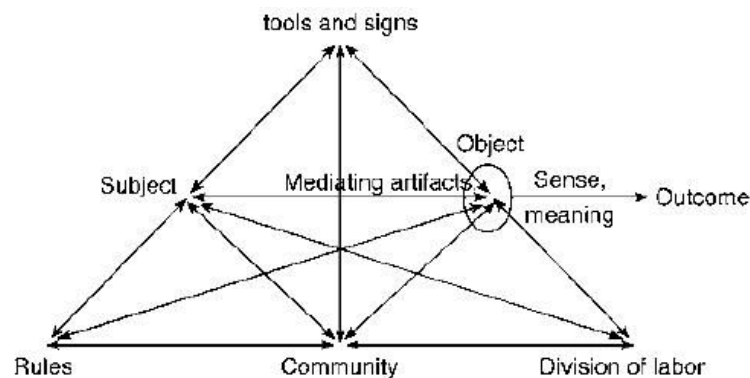


Figure 2.5. Structure of human activity system (Engeström 1987, p. 78)

This second generation of activity theory turned the focus from individual onto the complex interrelations between the individual subject and his/her community. The famous triangular mode of activity theory can be seen as a system consisted by six elements and four subsystems. The subject is some people; the object can be the aim or operation object of the activity, in material or mental; the community consists people or groups where the subject belongs to, and members in this community share the objects; the mediation of artifacts include all the things can be used to transform the object into the outcomes; rules are the regulations, laws, principles or social conditions, constraints and relationship among the members; the division of labor is the disposition of the tasks, the interests and the positions of the members. However, when the activity theory went international, questions of diversity and dialogues between different traditions or perspectives aroused and to be dealt with a third generation of activity theory, and this is the work of Engeström (2001), see in Figure 2.6.

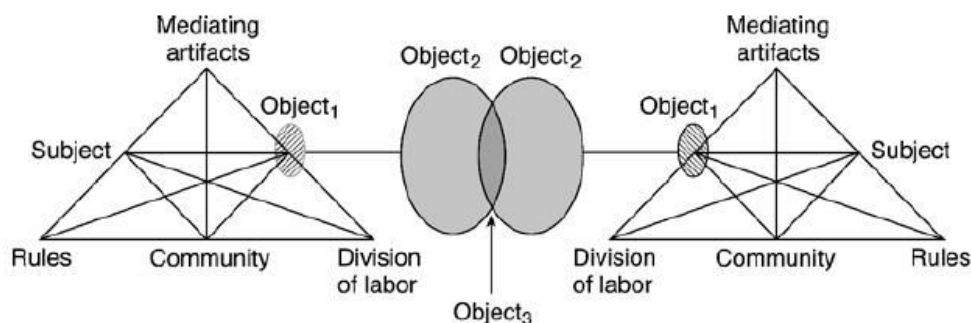


Figure 2.6. Two interacting activity systems as minimal model (Engeström 2001, p. 136)

In Figure 2.3.3, object 1 infers the initial state of unreflected, situationally given raw material, object 2 refers to a collectively meaningful object constructed by the activity system, and

object 3 means a potentially shared or jointly constructed object. Along with the third generation of activity theory, CHAT, Engeström (2001) proposed five principles for its understanding and adapting (pp. 136-137):

1. Seeing the activity system as a whole as the unit of analysis;
2. Multivoicedness, namely the “multiple points of view, traditions and interests” of the others;
3. Historicity, “activity systems take shape and get transformed over lengthy periods of time”;
4. Contradictions, “as sources of change and development”;
5. The possibility of expansive transformations.

As discussed in section 2.2, DAD has a root in Activity Theory (Gueudet & Trouche 2012). In the following section, two notions of system and collective in CHAT will be discussed by crossing to the “resource system” and collective dimension of DAD (see more in 2.2).

2.3.2 Two key concepts in CHAT and DAD: system and collective

This section reflects on how to integrate the two theories, CHAT and DAD, presented above to support this research. Some work had been done (Trouche, Gitirana, Miyakawa, Pepin & Wang 2018 online first) for the French case analysis (more details in section 5.4).

As what Drijvers et al. (2010) stated,

“It is clear that no single theoretical framework can explain all phenomena in the complex setting of learning mathematics in a technology-rich environment. Different theoretical frameworks offer different windows on it, and each view on the landscape can be sound and valuable [...] how do we manage to bridge the views of different theoretical perspectives, to understand, articulate, and value the different contributions that each of them offers, and to establish knowledge about their connectivity and their complementarity?” (pp. 121-122).

Thus in the following sections, the concepts of (1) “system”, which appears both in “resource system” and “activity system”, and (2) “collective”, as well as the possible ways to analysis the two concepts are presented.

System in resource system and activity system

System was mentioned in both “resource system” and “documentational system” in DAD, and “activity system” in CHAT. In this section, the definition and components of system are discussed based on the literature review, and discussions on how to analyze a system, as well as its differences in DAD and CHAT are presented in the end.

The term “system” comes from the Latin word *systema*, in turn from Greek σύστημα, referring to a whole concept made of several parts or members (Liddell, Scott, & Jones 1843). The concept of “system” was proposed firstly in 1824, in the field of natural science, by a French physicist, Carnot, to describe his steam engines, with respect to the system’s ability to do work when heat is applied to it. Later in 1950s, it got progressively integrated in the field of branches between science and technology Durand (1979). According to Swiss linguist Ferdinand de Saussure, system was defined as “a total organization consisted by elements that are mutually connected with each other, and these elements cannot be defined independently from others when talking about their functions and positions in the total.”

Durand (1979, pp. 9-12) proposed the four fundamental properties of a system:

- The *interaction*, which emphasize the mutual influences between the elements;
- The *globality*. Poussin (1987, p. 439) named this similarly as “totality”. A system is composed but more than a sum of the elements, and possesses some properties that the elements don't have: “It is impossible for me to understand the parties without knowing the system, either comprehending the system without knowing the parties.” (Durand 1979, p. 10);
- The *organization*, which could be the center of system. It is a layout of relations between the components. Also, the term of “organization” could be either a state or a procedure, implicating a kind of optimization of the components;
- The *complexity*. The concept of complexity is not the same as complication. The factor which matters the complexity is not the number of the components but the principle of the composition.

A system can be described from the (1) structural aspect, which is consisted of a frontier that can separate it from its environment; elements that can be identified, counted and classified; a network of relations for delivering and communicating anything possible in forms of energy or information etc.; and the place for stocking the materials, energies, the productions, the information, or the funding etc., which is indispensable for ensuring that the system can function well; Or from the (2) functional aspect, which is composed by the flow of the diverse materials, energies, information's etc.; the controlling center who receives the information and makes decisions; the feedback circles that allow the reflection on the decisions and regulations; and the buffers for allowing some necessary time for adjusting and ensure the system runs well. (Durand 1979; Poussin 1987). “The system should be defined by the conservation and stability, even sometimes the system could be in a state of dynamic balances, when facing changes in environments or objects, some internal conflicts and imbalances. A system could get evolved through a process of disorganization-reorganization, establishing a bank of solutions for maintain or adapt itself in a balance state” (Poussin 1987, p. 440).

When talking about teachers' resource system, even the components (resources) could be visible as material, one should notice that “system is not reality, but an analytic and synthetic view for studying some objects in reality”. (Poussin *ibid.*, p. 440).

To summarize, system could be analyzed, but the complete landscape of a teachers' resource/documentational/activity system should not be expected, not only because of the dynamic changes on the components, but also their relations. As what McLuhan stated boldly in his study (2014): “System’ means ‘something to look at’. You must have a very high gradient to have systematization. But in philosophy, prior to Descartes, there was no ‘system’. Plato had no ‘system’. Aristotle had no ‘system’.” (p. 74).

This section has presented the main concepts of DAD and CHAT, from its origin and development. This research will mainly adapt the second generation of activity system to study the individual teachers' resource work within collectives, and the third generation to see how the different collectives benefit to individual teachers' professional and expertise development.

2.4 First approach to Documentation Expertise (DE) and questions of research

The aim of this research is to propose a model of *documentation expertise (DE)* with specific dimensions and components, and its corresponding features, with respect to teachers' collective work. This section proposed a preliminary model of DE, based on the literature

review (section 2.1 and the theoretical frameworks already presented (sections 2.2 and 2.3). Two parts are included: firstly the preliminary ideas on the nature of DE (2.4.1), then restatements of the research questions, and research structure of the thesis (2.4.2)

2.4.1 Preliminary ideas on the nature of DE

This section presents ideas on the nature of DE: firstly an explanation on the terms choices; then a distinguish with teacher's *pedagogy design capacity* (Brown 2002, 2009; Leshota & Adler 2018; Remillard 2005, 2018), and *teacher design capacity* (Pepin, Gueudet & Trouche, 2017); in the end, reflecting the notions of expertise/knowledge/competence/scheme discussed in section 2.1 and 2.2, some preliminary ideas on the nature of DE are presented.

Documentation Expertise (DE): choice of the terms

Since documentation origins in French (discussed in section 2.2), and “explaining a definition in a very different language needs to deepen the corresponding concept, to give examples and counterexamples” (Trouche to be published), I propose to situate DE to its root, the terminology choice of DAD, for a deeper understanding and more precise description.

The expertise shown in teacher's documentation work is named as *Documentation Expertise (DE)* in this thesis. DE is considered as the expertise aspect of teacher documentation work, and one type of teacher expertise. As already discussed in section 2.2.1, the choice of “document” was drawn from the French word “ingénierie documentaire” (Gueudet, Pepin & Trouche 2012, p. ix), intending to match the “document management research” (Gueudet & Trouche 2009), or more precisely, to match the ideas of “information architecture” (from a discussion with Trouche in September 2018). The information architecture, as introduced by the Information Architecture Institute (2013), is a scientific field developed since 1970s, with the advent of computers, rooting deeply from library science, cognitive psychology, semiotics, cybernetics, discrete mathematics, and architecture itself. Rosenfeld and Morville (2002) defined it as “(1) the combination of organization, labeling, and navigation schemes within an information system; (2) the structural design of an information space to facilitate task completion and intuitive access to content; (3) the art and science of structuring and classifying websites and intranets to help people find and manage information; (4) an emerging discipline and community of practice focused on bringing principles of design and architecture to the digital landscape” (p. 4), and they expanded their definition to a series of operations: structuring (determining the appropriate information ‘atoms’ and decide how to relate them to one another), organizing (grouping those components into meaningful and distinctive categories), labeling (figuring out what to call those categories and the series of navigation links among them), finding (the access of browsing, searching, and asking) and managing (balancing the needs and goals with efficient content management and clear procedures).

Since terms close to information had been discussed in section 2.2.4 (resources category), section 2.2 (document and knowledge within scheme), and section 2.1 (information literacy), here I re-discuss them together in a perspective of information origins. According to ISO 15489-1:2001 (definition 3.10), document is “recorded information or object which can be treated as a unit”, this definition holds a similar idea of document in DAD: a document is a unit of resource and scheme of usage, while scheme of usage is recorded/attached to the resource. “Information” is not easy to define, especially when linking to the close concepts like data and knowledge. Rosenfeld and Morville (2002) considered data as facts and figure, knowledge is the stuff inside people's heads, and information exists in the messy middle. From the perspective of DAD, I keep the information as: For the users like teachers who we followed as research objects, their understanding on these terms could be not so distinctive

and strict, but for this thesis, document is chosen as more proper since it contains resources (potential to transform knowledge), and the scheme (recorded and analyzable with the four components from Vergnaud).

The term of expertise is chosen, instead of the competence as discussed together with scheme in section 2.2.2, because “expertise is considered to be highly contextualized” (Berliner 1988, p. 6): the label ‘expert’ is value laden, and “judgments of expertise are culture-bound” (Schoenfeld 2011, p. 328), the criteria of expert teachers and the nature of teacher expertise need to be investigated in specific cultural contexts and education systems (Li & Kaiser 2011). This thesis does not concern the criteria of expert teachers (further detailed choices of the targeted teachers will be presented in chapter 3), but holds a particular interest on what are the possible components of expertise (of documentation work) and how it could be developed in contrasting cases from different cultures, in this way, expertise is chosen.

Distinguishing DE from pedagogical design capacity and teacher design capacity

Notions related to teachers’ design competency need to be distinguished with DE, since teaching was identified as design (Brown 2009), or a ‘design profession’ (Clark & Yinger, 1987). Beside, “design” is also quite emphasized in DAD: “When appropriating resources, teachers adapt them to their needs and customs. This process of ‘design’ and interpretation of resources then continues ‘in use’ --- hence transformation is seen here as ‘design-in-use’” (Pepin, Gueudet & Trouche 2013a, p. 929).

Pedagogical design capacity (PDC, also discussed in section 2.1.3) was proposed by Brown (2002) as “an individual teacher’s ability ‘to perceive and mobilize existing resources in order to craft instructional contexts” (p. 70). For Remillard (2005), such capacity is an area of knowledge and ability that teachers need to use curriculum resources productively to design instruction, and a fundamental term in this definition is ‘mobilize’ (Remillard 2005, p. 228). It “is not what a teacher ‘has’, like knowledge, but characterizes a process by which the teacher utilizes their knowledge and other features together with features of the resource to design instruction for students” (Leshota & Adler 2018, p. 92). It is more than teacher knowledge, and it is about what teachers are capable of doing with that knowledge to ‘craft’ (Brown 2002, 2009) classroom episodes. Therefore, teachers need to be able to recognize and understand the affordances and constraints of available resources, and weave these with their personal capabilities to generate episodes that create opportunities for mediation in the classroom. (Leshota & Adler 2018).

While the *teacher design capacity* of Pepin, Gueudet and Trouche (2017) was initially dedicated to the interactions with digital curriculum resources, in which three aspects were included: (1) a clear goal orientation of the design (e.g. in terms of aims and content of learning), (2) a set of design principles/heuristics (e.g. a set of robust but flexible guidelines about how to address the design task), and (3) reflection-in-action type of understandings (e.g. the ability to collect information and adapt the initial design to circumstances during their instruction).

I took DE as larger than pedagogical design capacity and teacher design capacity as my previous work (Wang, 2018): DE appears not only in the phases of design and implement, but also of organize, save and share off.

Firstly, DE holds a similar scope of interactions between teachers and resources as the “curriculum use” of Remillard (2005), which “refers to how individual teachers interact with, draw on, refer to, and are influenced by material resources designed to guide instruction. This definition and the discussion that follows rest on the assumption that curriculum use involves an interaction between the teacher and the materials.” (p. 212), but as announced, Remillard

paid more attention on mathematics curriculum materials, while DE cares more than curriculum and material form resources (discussed also in the resource category in section 2.2.4).

Secondly, DE not only appears in the activities when teachers adapt their resources/schemes to confront situations, but also can be evidenced in teachers' resource systems. I consider that inside the teachers, they are also architects of resources for themselves, namely the way how teachers construct their resource system as an architecture, including the operations mentioned in Information Architecture such as structuring / organizing / categorizing / searching and managing.

To summarize, since documentation work involves all the interactions between teacher and resources, as the expertise aspect of it, DE should ingrate the properties of documentation work, and also the related components in it, i.e. resource, document, scheme and resource system (discussed in 2.2).

Some ideas on the properties of DE

The properties of DE should be decided from both teacher expertise (in 2.1) and of documentation work (in 2.2).

The model of DE could be enriched by involving more contrasting cases. As discussed in section 2.1, "expertise is specific to a domain and to particular contexts in domains" (Berliner, 2004, p. 201), and "is best thought of as a prototypical concept, bound together by the family resemblance that experts bear to one another" (Sternberg & Horvath 1995, p. 16). DE in this thesis takes the first priority on the expertise particularly in interacting with resources of the mathematics teachers for fulfilling their daily work (not only teaching in classroom, but also out of classroom). However, it doesn't infer that DE is uniform or homogeneous, or holds only by mathematics teachers. The components of DE could differ in different subjects, disciplines or even in different grades, thus, expanded and enriched continuously through further studies involving deeper follow-ups within more cases from more contrasting contexts.

DE of individual teachers should be situated, explored and explained in the contexts where they work in. This is the necessity of conducting contrasting case studies. For the teachers, on the one hand, they are in a given school/institutional situation, "the individual aspect of practice for each school within a given nation has typically some characteristics found in all schools, reflecting their interpretation of general practices that have developed within the school system, often developed and reinforced through teacher training institutions, further education, professional magazines, and so forth." (Hedegaard & Chaiklin 2005, p. 39), such as the Chinese Teaching Research Group, or the diverse didactical professional organizations in France (discussed in section 1.3). On the other hand, teachers are also in social-cultural contexts, since teaching is inherently a cultural activity (Stigler & Hiebert 1999), and "mathematics education is culturally shaped" (Bishop 2002, p. 120), teacher expertise could take different forms in different cultures, and teachers' working conditions exert a powerful influence on the development of their expertise (Berliner 2004). Vice versa, the way of teachers' mathematics teaching is also better to be understood in terms of socio-cultural practices (Goos 2005; Lerman 2001), for instance, the collective working culture and Confucius educational philosophy in China, and the pedagogy freedom in France (see more in section 1.3).

DE is assumed to be composed of schemes. When discussing teacher expertise, there are diverse terms like skill, ability, capacity, capability or competence appearing. I consider DE as one kind of practical expertise encompassing both specific knowledge and competency in with resources. As what had been discussed in Figure 2.3 (section 2.2.2), scheme is the

operational form of knowledge, and essential to understand the cognitive structure of competences. The operational invariant component of scheme is used to infer teacher's knowledge in action. That is to say, scheme is more than the knowledge in action (operational form of knowledge), and the rest three components, goals, rules of action and possible inferences could come in handy for other aspects of DE.

DE is supposed to contain a static dimension and a dynamic dimension. As Trouche proposed in his latest work (to be published): “we look at a resource system (a static view) as a structured entity; we should look at a documentation work (a dynamic view) as a structured entity as well.” His words emphasized again two key notions for understanding teacher's documentation work and DE: resource system (its structure) and scheme. In our pilot study (section 3.1.4), the resource system was used as a window to study teaching expertise on three Chinese expert mathematics teachers, and this work showed that if taking teachers' resources as a structured entity, then the position and function of some specific resources, as well as the preferences of the teachers will be seen more clearly. As for the scheme, Trouche et al. (2018 online first) proposed that the documentation system could be structured by the class of situations composing the professional activity of the teacher (according to the different aims of his/her activity).

These inspire me that (1) the static dimension of DE can be analyzed from the structure and elements of resource system, and (2) the dynamic dimension can be analyzed from the schemes that locate in teachers' specific documentation work in activities. To be notice that, I consider that teacher's resource system also contains a dynamic dimension, it changes and gets developed dynamically along with documentation work and teacher professional development, but it could be analyzed as a dynamic process consisted by several static moments. Figure 2.7 shows the two dimensions of documentation work and DE.

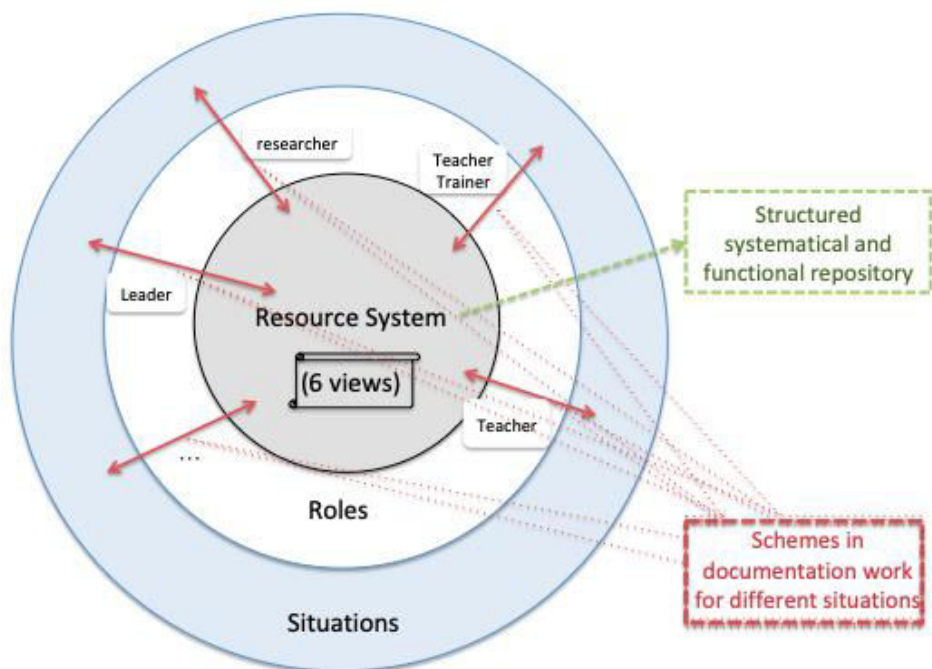


Figure 2.7. Two dimensions of documentation work/DE

A teacher, thus can be imagined as a Documentation Management System: the documentation work is a process of interacting between her/his resource/documentation system and the situations, for playing well his/her working roles, such as mathematics teachers, interacting with other colleagues, teacher educators... Meanwhile, the resource system gets enriched,

reorganized and developed. The components of the documentation expertise will be presented in next chapter, section 3.1.5, after the statement of the pilot study.

2.4.2 Research questions and structure of the thesis

After proposing the notion of DE, this section presents the research questions, and the structure of the thesis.

1. What DE could be found in mathematics teachers' documentation work? What are the components of DE and the corresponding performances of experienced teachers?
2. How DE could get developed through teachers' collective work? What are the factors that could be supportive for DE development?
3. Through two contrasting cases, is there any similarity of DE in both cases? What could be borrowed and adapted for a mutual benefit?

In the followings:

Chapter three presents the methodology for case study design, including data collection and analysis, inspired from the two theoretical frameworks stated in Chapter two;

Chapter four and Chapter five present the cases analysis;

Chapter six makes cross analysis on the two contrasting cases, discusses the results, and proposes perspectives for further research and development.

Chapter 3 Methodological design

To propose a model of DE, this research is conducted in two steps: (1) a first model of DE based on the literature review work (see in section 2.4); (2) a second model through the reflections from a pilot study (see in section 3.1.4), meanwhile the research questions, methodology and tools were also reflected and refined; then (3) through two contrasting case studies, a refined model of DE will be proposed. Details on the methodology for data collection and data analysis is explained in this chapter, from four parts: Section 3.1 presents the research design at a general level, including why case study is chosen, the dimensions for analyzing the contrasting cases and the pilot study, the second model of DE; Section 3.2 introduces the principles of methodology and the related tools; Section 3.3 describes the cases choice (including schools, teachers, and mathematic teaching topics), and tools for data collection in each case; Section 3.4 presents the data analysis methodology with descriptions of research landscape and procedures.

3.1 Research design as contrasting case studies

Research design is the logical sequence that connects the empirical data to a study's initial research questions and its conclusions:

“A logical plan for getting from here to there, where here may be defined as the initial set of questions to be answered, and there is some set of conclusions (answers) about these questions. Between ‘here’ and ‘there’ may be found a number of major steps, including the collection and analysis of relevant data” (Yin 2003, p. 20).

This section contains three parts: reasons of choosing a case study strategy (3.1.1), dimensions for data analysis of the cases and how to contrast them (3.1.2), and a pilot study (3.1.3) followed by reflections on methodology (3.1.4) and elements of the first DE model (3.1.5).

3.1.1 The choice of conducting case studies

Case study is chosen from three considerations: the *necessity* for exploring a model of one type of teacher expertise from teacher practices (according to the literature review, see more in 2.1 and 2.4); the characters of my *research questions*; and the characters of *teachers' interacting with resources* (from pilot study, see more details in 3.1.3).

The issue of mathematics teacher practice needs empirical studies:

“Didactical and mathematical praxeologies and their development [...] are co-determined (i.e., determined in their mutual interaction) by a whole hierarchy of institutional level that successively condition and constraint each other [...] many of the conditions of teaching practice, particularly those originating at the higher levels, cannot be changed by the individual teacher; some of them may be further modified by others, such as school principals, curriculum developers, or politicians.” (Artigue & Winsløw 2010, p. 51).

Case study is exactly the choice since as it is “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.” (Yin 2003, p. 13):

“In general, case studies are the preferred strategy when ‘how’ or ‘why’ questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life contexts. Such explanatory case

studies also can be complemented by two other types-exploratory and descriptive case studies.” (ibid, p. 1)

Yin proposed a table (Table 3.1) with three conditions for deciding the choice of the research methods: (a) the type of research questions posted; (b) the extent of control an investigator has over actual behavioral events; and (c) the degree of focus on contemporary as opposed to historical events.

Table 3.1. Relevant Situations for Different Research Methods (ibid, p. 5)

Strategy	Form of Research Question	Requires of Control of Behavioral Events?	Focuses on Contemporary Events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival analysis	Who, what, where, how many, how much?	No	Yes/No
Historical study	How, why?	No	No
Case study	How, why?	No	Yes

In this table, the five research strategies are distinctively presented with their characters and advantages, but each one could be largely overlaps with each other, especially when the three conditions mix in specific researches:

“...the first and most important condition for differing among the various research strategies is to identify the type of research question being asked... ‘what’ questions may either be exploratory (in which case any of the strategies could be used) or about prevalence (in which surveys or the analysis of archival records would be favored). ‘How’ and ‘why’ questions are likely to favor the use of case studies, experiments, or historical studies.” (ibid, p. 7).

Back to the three research questions: “(1) *What* DE could be found in mathematics teachers’ documentation work? *What* are the components of DE and the corresponding performances of the expert teachers? (2) *How* DE gets developed through teachers’ collective work? *What* are the factors that could be supportive for DE development? (3) Through two contrasting cases, *what* are the similarities/differences of DE in the two cases? *What* could be borrowed and adapted for a mutual benefication?” Seeing from the form of the research questions, they are mostly about “what” and “how”. Then the control of behavioral events is not necessary, because this research aims to see the natural facts of teachers’ working with resources. Lastly the research aims at following up teachers’ current activities, with interviews on their previous working experiences as the contextual information. In this way, there are only two strategies remained from table 3.1: case study and survey.

Strategy	Form of Research Question	Requires of Control of Behavioral Events?	Focuses on Contemporary Events?
Survey	Who, what , where, how many, how much?	No	Yes
Case study	How , why?	No	Yes

Finally, case study is chosen also due to its ability in dealing with full variety of evidence:

“Case study ... adds two sources of evidence... direct observation of the events being studies and interviews of the persons involved in the events...the case study’s unique strength is its ability to deal with a full variety of evidence--- documents, artifacts, interviews, and observations.” (ibid, p. 7)

This thesis is also an “investigation”, so some supplementary methods and tools of survey are also adapted. Details about the choice of the case and tools for data collection will be presented further in section 3.2.

3.1.2 Contrasting analysis dimensions

This PhD research is not designed as a comparative study, but an investigation with a common goal (a framework and components of mathematics teachers’ DE model) through two contrasting case studies (China and France). But even so, after the two cases, it is also needed to discuss how to cross the cases analysis by comparing the results and reflecting on the mutual inspirations.

“Comparative studies aim to identify and explain differences of homologous phenomena in different contexts, which “may be based on different assumptions ranging from presumably universal models of mathematical competency, to in-depth comparisons of local practices in two specific contexts, in which one pays the greatest attention to, for instance, the linguistic, cultural, societal, and intellectual specificities of the two environments.” (Artigue & Winsløw 2010, p. 49).

On the one hand, a common framework is needed to permit the comparison; on the other hand, factors of culture and institution need particular attention, comparative researches on didactics often take place within fairly homogeneous cultural and institutional settings, which, in return, make the culture and institution gain less attention.

As discussed in 2.4, DE is assumed as one type of teacher expertise closely situated in the context where teachers work in. I am not expecting to find an universal model of DE, because the contexts (cultural and institutional factors) diverge a lot, and individual teachers’ teaching practice conditions often cannot be changed or decided by themselves, but by other conditions such as school principles, curriculum developers or politicians (Artigue & Winsløw 2010). Based on these considerations, Anthropological Theory of the Didactic (ATD) is chosen as a tool for making contrasting analysis.

Chevallard (2002) proposed, in the ATD framework, a hierarchy of 8 levels of determination (subject, theme, sector, domain, discipline, pedagogy, school and society) (p. 10). In a further study, Artigue and Winsløw (2010) developed it into a 10-level model (Figure 3.1) for making comparison studies.

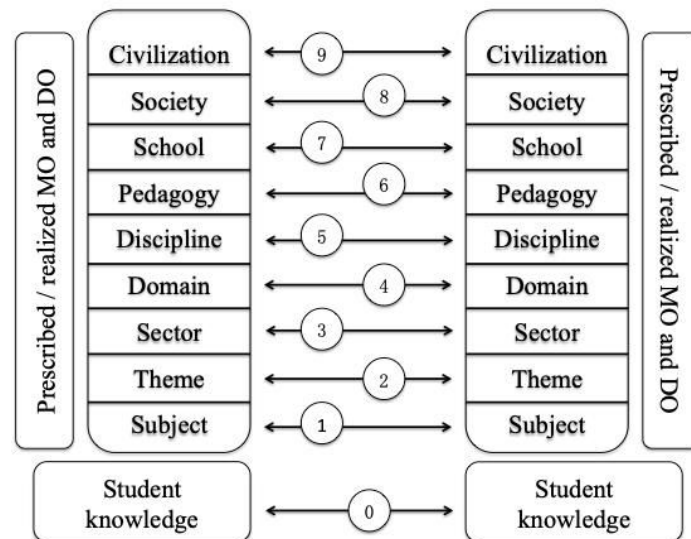


Figure 3.1. Possible levels of comparison of the co-determination of mathematical organization (MO) and didactical organization (DO) in two contexts (ibid, p. 53)

The 10-level (from 0 to 9) were explained as:

0. Student knowledge in one or more specific subjects, situated and articulated within certain themes or sectors.

1. Subject prescribed by programs or official evaluations;
2. Theme prescribed by programs or teachers, or inferred from observation of several subjects within the theme;
3. Sector programs or teachers, or inferred from observation of several themes within the sector;
4. Domain within a given discipline, described in programs or by teachers, or inferred from observation of several sectors;
5. Discipline based on program or other evidence (such as observation and assertions by teachers);
6. Pedagogy prescribed by schools or programs, observed or described by teachers;
7. School or teaching institution, such as the conditions and characteristics of it and the obligations or autonomy of teachers;
8. Societies including in which way the school are governed, founded and systemically organized etc.
9. Civilization or cultural contexts, the principles for the role and meaning of teachers' work, or education ideas.

Levels from 1 to 9 within this 10-level determination run through the case follow up and crossing analysis, which is further concluded as two main levels (Figure 3.2).

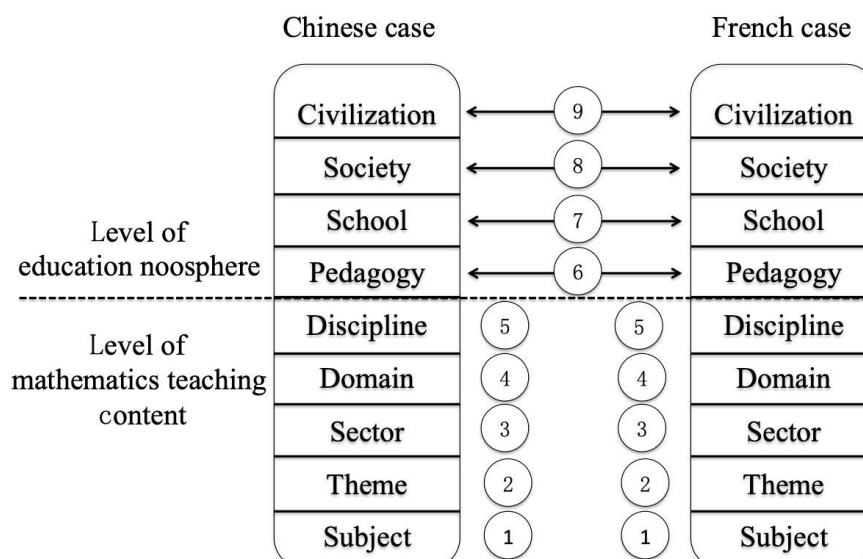


Figure 3.2. Two main levels of case follow up and analysis for the two contrasting cases

(1) Level of mathematics teaching contents, which locates in teachers' specific teaching activities, including the discipline, domain, sector, theme and subject (level 1-5). In this level, the two cases did not take the same mathematics teaching content mainly because of the different curriculum arrangement and teaching progress of each side. For example, during the three years' follow up along with my thesis, teachers in the Chinese case took a regular shift system (the teachers teach the same students and change their teaching grades along with the students), while the French teacher took the semester shift system (the teachers teach the same grades in fixed mathematics classrooms, the students change). Here reminds some questions on the teaching contents: the choice of the topic needs to combine with the research condition, taking what the teachers will teach as their regular job: the Chinese case took a topic of "properties of inequality" (of grade 6) in the domain of algebra, and the French case took "introduction of algorithm" (a new topic for students in grade 6 to 9) in the domain of algorithm, they belong to a larger domain of computation program (see more detail explanation in 3.3 case design).

(2) Level of education "noosphere" (Chevallard 1985), including the pedagogy in the curriculum, the decisions or regulations from school level, curriculum developers or politicians, and the potential cultural influences (level 6-9). Generally, teachers cannot change these factors directly, and have to adapt to and get influenced. In this way, inside each case, the teacher's personal working trajectory, education background, training and working experiences, need to be considered (see more details in Chapter 4 and Chapter 5). Then to cross and compare the results of each case, the level of education noosphere will be adapted for contrasting analysis (see more details in Chapter 6).

To situate individual teacher's resource work to a larger context of culture, institution and language, some work has been initiated, for example in the case of France and Norway (Pepin, Gueudet & Trouche 2013b). In May 2018, the Re(s)ources 2018 International Conference was hold dedicated to teachers' resources work and reflecting on Documentational Approach to Didactics (Gitirana et al. 2018) during the ten years since it was born (Gueudet & Trouche 2008). A young researcher workshop was organized (Gitirana *et al.* 2018 p. 373) with a session specifically for exploring secondary teachers' resource work by analyzing their lexicons when naming and describing their resources and their documentation work in contrasting contexts (Trouche to be published). A comparative study (Wang, Salinas & Trouche 2019) between China (the same case analyzed in Chapter 4) and Mexico was

conducted, and the results showed that how teachers name and describe their resource system and documentation work (see more in section 2.2) provided us a view to see their resource system, and the naming contain the influences from the cultural, institutional factors and personal experiences.

Data for making the contrasting analysis include interviews, and text analysis (such as the curriculum program and national policy documents). The contrasting analysis includes a crossing between Chinese case and French, for distinguishing the similarities and differences of DE in different contexts, and also a comparison between the teachers inside each case, for identifying the characters of DE on those experienced teachers.

The aim of this research is to explore and present the holistic and meaningful characteristics of what happened on teachers, with detail evidences about their choices and usage of resources, the explanations and ideas hold etc. In the following section 3.1.3, the pilot study will be presented followed by a secondly refined model of DE (3.1.4) and based on the reflection, methodology and tools (3.2), as well as case choice and design (3.3) will be presented in details.

3.1.3 A pilot study based on the research proposal in 2014

In 2014, based on my research proposal for my PhD project, a pilot study (Pepin, Xu, Trouche, & Wang 2016) was conducted for exploring teacher expertise through the resource systems of three Chinese high school mathematics teachers. The results brought me the reflections on both the methodology and tools, and my first DE model, as well as the factors supporting and constraining teacher's documentation work.

The three mathematics teachers were selected from a high school where I did a practice teaching as mathematics teacher from September 2013 to February 2014. Built in 2004, this high school is located in Suzhou (a big city in Jiangsu Province) with a school population of 1182 students (in 34 classes) and 136 teachers. In the year we conducted the study, the average age of teachers was 38 years, with an average of 15 years teaching experience. The school had an excellent reputation: in recent years the whole team of teachers had been awarded the title of "excellent teacher community in Suzhou".

Inside this school, teachers of the same discipline shared a large office, providing opportunities for exchange of ideas and for discussing problems face-to-face. Each teacher was equipped with a computer (offered by the school). At least three official mathematics QQ groups (§ 1.2.2) were available for each teacher (at school, district, and city level). Beside the QQ groups, the school had its own online platform, allowing teachers to submit and download resources, such as lesson plans and courseware shared by others, teaching resources purchased by the school, and the official government resources. Particularly, this high school was a key school in its district and was famous for its mathematics teaching, which means students who studied in this high school generally performed better than the other high schools in mathematics exams.

All the teachers who teach the same discipline in this high school were arranged to work in a big common office, and each teacher was equipped with one computer and a fixed office desk. The whole group of teachers constituted a Teaching Research Group (TRG, § 1.3), and often is led by an experienced teacher. Inside each TRG, teachers were further divided into different mathematics Lesson Preparation Groups (LPG, § 1.3) according to the grade they were teaching, and each group was also under a leadership of an experienced teacher, who generally was elected by the teachers and supported by the head of the school. Leaders of TRG and LPG can be the same person. It is a strong teaching team evidenced by the title of "model of teaching experimental reform in Jiangsu province" given to the math TRG. Each

mathematics teacher, generally, was arranged to take in charge two classes (which was called “parallel classes”), except some novice teachers, who was often designated one class.

These three mathematics teachers, with different teaching experience (Zhang - 23 years, Ji - 18 years, Jiang - 8 years), were chosen on the basis of being regarded as experts by the education authorities (each of them was working as the leader of LPG in the grade they were teaching; their classes/students had excellent examination results); among them the most experienced one, Zhang (23 years working as mathematics teachers), was the leader of the whole mathematics TRG in this school.

During almost six months in the same office, I worked with them everyday. Due to my job there, I conducted a long term observation on how the three teachers (individually) worked in the collective activities of TRG (such as preparing mathematics exam papers collectively for a city-level examination); how they interact with the other colleagues (such as giving instructions through informal discussions in the office); and how they used their resources during classroom instruction (for example sometimes they need to prepare or help some teacher to prepare open classes). The observations were kept in a form of field notes as my working report for this teaching practice required by my university.

After a long term observation on their office work and classroom teaching, in the end of February 2014, I conducted two rounds of in-depth interviews about their resource work and perceptions about teaching expertise: (1) The first interview focused on their backgrounds and careers, and work/resource conditions (schools in which they used to work for; collective working experiences with their peers; teaching resources used in their daily teaching especially for lesson preparation). In the end of the interview, each of them was invited to draw a graph to describe their resources (SRRS, standing for Schematic Representation of their Resource System, a tool to be defined in section 3.2.2), to reflect and represent the links of the resources they mentioned in the interview; (2) The second interview focused on the notion of expertise: the teachers were invited to explain and define, for their personal view, what is an “expert” as compared to “novice” teacher, and describe how to develop a novice into an expert, in the end they were asked to explain what they had done over the past five years to enhance their expertise.

The interview audios then were transcribed (in Chinese) and translated (in English). For better transmitting the information of the interview to the non-Chinese speakers, a first English translation was made by me and then checked by a second Chinese speaker, then we took the chance of seminars (under the JoRISS platform, see in section 3.3.1), to involve a non-Chinese speaker discussed, in English, with Chinese students (majoring in education) on the different meanings of the keywords. In this way, a new translation set of these interviews was produced based on negotiations. It is this opportunity we started to reflect on the issues of languages go between Chinese-English-French, and the different expressions of teachers and researcher. A project, “*Contrasting naming systems used by teachers in describing their resources and documentation work, towards a deeper analysis of teachers’ resource systems*” (Trouche, to be published; Wang, Salinas & Trouche, 2019), was incubating since then (see Appendix 1.8).

The results showed huge differences on:

(1) Teachers’ understanding on what could be considered as resources for them. For instance in the SRRS of Ji (Figure 3.3), people (colleagues and friends), software (social communication application like QQ) were counted as his resources.

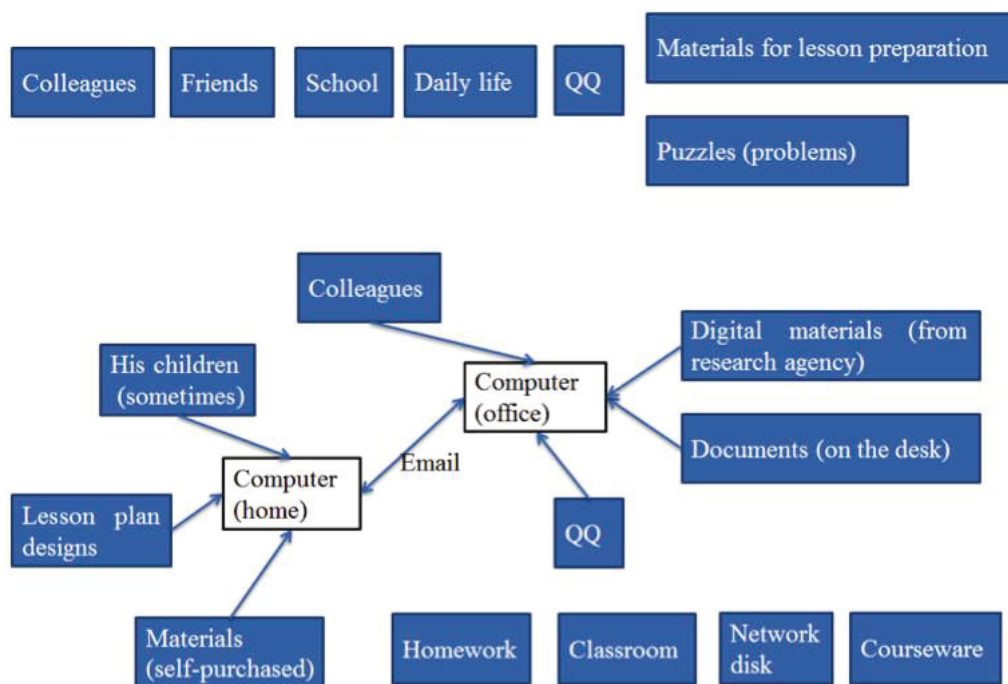


Figure 3.3. The SRRS of Ji

Also, due to the language (resource in Chinese is a more abstract term than material), when explaining the resources, sometimes teacher referred to specific things (like “computer”, “lesson plan design” for Ji), or to general things (such as “daily life”, “classroom” for Ji).

(2) Teachers’ own category of resources, shown in their resource systems (see Jiang’s SRRS Figure 3.4). Teachers could categorize the resources either based on the location (at home or in computer), either according to the source (Jiang emphasized “self-purchased” when explaining his books), or function (for preparing math competitions, or for making exam papers).

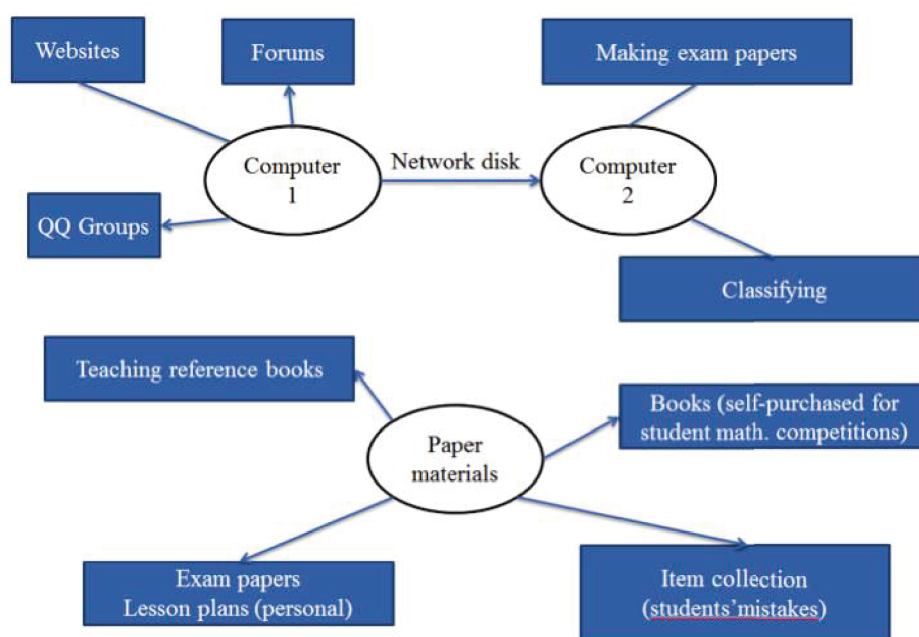


Figure 3.4. The SRRS of Jiang

The category of the resources from the teachers’ view, also echoes the principles of methodology (see in section 3.2.1 in the following), emphasizing the importance of teachers’

involvement in the research. The interview with Jiang showed also some links among the flow of the resources: he had personalized resources (exercises he stored in his computer 2 at home) and organized these resources in a lived way regularly (he explained that each Saturday morning he would classify the exercises he collected and accumulated from the forum or QQ Groups outside his school), then he shared these resources with her colleagues inside his school through making exam papers or exercises dedicated to students. In this high school, each evening (between 18h-19h) the students need to take a one-hour mathematics exercises practice, which is named as “brain exercise (脑力操)” (5-10 exercises on an A4 paper sheet). Such form exercise was a feature for this high school, and also a chance for the mathematics teachers to exchange their resources (exercises): the task of preparing these exercises, or exam papers) was conducted with a duty system: each teacher had to take turn, choosing and selecting the exercises for the whole grade. Jiang was often considered by his colleagues as an “exercise bank”.

(3) The tricks for developing teaching expertise, Jiang and Zhang emphasized the resources accumulation and sharing with others, Zhang and Ji stressed the reflection on teaching practice by combining education researches and theories, and further enhancing the detail teaching practice on to the level of theories (like Zhang, Figure 3.5).

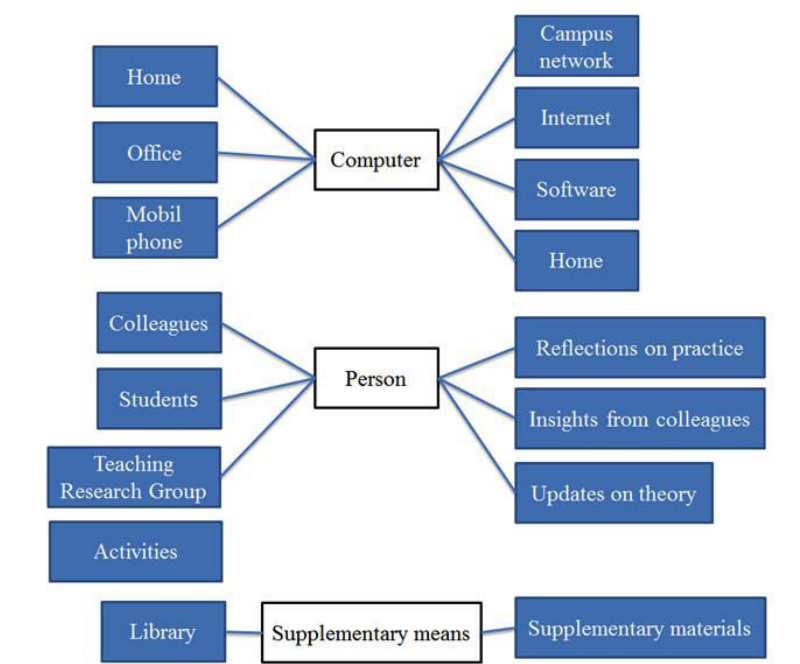


Figure 3.5. The SRRS of Zhang

For Zhang, attending research project with other teachers (outside school) and researchers (from the universities), reading educational theoretical books (from library) were counted as “supplementary means” to obtain resources.

(4) Preferences or personal working habits towards resources, which showed the difference in using digital resources and technology. For example, some centered their work with paper materials like textbooks (in the case of Ji), some spent more time on taking profit of online resources, and accumulating digital resources with computer or cloud drive (in the case of Jiang), teachers could prefer to prepare lessons with PPT (like Jiang), or hand-written lesson plan and teach with chalk and blackboard (like Ji), or mental preparation without any written lesson plans (like Zhang).

To summarize, even for teachers working in a same space with common resources and frequent exchanges, individual’s resource work could diverse a lot and relying on teacher’s

personal education background, working experience or habits, and influenced by cultural and institutional factors, such as the Chinese collective working culture since Confucius, Teaching Research Group settled for teachers' compulsory collective work, and the ICT equipment condition of the school. To learn better teacher's resource system, it needs confronting more the views of teachers. One-off glance is far less enough to know precisely the structure and scope of resource system, let alone how it is organized and integrated. This is also emphasized by one of the principles presented in the following section 3.2.

3.1.4 A reflection from the pilot study to the DE model

The results showed the diverse structures and components of their resource systems, even though they worked in the same space with many shared resources and frequent exchanges: (1) In order to categorize the resources in their resource systems, some referred to the location (at home/office or in computer/notebooks), or to the source (from colleagues or self-purchased), or to the function (for preparing exams or for homework exercise); (2) In order to organize their resource systems, some centered their resources on printed curriculum materials and kept pencil-paper notes, while others focus on digital resources and linking the resources through cloud drives; (3) In order to denote the resource elements in their resource systems, some considered only material resources like textbooks, while others also referred to the collective discussion with colleagues, social communications and cooperative projects.

There were also different strategies in developing expertise revealed from their self-descriptions about some specific lesson preparation activities: someone valued the openness of the resource system, sharing and exchanging resources/experiences with others, someone stressed to combine their teaching practices with educational theories; someone suggested to keep up with the requirements and trends of the curriculum program and examinations.

This pilot study also yielded some reflections on the DE model. When studying an individual teacher's resource system, three aspects are worth to be considered: (1) the collective aspect, especially those with cultural and institutional characters, such as the Chinese Teaching Research Group (section 1.3); (2) the student aspect, which was emphasized by a Chinese teachers in the pilot study as important to get teaching effects feedback for better adjusting their following lessons; (3) the design aspect, which reflects to what extent the resources were proceed, forming teachers' personal resources. DE could differ in terms of these aspects in different teachers.

Based on the reflections from the pilot study, combining the section 2.4.1, some ideas about the nature of DE can be re-emphasized:

- Unnormalized and off standard. DE is neither a standard nor a universal stereotype for all the mathematics teachers, but a framework to be verified and enriched through more contrasting cases;
- Contextually diverse. DE contains a contextual and culture-bound character in different contexts. This is not only that it inherits the culture-bound nature of expertise, but also it echoes the cultural aspect of resources, which makes DE diverse in different cultural and institutional contexts.
- Bi-direction of adapting and self-adaptiveness. As the expertise aspect of documentation work, DE should be evidenced in both adapting resources (instrumentalization) and self-adapting to resources (instrumentation) (see more in section 2.3).
- Multi-dimensional framework. DE could be analyzed in terms of two dimensions: the static dimension, i.e. the structure and elements of resource system; the dynamic dimension, i.e. schemes related to teachers' specific documentation activities, including

how they organize and maintain their resource systems. The resource system develops dynamically along with teacher professional development, but it can be analyzed as a dynamic process consisted by static moments, like making screenshots from a video.

3.1.5 A conceptual model of DE

Continuing the discussion on the nature and assumptions on the DE model discussed section 2.4, this section presents the specific components in following three perspectives: The DE perspective of naming systems, the DE perspective of viewing the resource system, its content and structure (as a static dimension, § 2.4.1, Figure 2.7, a *picture taken at a given moment*), and the DE perspective of analyzing schemes of documentation work (in a dynamic dimension).

The DE perspective of analyzing teachers' naming systems

The names used by teachers for naming both their resources and their documentation work have to be considered as a structured set of words/expressions. They give us a lens for capturing certain properties of their resource system, from a static as well as for a dynamic point of view, for example to understand what a teacher considers as his/her main resources. Three features will be considered for studying these resources: (1) Their content (2) Their position in the resource system (their links with other resources) (3) Their activeness (are the resources often used? How are they managed?)

The DE perspective of analyzing the resource system with respect to different views

Resource system is a dynamic entity, but it could be studied in some given moments. These given moments provide us the chances to see the structure and content of resource system in a static view, which is called the static dimension related to the structure of teacher's resource system. We propose six views (see in Figure 1). A "view" could be understood as a lens used by the researchers to study the resource system and its structure/elements. Three of them (collective, student and design), as discussed before, were inspired by the pilot study section. The other three were chosen concerning the key words of the research field: mathematics and didactics (Gueudet & Trouche 2009), and curriculum (Pepin et al. 2017). The relevance of these choices will be questioned over our case studies.

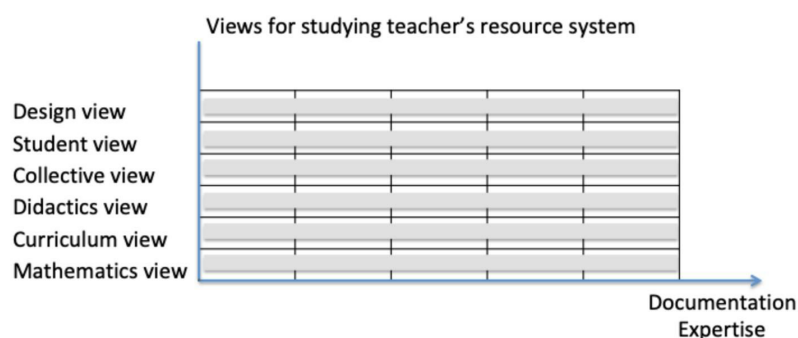


Figure 3.6. The six views for studying teachers' resource system

The horizontal axis denotes that DE is developing continuously over the time, but it does not mean that an advanced or expert teacher must be strong from each view. Besides, the evaluation of DE is not discussed in this study. On the vertical axis, there is no hierarchical order among these six views. One resource can be seen from several views. For instance, inside a teacher's resource system, a curriculum program could be seen in both, the views of didactic and curriculum.

- The mathematics view allows the teachers to gather mathematical information and make logical considerations from the perspective of mathematics;

- The curriculum view assists the teacher to catch the ideas and requirements from the curriculum program or the textbooks;
- The didactics view distinguishes teaching as a profession (Berliner 1988), providing the principles guiding teachers' practice and resources choices related to their teaching and school settings (this view integrates for us both elements of mathematics teaching content and elements of education noosphere, see Figure 3.2);
- The collective view refers mainly to professional collectives, allowing teachers to take profits from the collective interactions, enriching their resource system with new resources, or learning new schemes of working with resources;
- The student view allows the teachers to arrange their resource design in terms of the students' needs/interests, and take their feedbacks as important references to adjust the following teaching;
- The design view is closely linked to teachers' personal documentation work habits and preferences.

The six views and three indicators are proposed for exploring the structure and elements of the resource system, which is considered as a static dimension. The management of the resource system will be considered as part of the dynamic dimension in next section.

The DE perspective of analyzing schemes of documentation work

The dynamic dimension of DE is assumed to consist of different schemes related to interaction with resources, including how to manage the resource system, and how to integrate the available resources to face situations.

As discussed before, schemes (and their four components) are inseparably linked to situations. For teachers, the situations are either familiar or unfamiliar. Thus I assume that no matter if the necessary competences or resources are ready or not for the situations, the scheme can be decomposed into sub-schemes, and named based on the goal/sub-goals of the situations. The analysis on teachers' specific activities will take the scheme/sub-scheme and situation as the contexts and basic units.

Similarly to what Shulman (1987) proposed in his model of *Pedagogical Reasoning and Action*, the six activities (comprehension, transformation, instruction, evaluation, reflection and a new comprehension) form a cycle of teacher' pedagogical reasoning. Inspired by this, five phases were selected based on the definition of documentation work (Gueudet, Pepin & Trouche 2012): searching, selecting, adapting, accumulating and reflecting (Figure 2). They do not necessarily occur in a sequential order. Since documentation work is a continuous "process", DE could be evidenced in more than five phases if further studies subdivide the process in depth.

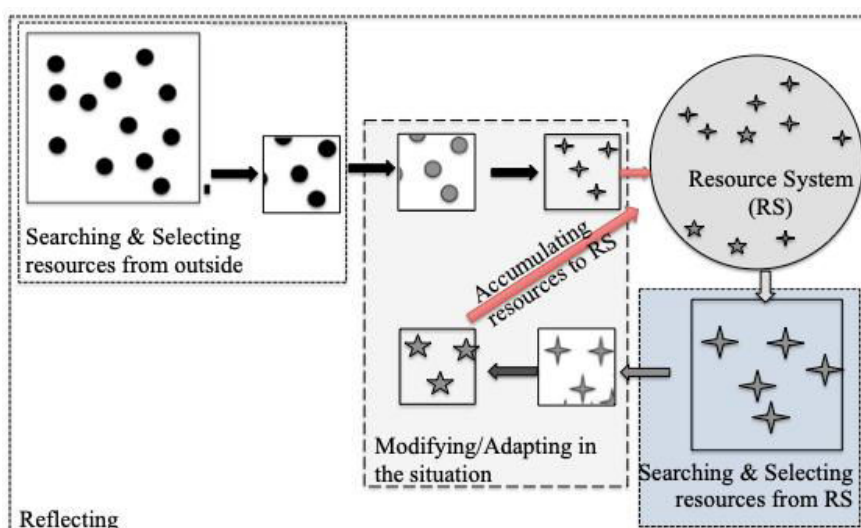


Figure 3.7. The dynamic five phases process for following DE

Figure 3.7 shows a process of teacher's documentation work and how a resource system gets developed: in front of a given situation either familiar or not, a teacher could search for resources either in (the grey circle filled with stars) or out (the white square filled with black dots) of their resource system. The four-point and five-point grey stars mixed in the resource system refer to different types and functions of resources. For example, a teacher selects resources from her/his resource system (four-point stars in blue square), adapts and modifies them according to the needs of situation (from four-point stars in white square to five-point stars in grey square), and in the end accumulates it back to his/her resource system. While she/he could also search from sources that are not familiar for them (black dots in white square), makes modifications for making them adaptive to the situation (from grey dot in white square to four-point stars in grey square), then accumulate to the resource system. The changes of the colors and shapes refer to the transformation. Reflecting accompanies the whole documentation work.

The five schemes involved in the current conceptual model are not presented in details with all of their four components (2.2.2), but based on the second (rules of action) and third component (*operational invariants*), namely the conceptual basis for choosing the most appropriate rules of action. The specific contents of the five schemes, as well as the remaining components (goals and inferences) will be illustrated in specific situations of the contrasting cases.

- Scheme related to searching for resources.

Searching for resources includes the integration of available resources and experiences. Generally the expert teachers bring richer and more personal resources of information to the problem that they are trying to solve (Berliner 2001), draw on their previous teaching experiences as well as the reflections thereon (Borko & Livingston 1989), or use planning materials from previous years as cues (Livingston & Borko 1989).

- Scheme related to selecting resources.

Selecting resources is a process of identifying the useful resources by referring to factors like teaching objects, students' learning conditions, requirements from the curriculum program, and teachers' own understanding about what should be taught.

- Scheme related to adapting resources.

Adapting resources comprises a process of transforming the resources into a form ready to be

used, or familiar for the teacher. Experienced teachers can balance content-centered and student-centered instruction (Borko & Livingston 1989), and adjust syllabus guidelines and institutional expectations with their own educational beliefs and ideologies (Calderhead 1984).

- Scheme related to accumulating resources.

Accumulating resources belongs to the resource system management. Experienced teachers have the consciousness to include, share off and store the resources in a structured way. Since accumulating resources depends on the personal working habits, it could differ among different teachers.

- Scheme related to reflecting on the documentation work.

“Doing and thinking are complementary” (Schön 1983, p. 280). Reflection appears in the whole documentation work, and makes the development of the resource system and schemes possible.

There are also some inspirations on the methodology from this pilot study, which is to be presented in the following section.

3.2 Methodology and tools

In this section, methodology will be firstly presented from main principles (3.2.1), then followed the tools for enlightening my first research question, the model and components of DE from static dimension (3.2.2) and dynamic dimension (3.2.3); for answering the second research question about how DE get developed through collective work, tools for following the collective aspect (3.2.4) are presented. The third question about the lessons could be borrowed will be drawn in Chapter 6, based on the results in Chapter 5 and 6.

3.2.1 Main principles of Reflective Investigation grounding the methodology

This section presents the five principles of the main methodology, reflective investigation (Trouche, Gueudet & Pepin, 2018 online first), which grounds the following methods and tools.

Reflective investigation was proposed as an empirical research methodology since the birth of DAD (2008). With an emphasis of “reflective” stance of the practitioner (Schön 1983), it involves the object of study (targeted teachers) in the study (Gueudet, Trouche & Pepin 2012), especially in the data collection stage. Teachers’ reflection on their previous answers provides a continuous data flow and hence an opportunity to identify and follow the changes and developments. Besides the involvement of data collection, this methodology also emphasizes teachers’ involvement of teachers’ professional development along with the researchers. For example, concepts like “resource system” or “documentation expertise” are both notions from research fields, which are also being studied in the research work where teachers involve in. In this way, involving the research also brings teachers opportunities to reflect on their own professional development through the researches.

The methodology of reflective investigation was proposed with four principles (Gueudet, Pepin & Trouche 2012), then expanded into five (Trouche, Gueudet & Pepin 2018 online first): principle of broad collection of the material resources used; long-term follow-up; in- and out-of-class follow up; reflective follow-up; confronting teachers’ views and materiality of their work. These five principles instruct the methodology and tools design for analyzing teachers’ documentation work.

- A principle of *long-term follow up*, for documentation geneses are ongoing processes, and also, schemes develop over long periods of time, which need a long-term follow

up “within practical constraints”. A documentational genesis is an ongoing process, and deeply interconnected with the teacher’s professional development. As what had been discussed on scheme in section 2.2.2, the formation/development of scheme takes time and different situations;

- A principle of *in-class and out-of-class follow up*. The classroom is an important place where teachers implement, adapt, revise and improve lessons and resources, and make direct interactions with students, getting their feedback as an important resource. But documentation work also occurs outside classroom, such as at home or in their staff rooms at school;
- A principle of *broad collection* of the (material) resources used produced throughout the documentation work, which goes along with the wide meaning of resource (anything can re-source teachers’ activity). A broad collection of the (material) resources could beyond the form of digital or un-digital ones. The scope of resources considered by DAD is large, resources could be everything with the potential to re-source teacher’s activity, and document could be anything that evidence and document the resource work. However, there remains a preference of “material”. As announced by Trouche, Gueudet and Pepin (2018, Online first), the resources studied in DAD lean on the definition of “mathematics curriculum resources”(Pepin & Gueudet, 2018 online first): “all the material resources that are developed and used by teachers and students in their interaction with mathematics in/for teaching and learning, inside and outside the classroom”, including text resources (such as textbooks, teacher curricular guidelines, websites, worksheets, syllabi, tests), other material resources (such as calculators), and digital-based or ICT-based curriculum resources (such as e-textbooks). The material aspect of resources is not referring the existence form of the resources, but emphasizing the “evidential” function of document: social resources (such as conversation among teachers) (Pepin & Gueudet, 2018 online first) could be resources only when there infers specific topic/subject with the potential to evidence the resource work, another example, the interaction between teacher and students could be a resource only when the teacher gets specific feedback from students, otherwise, the interactions is just a form of sourcing resource, not the resource itself.
- A principle of *reflective follow-up* of the documentation work, involving the teachers closely during the whole data collection phase, which serves also the previous principles of *in-class and out-of-class follow* and *broad collection of the resources*. Reflection is emphasized by DAD, in which teacher’s views on her/his documentation work are required to be confronted. Two reasons are located: (1) the documentation work is a dialectical process of the productive (instrumentalization) / constructive (instrumentation). Teacher produce document with resources, meanwhile the activity also entails a modification of the teacher’s professional practice and beliefs. (2) Seeing from the final aims of this approach, it is used for better understanding teachers’ work, and give advises to the policy makers for supporting teacher professional development. The involvement of teachers into the research, is indeed a process of cultivating teachers’ conscious on resources work.
- A principle of confronting the teacher’s views on her documentation work, and the materiality of this work. Gueudet & Trouche (2009) announced in their perspective part when DAD was proposed that three intertwined components of a resource/document require to be taken into account: the material component, the mathematical content component, and the didactical component. The three components decided that researches on teacher documentation work needs to be rooted in empirical studies within specific cases, and the follow up needs to be precise on the

level of discipline (for mathematics teacher for example), and of didactics (for general teacher). Hence, on one hand, the research scope of DAD, currently located in education field for studying the process of teaching and learning; on the other hand, teacher documentation work needs to be studies in a holistic system, with different levels (perhaps more than resources, discipline and pedagogy) on the work, also on the individual teacher by tracing back her/his past experiences: “Following the work of a teacher means following interrelated stories: stories of the collectives she is part of, stories of their documents, and stories of her professional growth” (Gueudet & Trouche 2012, p. 320). The term of “story” was replaced by ‘genesis’ to “underline the idea of development boosted by itself, fed by an environment, directed towards a higher level of organization.” (ibid., p. 320).

As announced in 3.1, this research aims at making empirical case study with survey methods as supplementary tools. In the following sessions, tools for data collection are presented inspired by and corresponding to these principles.

3.2.2 Static dimension: From Schematic Representation to Inferred/Reflective Mapping of teacher’s resource system

This section presents the tools of inferred/reflective mappings of resource system, for following teacher’ resource system, which could be analyzed for the static dimension of DE (model in 2.5).

As presented in section 2.2, in terms of resources, *sets* of resources and resource *systems* are not the same entities, as resource system is above all a structured entity.

*“The researcher visits the teacher... and asks (during the first interview) the teacher to draw a **schematic** representation of the **structure** of the resources she uses.* (Gueudet & Trouche 2012, p. 28).

The *Schematic Representation of the Resource System (SRRS)* was proposed by DAD as a tool for representing the structure of teachers’ resource system in the teacher’s view, and it was adapted in our pilot study (section 3.1.3): the three Chinese mathematics teachers were asked to draw a SRRS based on what they had explained for resource work,

Some reflections were drawn from this pilot study, for better adapting this tool:

(1) From the “representation” to “mapping”. As discussed in the part of scheme (section 2.2) and the differences between artifact and instrument, resources and documents (section 2.3), representation is a complex expression between the subject’s mental world and the outside. On the one hand, it takes time to “represent” with the reflection on their previous experiences and understanding of their resource systems, and on the other hand, it may appear information loss when trying to produce and express out such representation. In this way, I choose *mapping* instead of *representation*, for mapping is less formal than representation, and it could lead to different drawings from different views, this make it more flexible for teachers to express their understanding on their resource systems.

(2) From “schematic” to “reflective” and “inferred”, which is used to distinguished the mapping from the view of teacher and of the researcher. As announced in the pilot study (section 3.1.3), the three teachers draw very different SRRSs even they worked in the same high school and were exposed to a common working space, and shared many common resources. This reveals the differences on understanding “what is resource system” between teachers, and also between teachers and researchers.

As announced for the first DE model (section 2.4), resource system itself has both a static and a dynamic dimension, it could be analyzed through static mappings or graphs for some time

points of teachers, and it is also developing and changing along with the time, which means that teachers could have different mappings in different periods, the individual teachers could tell by themselves about how they organize and represent the resource systems in a developing and relatively complete way.

There are also some inspirations on the methodological tools. Schoenfeld (2011) pointed out that one needs to be careful about researchers' own orientations on expertise. This echoes the principle of "confronting teachers' view" (Trouche et al., 2018 online first) in DAD. To understand the structure and elements of teachers' resource system from their own views, the tool of SRRS is not enough to get a deep understanding on teachers' view on their resource and the structure of their resource system, thus it is expanded into (1) a view from researcher, "*Inferred Mapping of Resource System (IMRS)*" (made by the researcher based on the observations on and interviews with the teachers about their resource work) and (2) "*Reflective Mapping of Resource System (RMRS)*" (made by the teachers based on their own reflection) (Rocha 2018; Wang 2018). To be noticed that, IMRS and RMRS were proposed to better understand the structure of resource system. A project closely linked to this was presented also in section 3.1.2, using teachers' naming system when they were describing their resources and documentation work. With a consideration of flexibility, the order of IMRS and RMRS could be different, for example, a reflective version of IMRS could be developed through a further interview where the teacher is asked to make modifications/complements/explanations based on the previous IMRS drawn by the researcher.

To capture the successive changes of teachers' resource systems, these mappings need to be conducted repeatedly for obtaining different descriptions on resource system from the teachers, and for catching the changes on the drawings caused by teachers' better understanding of their resource system, or the development of it. Considering flexibility, the adapting order of IMRS and RMRS could be different: a RMRS can be developed through a further interview based on the previous IMRS, and vice versa.

To be noticed, the mappings are neither one-off nor final version of representations of teachers' resource system. On one hand, resource system has a complex structure and could be represented in several ways, mappings of representations can only describe part of the whole resource system; on the other hand, resource system is also in a dynamic process of being improved, complemented, and reorganized continuously, and gets developed along with teachers' professional development, teachers could also have further/deeper understanding towards their resources and resource system, along with growth of teaching experiences and technology development, the different mappings could reflect their contemporary understandings at those moments.

As what had been presented in 2.4.2, the static dimension is conceived to be explored through six views (mathematics, didactics, curriculum, student, collective and design), with three factors to consider (resources content, activeness and position in the whole structure). Hence, only some mappings are not enough to know the resource content and its activeness, supplementary tools are also needed: a survey of the teachers' resource working environment by interviewing principle or other teachers or with some official documents; (reflective) interviews on resources about what are they, observations for how are they adapted, some intense period follow up about how the resources are designed and used etc.

3.2.3 Dynamic dimension: RI-Box, interviews, observation and videos

This section presents the tools for following and analyzing the dynamic dimension of DE. The tools for case follow up and data collection, including two types: a general long-term follow

up with survey tools like RI-Box (see below) based on technology; and a face to face follow up with interview, observation, field notes and video records for specific teacher resource working activities, including lesson preparation/implementation/ reflection. The tool for case analysis, AnA.doc, is also developed and presented.

RI-Box for reflective, long term, out-of-class and distance follow up

Considering the methodology principles of reflective, long-term, out-of-class follow-up, a tool of online “Reflective Investigation Box (RI-Box)” was proposed, for making long-distance follow-up due to the constraints of long-distance locations of the two cases, is developed with the support of available technologies or applications. The choice of the technical supports depends on the using habits or popularity of the targeted teachers (for example, Dropbox in France, QQ in China). The “Box” in RI-Box is a metaphor of online “space” for making a remote follow up of the teachers, it could be:

- A natural space that the teachers actually build and use, then the RI-Box could be built just giving the researchers an access permission, so that the researchers can enter and observe regularly to follow the exchanges in this space. For instance, a common Dropbox folder shared among a group of teachers, where they usually upload/ revise/ exchange the resources for teaching (articles related to the topic to be taught, videos as references for some activities etc.), or a WeChat chatting group (§1.2.2) gathering some teachers where they often share information/ messages or various forms of resources (photos, videos, or documents etc.) in it.
- An artificial space created particularly for the research, in which the targeted teacher could share her/his resources that used in her activities (such as lesson plans, screenshots of her/his blackboard writings, documents that were took as references for lesson preparations etc.), and also exchange questions and answers with the researchers regularly as informal interviews, either about the resources in the RI-box, or about lesson observation, or some complementary questions.

The RI-Box is a tool for following up teachers’ resource work in distance. Besides, it is also a kind of data: a space for teachers’ collective work, which deserves some attention on the contextual factors, such as the functions of this space, the mode of their collective work, the roles of the members etc. This links closely to taking seriously cultural, institutional and technological considerations.

According to the principles of “long-term”, “in-class and out-of-class”, and “broad collection of the material resources”, the whole data collection was conducted in successive stages combining a various of tools in each case contexts:

Stage 1: Interviews about teachers’ resource work and their resource systems;

Stage 2: An intensive follow-up and observation (generally lasts three months) for their school activities, including classroom teaching and regular meetings with other colleagues. Field notes were taken by the researchers;

Stage 3: Long-distance follow-up through RI-Box. Meanwhile, printed logbook was also adapted and the teachers were asked to fill it during a short period (one months for example);

Stage 4: With some specific teaching topic, a series of videos, including teachers’ collective lesson preparation work, lesson implementation, and reflective interviews after the lessons were recorded as videos for a further analysis.

Considering the different contexts, there could be some differences when adapting the tools. Further explanations will be presented in 3.4 the research design part.

AnA.doc: an online data shared platform among the researchers

I also took the advantage of AnA.doc as a tool for making collaborative analysis with other researchers. AnA.doc is a platform developed for the analysis of teachers' documentation work (Alturkmani, Daubias, Loisy, Messaoui, & Trouche, to be published).

On the platform, AnA.doc distinguished two essential levels: a level of situations, for *storing* data, a situation here infers an occasion for teachers to work for/on/with resources; and a level of Webdoc, a Webdoc represents a preliminary analysis, supported by excerpts of data, and opening a discussion for *analyzing* the data. Each situation can be designed into one or more *Webdoc* for analyzing it according to a given questioning or research interests of the researchers. Thus it is possible to design alternative Webdoc for developing different analysis.

The data related to specific situations of teachers' working with resources were shared among a team of researchers. Situations include lesson preparation videos, lesson implementation videos, and reflective interviews. Each situation contains a self-presentation of the teachers (about their working context, their educational backgrounds, training and working experiences etc.).

The tool of AnA.doc was not designed at the beginning for my research, but was created during the research, when we found the potential value of sharing data, and inviting different researchers to the data analysis with diverse views on both theoretical frameworks and analysis methodologies. In 2018, a collaborative analysis on the French case (a situation of collective lesson preparation) through different theoretical frameworks was conducted (Trouche, Gitirana, Miyakawa, Pepin & Wang 2018), details about this analysis had been presented in section 2.3 and will also explained further in Chapter 5, the French case analysis.

3.2.4 Collective dimension: Documentation-working Mate

This section presents a specific methodological tool for following the collective aspect., the documentation-working mate (DWM).

To understand better the influences from collective aspect on teachers' documentation work, DWM is proposed as a tool for the researches to pick up the smallest unit of teachers' existing collectives (Wang, Trouche, Pepin 2018; Wang 2018). DWM refers to a relationship within a pair of teachers, who work closely on resources, and have mutual influences on each other's documentation work. B is the DWM to A, it also means A is the DWM to B. In this research, with a main targeted teacher to follow, the information from her/his DWM could offer a supplementary view, meanwhile the interactions between the DWMs allow us to see the mechanism of their collective working and the influences to them.

In this study, the term of mate is chosen instead of peer. Turner and Shepherd (1999) proposed the notion of "peer" in the field of "peer education", with a series of standards for defining "peer". Mate, according to the Oxford Dictionary, refers to "a fellow member of joint occupant of a specific thing, like table-mate" (with the "underlying concept being that of eating together"). Considering teachers' collective working condition, mate is more proper: they are more probably to work in a mixed collective, with different teaching years and expertise levels.

The choice of DWM is made by the teachers, through a two-way choice, to get a smallest collective consisted by two teachers. In the end of interview, teachers will be asked a question: "Could you point out someone who works most closely with you in your resource work? The one who influence you most, or you often help each other?" The teachers could offer more than one name, then it is the turn of researcher to pick one of them as her DWM. In this way, DWM is also a relationship between the two teachers, which means the two teachers are

DWMs for each other. It is assumed that DE gets developed through the collective interactions between DWMs. The two DWMs should be taken as a whole, a zooming-up of the larger collectives where they both worked in, which reveals that the DWM needs to be chosen from the collectives where the targeted teachers were working, such as TRG, or cooperative projects in AeP (more details to be seen in section 1.3 and 3.3).

The choice is generally decided with the following characteristics:

1. There is no boundary or constrain of age/education background/expertise levels for being Documentation-working Mate, they could be either experienced or advanced teachers, or colleagues with different working experiences;
2. The most important indicator is the resource aspect, “interacting frequently, or influence deeply in resource work”;
3. Each teacher could have several DWMs, the relationship between he/she and his/her DWMs could be colleagues, or mentors/apprentices, or trainers/trainees etc.

Besides the targeted teacher, her/his DWM will be followed in a same way as the targeted teacher, especially the video of teachers’ resource working, their collective work will be paid particular attention. Of course, since teachers’ collective work takes place in different occasions with different technologies, the DWM is not the only tool for following the collective work, there are also the data sources from the interview with the teachers, the short-term intensive observation of their school work and interactions, and also the long-term long-distance follow up through RI box. The detail procedures will be presented in section 3.3, the case design part.

3.3 Cases design

This section presents the case design in four parts: a background of the institutional supports from the research projects (3.3.1), then the cases choice criteria (3.3.2), the tools adapted in Chinese case (3.3.3) and French case (3.3.4).

3.3.1 Project background for the research

This PhD project is a cross field of two projects: CORE-M (Collective, Resources, Mathematics) in China and France developed in the frame of the JoRISS¹² platform (Joint Research Institute for Science and Society) and ReVEA¹³ (Ressources vivantes pour l’enseignement et l’apprentissage) project in France.

CORE-M project (2011-2014) aimed at exploring the role of collectives and resources for developing teacher expertise in a time of change, particularly in the field of mathematics teaching. It was founded and supported as a sub project by JoRISS, and a follow-up of the C2SE (French-Chinese Lab for comparing Curricula in Science Education) project, which dedicated to carry out a descriptive comparative study on the science curriculum (mathematics, physics, chemistry, biology, technology, and comprehensive science) prescribed for compulsory education and effective teacher resources between China and France. The Chinese case involved in this study was decided in the end of CORE-M project in March 2014. In that moment, CORE-M project was conducted in a middle school in Shanghai, and this middle school later became my case (see more detail in section 3.3.3).

¹² JoRISS is a research platform shared by ECNU and ENS de Lyon, supporting collaborative projects in several scientific fields including education.

¹³ ReVEA is a national project funded by the French National Agency for Research

While ReVEA was a French national project (Gueudet, Boilevin, Gruson, Jameau, Le Hénaff, Lebaud & Quéré 2018), aiming at doing researches about the lived resource for teaching and learning resources. This project went through my whole PhD thesis (during 2014-2018). The French case was chosen and analyzed also for this project. The data collection was conducted under the framework of ReVEA project. For example, the interview with the targeted teachers about their resource work used the same interview structure of the ReVEA project.

Another kind of support was the financial support for collecting data between the two countries, and conducting sub projects for more specific research issues (for example the AnA.doc project presented in section 3.2). Further details for each case are coming in section 3.3.3 and 3.3.4.

3.3.2 Criteria for the case choice (teacher, school, teaching contents)

This section presents the criteria for the case choice, including three parts: choice of teachers, choice of school, and choice of mathematics teaching contents.

The choice of teachers: service year, recommendation, activeness in collective

This section presents the criteria of the teacher choice. The case study is not for “representative” of an “average” teacher, but an advanced case, due to (1) their willingness for participating this research, (2) teaching performance recognized by their colleagues or leaders; (3) stable and confident resources usage; and (4) rich collective working experiences as leader or core members of existing collectives.

Experience is a crucial factor but not an absolute reason for the choice. Long teaching experience does not lead to high teaching expertise, even though distinguishing the two is difficult (Berliner et al. 1988), and probably the growth of some teachers’ expertise stalled despite their continuing to accumulate teaching experience, till they retire (Berliner, 1988) (Lian 2008). In the studies about expert teachers, the service length diverse a lot: “more than 5 years of teaching experience” (Carter, Cushing, Sabers, Stein, & Berliner 1988); “at least 7 years of classroom experience, including 3 years or more in the subject s/he now taught” (Moallem 1998); “at least 10 years of teaching experience” (Gu, & Wang 2006; Li, Huang & Yang 2011; Li & Huang 2013); “an average of 12.6 years teaching experience” (Lin 1999); or “at least 15 years of teaching” (Lian 2004, 2008). In the “five stage model of pedagogical expertise development”, Berliner (1988) inferred the time for being novice (first-year), advanced beginner (2-3 years), competent (3-5 or more years), proficient (after approximately 5 years), but only expert, he did not notice the year of becoming an expert, because only a very few number of proficient can move on to this stage. Thus, the service year of the teacher chose need to be as least 5 years, the longer, the better.

The recommendations could come from school principals (Carter, Cushing, Sabers, Stein, & Berliner 1988), or colleagues who used to observe their lessons (Han 2005; Li et al. 2005). Also, those who have cooperation with local universities (Allen et al. 1997) and recommended by the county teacher center coordinator or university faculty member (Livingston & Borko 1989), or whose students had been in top 15% in standardized tests (Leinhardt, 1986), or who had researched senior level or special rank (Gu & Wang 2006; Li, Huang & Yang 2011; Li & Huang 2013), or served either as senior teaching consultant in their school district or chairs of mathematics teacher committee in local schools, and mentored student teachers (Lin 1999). Yang (2014) summarized 5 criteria for identifying expert teachers: teaching experience; student achievement; social recognition and reputation; principal's nomination; and professional or social group membership. Since teachers were working under quite different conditions in the respective countries, or even in same countries but in different cities or schools, thus rather than sampled for ‘typicality’ (to represent a

typical teacher in the context), I chose one experienced teacher from each educational environment, and one Documentation-Working Mate for each teacher.

Collective working, as discussed in Chapter 2, is unavoidable for teachers' daily work, and is believed to be beneficial for teacher professional development. For better understanding the collective working aspect of teachers' documentation work and how it helps teachers' documentation expertise development, the teachers are chosen from those working actively as the leader or core members in collectives. It is better if the teachers chosen have a habit of working collectively (like the French case), or have an ordinary collective working activities (like the Chinese case), or they personally have some roles to work collectively with others, for example, the teacher in Chinese case has to instruct novice teacher, the teacher in French case holds a position in in-service teacher training. In this way, the collective working of the teachers chosen will be able to be followed and observed in a natural and active way.

The choice of the schools: supports

This section presents the choice of the school from a consideration of the project supports.

The last but very important criterion is the supports of the schools where the teachers work in. As presented in Chapter 1, there are different working culture and collective working forms for teachers in China and France (see more details in section 1.3). To follow the teachers' work at school and their collective working with other colleagues, is sometimes disturbing for teachers' regular job and school work. This makes the supports from the schools necessary. In this way, the schools were chosen firstly for consideration of commodity, there are or were some cooperative relationships with the university of institutions where I worked in (ECNU vs. FIE). For example, the middle school in the Chinese case is associated to my Chinese university, and linked to the CORE-M project (see more detail in 3.2), while the middle school in the French case is a member of AeP (see more detail in 1.3) and also involved in the ANR ReVEA project (see more detail in 3.3.1).

The choice of the Mathematics teaching content

The tools as well as the specific choice of the teaching contents are different, due to the different contexts. In the following section, the choice of tools and mathematics teaching content will be presented respectively.

The choice of “properties of inequality”

For the mathematics teaching content in the Chinese case, “the properties of inequality” was chosen. It was the content of grade 6, for two reasons: the teachers were going to teach this topic according to their teaching plan when I went for the data collection, and the targeted teacher Gao was appointed to instruct her apprentice, Yao, for preparing an open lesson on this topic. This open lesson preparation provides a good chance for research to see the intense collective working between Gao and Yao. Appointed by the principle, the novice teacher, Yao, had to prepare this lesson carefully with the instruction of her mentor Gao. Since it was the first formal open lesson after Yao started to work in this middle school, the teaching results would be closely linked to her teaching evaluation: this was a crucial occasion for both Gao and Yao, and a chance to see their intense collective documentation work on the topic of algebra.

The choice of “introduction of algorithmic”

“Introduction of algorithmic” was chosen as the teaching content of the French case. I chose this because it was a new teaching content introduced for the first time to the new French curriculum implemented since September 2016 (MEN, 2016), in middle school stage of cycle 4 (grades 7-9). For both Anna and Cindy, they had no experiences in teaching this topic, nor

received any training about how to teach it. According to the requirements of the new curriculum, teachers have to coordinate within the same cycle (see section 1.1.2). In this way choosing this topic provided a chance for the researchers to see their intense documentation work, on a topic both close to algebra (conceived as a program of computation) and far from ordinary curricular mathematics (Modeste 2012; Modeste & Ouvrier-Buffet 2011; Modeste & Rafalska 2017, Rafalska, 2019).

Contrasting the two cases, although the teaching contents are different (inequality vs. algorithmic), they are linked to the field of algebra, which holds an important position in the curriculum in both cases. Due to the administration differences, the teachers selected also teach in different grades (grade 7 vs. grade 6/8), but they are both experienced in teaching all the grades, and hold responsibility in organizing the mathematics teaching in their schools. The collective working contexts, especially the choice of their DWMs, are mainly decided by their nature working condition, in the Chinese case there are three teachers, consisting by one very experienced teacher and her two apprentices; while in the French case there are two teachers who often work together equally with almost the same expertise levels and working experiences. Specific implementation of the tools will be presented in the two following sections.

3.3.3 Tools designed and prepared for the Chinese case data collection

This section presents the tools for the data collection in the Chinese case. A further presentation about the tools adapted along the timelines to see in section 4.2.

1. Observation, field notes and formal/informal interviews (in 2017). At the beginning of the follow-up, an intensive follow-up of Gao was last 3 months, including a three-week full-day observation of her school activities, both her classroom teaching and her office life. During this three months, her resource work, including the resources she prepared and used for mathematics teaching, and the way she accumulated and shared out with others etc. Field notes, from the observation and informal interview about the resources usages were taken by the researcher.
2. IMRS and R-IMRS (in 2017). In March 2017, for each of the teachers interviewed (Gao, Yao, Liu and Zhang), after the interview about their resource work, I draw a mapping to represent their resource system, which is called Inferred Mapping of Resource System (IMRS), then each of them will be invited to a second interview to make some modification or supplementation based on IMRS, which is called Reflective IMRS (R-IMRS). In October 2017, the main teachers (Gao & Liu) were invited to draw a second mapping of their resource system, which is called Reflexive Mapping of Resource System, in this time, I did not show their previous mappings to them. The differences and links between these different versions of mapping of resource system will be explained further in Chapter 4.
3. Video records for collective MOKE activities (in 2017), including open lesson implementation, collective discussion after lesson, individual interview with the teacher who gave the lesson.
4. Specific tools for a continuous follow-up:
 - Logbook of daily resources (one month in 2017). After the open lesson observation, and before I left China for France, I printed a logbook and sent it to Gao, Yao, Liu, and Yao. On this logbook, there is a list of resources obtained from the interview with the teachers, or the observation by me (see more in the appendix), the teachers were asked to fill this logbook at the end of

each day, put a “√” after the resources they had used. The logbook was kept for one month (from May to June 2017).

- WeChat group chatting follow up (from 2017 to 2018). For a long distance follow up, I jointed two WeChat groups formed by the teachers, and traced regularly their interactions in the groups. Details will be presented in Chapter 4.

Due to the contexts in China and France varying a lot, in the following section (3.3.4), the tools adapted in French case were different from the Chinese side, but they shared the same methodology principles.

3.3.4 Tools designed and prepared for the French case data collection

This section presents the tools for the data collection in the French case. A further presentation about the tools adapted along the timelines to see in section 5.2.

1. Observation, field notes and formal/informal interview (from March to May in 2015). At the beginning of the follow-up, an intense follow-up of Anna's school activities was also conducted during 3 months, including a four-time a week observation of her classroom teaching and some school meetings and teacher training sessions. Beside, some regular meetings in other collectives like APMEP (Association of mathematics teachers of public education) (see more in Chapter 5) and AeP (see more in Chapter 1) was also observed. Most of these activities were conducted together with Cindy. Field notes were taken during this observation. The online RI-Box was created and adapted based on Dropbox (details see in 3.2). During the three months, Anna shared her resources (lesson plan and screenshot of her blackboard writing) in this RI-Box. Also, she communicated with the researcher through an online document shared in this RI-Box, generally we (Katiane and me) proposed questions on this document about her resource used in the class, she answered it regularly in texts.
2. RMRS. In the end of the three-month observation in June 2015, interviews about Anna's and Cindy's resource work was conducted, and they were asked to draw a mapping to describe their resources.
3. Video records for collective lesson preparation activities (two times, first one in May 2016, and second one in January 2017).
4. Specific tools for a continuous follow-up.
 - RI-Box based on Dropbox;
 - Dropbox follow-up on the lesson plans in their common folder for algorithmic teaching (from 2016 to 2018).

3.4 The procedure flow of the whole research

This section presents a summarization of this chapter and the flow of the PhD research in an overview (See in Figure 3.8).

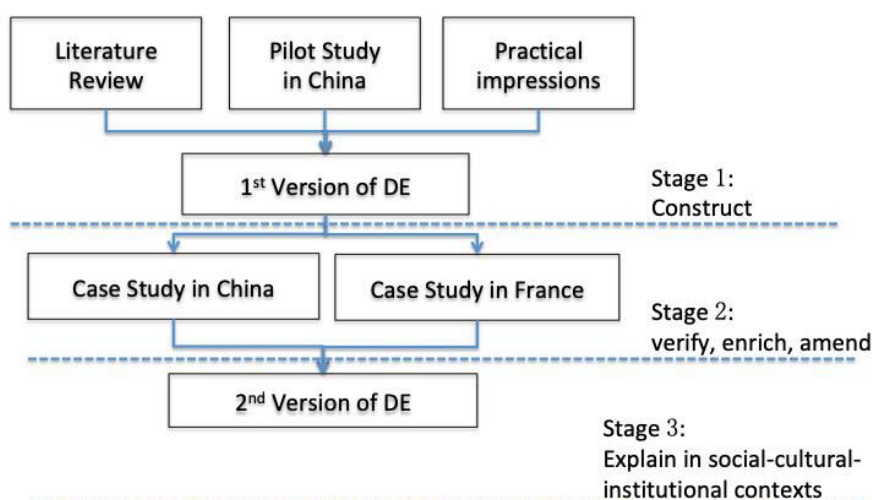


Figure 3.8. Flow towards a model of DE

For exploring a model of DE, the research is designed as a case study in two contrasting cases. Efforts were made in two stages: the first conceptual DE model generated through literature review (2.4) and a pilot study (3.1.3) as well some impressions on the teachers' practice in the targeted school before the formal data collection; then a refined DE model through case studies in China and France, in which the model was verified, enriched and amended.

This chapter presented the methodology for this research, and a first model of DE based on the literature review work and pilot study. The description of design for data collection and analysis will be presented with larger social-cultural-institutional contexts in Chapter 4 and 5, and the results will be contrasted in Chapter 6.

Chapter 4 Case study in China

With an aim of exploring teachers' resource work and their expertise shown in this process, this research proposed a conceptual notion of DE (2.4) and a preliminary model (3.1.5) based on the literature and a pilot study. To refine this framework, case studies are presented in the following chapter. This chapter presents the case study in China in five sections: section 4.1 is about the context information of the case; section 4.2 presents the specific timeline and tools adapted during the data collection; section 4.3 analyses DE following the naming systems perspectives; section 4.4 analyses DE following the resource system views perspective; section 4.5 analyses DE following the documentation schemes perspectives, taking profit of a series of MOKE activity; section 4.6 concludes in balancing the specific and generic aspects of this case study for improving our current DE model and answering our research questions.

4.1 Chinese case: setting the scene

For better understanding the details of “education noosphere” (see in section 3.1.2), this section presents the case based on the “situation landscape description” model of AnA.doc (see in section 3.2) from four parts: the three teachers, Gao and her DWMs involved in the case (4.1.1), the school they worked in (4.1.2), the support for their documentation work (4.1.3) and their collective working support (4.1.4).

4.1.1 Gao and her two Documentation-Working Mates (DWMs)

This section presents the three teachers involved in the case study. They came from the same school: the targeted teacher (Gao) and her two DWMs (Liu and Yao) (Table 4.1), who had close interactions with her (criteria for DWMs had been presented in section 3.3.3) since the same year 2014. Information is mainly based on the interviews with these teachers and the head of the school, as well as my observations on Gao's school activities.

Table 4.1 The profiles of the three teachers in the Chinese case

Teacher	Working experience	Diploma	Major	Marks
Gao	Middle School J (1993-2007) Middle School A (2007-now)	Junior college (1993) Bachelor (2003)	Elementary education management	Ex-leader of math TRG (2007-2013) Leader of LPG (2013-now) Leader of her grade group (2013-now)
Liu	Middle School M (2002-2014) Middle School A (2014-now)	Bachelor (2002)	Mathematics and computing science	She worked with Gao in same office and taught the same grade as Gao since 2014
Yao	Middle School A (2015-now)	Master (2015)	Physics (bachelor) Mathematics education (master)	6 Month Teaching practice (2014); Internship year (2015) under Gao's supervisions; She was teaching grade 6 in 2017 (when Gao and Liu were teaching grade 8)

Gao is one of the most experienced teachers in her school, but compared with other mathematics teachers in her school, she is not a very “traditional” teacher: she had no education background in mathematics or mathematics education. She graduated in July 1993 with a diploma of junior college, majored in elementary education management and then started to work in Middle School J. In 2003, she continued her study in education

management after a “top-up exam”, through which she could continue to study part time in the university and finally get a university diploma. During her junior college and university study, she received general training to teach all the subjects for primary school students, including mathematics, Chinese, English, music, sports and arts.

As introduced in section 1.3.1, the data in 2010 showed that only 55.7% of Chinese teachers (including mathematics) have university diploma, and among them, almost 2/3 gain their university diploma via in-service training but not formal and full-time higher education (Ding 2010; Wang 2013). Identifying teacher expertise with diploma (e.g. Swanson, O'Connor, & Cooney 1990) (see more in section 2.1.2) as one factor is not the case of Gao. It is not fair without situating the teachers' experiences (in both education and continuing education) into the cultural-historical situation of Chinese teacher education. The history of Chinese teacher education system, like the modern school system (see in section 1.1), is not long (introduced also in section 1.2.3). Along with the curriculum reform trends, the Chinese teacher education was also influenced by the United States and the Soviet Union. The formal independent exploration on teacher education reform starts along with the education and curriculum reforms undergoing in the economic and social transformations of the country in the late 1990s and early 2000s, the policies and activities related to teachers is also in progress. It was considered that the policies in 1980s focused on repairing teacher education, while the policies after 1990s targeted issues of quality assurance and teacher quality improvement (Zhou & Reed 2005). During these two decades, the efforts were made in in-service teacher training (for upgrading the in-service teachers' qualifications) and continuing education (Paine & Fang 2007). In 1994, the Teacher Act (MOE, 1994) formally identified teaching as a profession with different levels of qualification: the elementary school teachers have to obtain diploma from normal schools (3-year program) or higher level institutions; lower secondary school teachers have to obtain diplomas from normal colleges (3-year teacher training); higher secondary school teachers must have a bachelor degree from universities (4-year program). These are the minimum requirements, and along with the economic and technology development, later in some developed areas, some middle schools (secondary or high) could require their teachers to have postgraduate degree (Wang 2009). In 1995, the first Stipulations of Teacher Qualification Certification (MOE 1995) was proposed and then it was refined with more details in 2000 (Paine & Fang 2006). In 1999, the Ministry of Education encouraged creating teacher preparation programs not only in normal schools, colleges or universities, but also in comprehensive universities (MOE 1999), which caused an increasing number of teacher candidates. In 2004, the state launched a new document with drafting standard for teacher education institutions, curriculum of teacher education and quality of teacher education (Zhu & Han 2006).

Situating Gao's experiences into the context of Chinese teacher education reforms, we could see that merely comparing a teacher with the international level data on diploma is not enough reasonable, what Gao obtained and chose is closely linked with the contexts of teacher education and teacher qualification system (Table 4.2).

Table 4.2. Events of Chinese teacher education and of Gao

	Events of teacher education in China		Gao's experience
1980s	Teacher education repairmen (in-service teacher training)		Gao was in her lower secondary school and primary school study.
1990s	Quality assurance and teacher quality improvement (continuing education)		In 1990, Gao started her college study (for 3 years)
	1994	The Teacher Act (MOE, 1994)	In 1993, Gao graduated from junior college, and started to work as a mathematics teacher in

			middle school J.
	1995	Regulations of Teachers' Qualification (MOE, 1995)	
	1999	Teacher preparation programs started to be created in comprehensive universities	
2000s	2000	Refined Stipulations of Teacher Qualification Certification	In 2003, Gao got her university diploma through continuing education
	2004	Drafting standards for teacher education institutions, curricula and quality	Since 2007, Gao started to work in Middle School A

In the time of Gao's study and graduation (1990-1993), it was still the traditional Chinese "job for life"¹⁴ for teacher profession in Shanghai, which was so-called the period of "iron rice bowl" (Zhou & Reed 2005, p. 209). The best choice for the top students in lower secondary school then was not the high school and university, but the junior colleges, where the Soviet mode was adapted, students could become a teacher with permanent position after 3-year's free-charge training. The enrollment for entering the colleges was competitive (acceptance rate was less than 10%¹⁵), and Gao was one of them. When she graduated, it was an on-demand employment period in Shanghai, which means teachers were assigned jobs according to the local needs, so she chose Middle school J who demanded mathematics teachers and taught mathematics since then.

In her current middle school A, she was the most experienced teacher in her school. Gao worked as a middle school teacher since 1993. She started to work in the current middle school since 2007. She worked as the leader of mathematics Teaching Research Group (TRG) (see more details in section 1.3.1) from 2007 to 2013, and is the current leader of mathematics Lesson Preparation Group (LPG) of grade 8 (in 2017). She was recommended by the head of the school to join my research as an "expert" subject. She was also widely recognized and respected as leader and expert among her colleagues in her school, since the leader of TRG or LPG is generally played by the most experienced teacher in the discipline (Wang, Trouche & Pepin 2018).

She had different working roles to play at school. Like most of the other mathematics teachers, she had two classes in grade 8 to teach (in 2017), and 6 lessons for each class, in total 8 teaching hours each week. At the same time, she worked as the head teacher of one of these two classes, in charging of managing the classroom and students affairs. However, teaching time is far less than their working time. According to the principle of the school, teachers in this middle school were demanded to mark students' homework one by one and help them to correct the mistakes, face to face if necessary. For Gao, she started to work at school at 7 in the morning till 5 in the afternoon (from Monday to Friday). Besides teaching, she had to deal with students' homework, attend the teacher training sessions or teaching research activities, organizing the lesson preparations for the whole grade, prepare exams etc. Working as the leader of math LPG in grade 8, Gao had the responsibility to coordinate the teachers in her grade and unify the teaching progress, or organize discussions when other teachers meet teaching problems.

Among Gao's colleagues at school, Liu and Yao are the two who have more interactions with her (Figure 4.1): Liu shares a same office and teaches the grade with Gao (since 2014), while Yao was under Gao's supervisions since she started to work this school (also since 2014).

¹⁴ See "job for life" on: https://en.wikipedia.org/wiki/Iron_rice_bowl

¹⁵ "The Paper" (November 09, 2017, retrieved 29 January 2019 from https://www.thepaper.cn/newsDetail_forward_1854474 (in Chinese)



Figure 4.1. Teachers chosen in the Chinese case (in 2017)

Liu is not a novice teacher. She graduated in 2002 with a bachelor diploma from a normal university, majored in mathematic and computing science. Then she taught middle school mathematics in a rural district of Shanghai (School M) during 2002 to 2014. In 2014, she changed her job into this Middle School A. Since then she started to work closely with Gao, they taught the grade (since grade 6), worked in the same LPG and TRG. In their school, all teachers from the same grade were arranged to work in a same office, since 2014 till 2019, Liu had been always working with Gao in the same office, with their desks next to each other, which allows them to discuss whenever they needed.

“We do it whenever we need. For example, when marking the exercise or the homework, we find some mistakes that often made by the students, then we will share it among the teachers, ask them does this happen in your class or is there any similar phenomenon, etc.... we will fix the problem when we meet it... So that is also the reason why we keep the teachers in the same grade in a common office, we can communicate in time.”
(Appendix1.1_GAO24)

Yao was graduated in June 2015, and started to work in this middle school the same year. But in 2014, she spent half a year in this school to do her teaching practice (the requirement of the teacher education program in her university) under Gao’s instruction. Then since 2015, Gao started as a teacher in this school. According to the regulation of this middle school, the novice teacher would not be arranged to teach at the first year, but to learn from a mentor (a so-called one-to-one mentor-apprentice mode), so she continued an internship year with Gao in 2015. Then in 2017, she was arranged to teach two classes of grade 6 (while Gao and Liu were teaching grade 8), in another campus. Along with the Chinese old saying “a teacher for a day is a father for a lifetime (一日为师 yī rì wéi shī, 终身为父 zhōng shēn wéi fù)”, even worked in different grades, Yao still turned to Gao for helps and instructions when she met any problems in her teaching practice, or when she had some important tasks such as preparing an open lesson or MOKE (had been introduced in section 1.3.1). For Yao, Gao was her first choice of DWM, while for Gao, Yao is also an important output to show and transfer her expertise: she admitted that she also experienced a process of reflection when instructing Yao or other teachers.

In this middle school, besides Gao, there was another experienced teacher, Zhang worth to be introduced here. Zhang was the current leader of math TRG, while Gao is the ex leader, which means Zhang and Gao were two teachers with similar level of expertise. Zhang graduated in 1995 with a bachelor diploma of mathematics education from a normal university, and she had two classes to teach in grade 7 (in year 2017). Considering the human resource distribution, in many schools, the most experienced teachers are generally not arranged to teach the same grade, so that they can lead and cultivate different teacher teams. This is part of the reasons why Gao and Zhang were arranged to teach different grades. Even though she worked in different grade as Gao, and did not interact with her quite often and close, but

working in the same TRG with Gao and as the leader of math TRG, sometimes she had very interesting discussions with Gao in TRG activities, especially in MOKE.

This section has presented the portraits of Gao and her two DWMs, Liu and Yao. As one of the most experienced teachers, Gao worked closely with her two DWMs since the same year (2014), one worked with her in the same office (Liu) and one took her as the mentor (Yao). In the TRG activities, besides Liu and Yao, Gao also have interactions with other experienced teachers such as the leader of TRG, Zhang. As introduced in CHAT (see more in section 2.3), in the activity system in TRG, Gao hold some role (e.g. mentor) and took some division of labor (e.g. giving instruction), meanwhile during the collective discussion, she had also opinions that may fit or different from others. As Engeström (2001) suggested, taking “contradictions” as “sources of changes and development” (pp.136-137), these different ideas could be regarded as contradictory exchanges (to be addressed in section 4.4).

4.1.2 The context of Gao’s school

This section aims at presenting the school condition where the case was chosen: the scale of the school, the information mainly comes from the interviews with the school principle (two school visiting in November 2015 and February 2017 respectively).

The Middle School A is a normal public school located in the center area of Shanghai. Seeing from the scale and students’ average performance, this school is an ordinary school (neither top nor bottom). According to the principle, subjects of science and mathematics are the two strong disciplines of this school.

There are two campus of this middle school, one in the center city (where Gao and Liu worked), and the other is in suburban area of the city (where Yao started to work since 2016). Such a phenomenon that one middle school has two or more campuses started since about 2005, for a consideration to balance the education resources in different regions of Shanghai (center city and suburban areas). The two campuses are a bit far away from each other, taking 40 minutes by car. Since the suburban campus was a new campus, some new recruited teachers were arranged to work there, under need frequent instructions from the experienced teachers. Yao was one of them: she was trained under Gao’s instruction for one and a half year, then in the new campus she had a new mentor (Zhao, will be introduced in section 4.3 and 4.4) who taught the same grade as her, but she still took Gao as her first mentor for help when she needs instruction, for example the MOKE activity to be analyzed in this chapter.

There are more female teachers than male teachers in this school, which is the reason why my research objects are all female teachers, and also it explained that sometimes teachers were not quite sufficient in this school. In 2015, in the two campuses of this middle school, there were totally 13 mathematics teachers (11male and 9 female) and 25 classes (about 35 students in each class) in 4 grades. While in 2017, there were 5 teachers (one mathematics) were in long-term maternity leave during the term (September 2016 to February 2017). This caused a lack of teachers, and one of the teachers who used to agree to join my research quit. Under this condition, Yao was appointed to charge 2 classes in grade 6 (while in general, novice teacher has only one class).

For the working situation, as mentioned in section 1.1.2, there is an exam cultural influence in teachers’ work. The head of the school also introduced the pressures for teachers in preparing their students for the high school entrance exam (中考, zhōng kǎo). High school is not included as compulsory education in China, and a good high school is often considered as a half-succeed in entering a good university. Thus, the enrollment rate for key high school became also an important factor for the parents sending their children to a middle school or not. In Shanghai, between the private schools and public schools, there remains also a long

history of competition for students. Generally, the private middle schools were considered as better (with better teachers and higher enrollment rate in key high schools) than the public schools. Teachers in such a situation have to try their best to prepare their students (with ordinary performance) in the final high school entrance exams. Supports from the school to teachers' resource work and collective work will be presented in detail in the following two sections.

4.1.3 Mathematics teachers' documentation work support

This section aims at presenting the resource working supports for the teachers from an institutional level. Inspired by the early work of Gueudet & Trouche (2009), it is assumed that in this school, there exists a collective "school resource system" shared by teachers and benefit the individual teachers' resource work. In the following, a brief description of the resource supports is made from four aspects: materials, technologies, school-based resources and the opportunities provided to teachers to obtain resources.

This school adapts a class-based teaching system, which means students are arranged into different classes with fixed classroom and their daily lesson schedule. Teachers attend the classroom and give lesson according to the schedule. In this school, there is a teaching building with four floors. Considering a more convenient management, all the classes from one grade are arranged in the same floor, with a teacher office shared by all the teachers who teach this grade (like the case of Gao and Liu introduced in section 4.1.1). Teachers, in this school, work full time from Monday to Friday, from 8am to 5pm. In addition to give lessons in classroom, the teachers have to spend the rest of their work time in their common office (Picture 4.1) with other teachers.



Picture 4.1. A personal working space in a common teacher office

Each teacher has a personal working space with a fixed office desk, a personal cabinet next to his/her desk, a laptop given by the school, a common printer and a common working space with a long desk and some chairs located in the middle of the teacher office. Students often work in this common space when their teachers give them extra instructions. Such a working condition provides teachers opportunities of both resource work and collective work: they can exchange the students' problems or learning difficulties quite conveniently in or cross the disciplines; they can also create, exchange and share resources in a more interactive way.

Each classroom is equipped with a desktop computer linking to the projector. Teachers can teach with this equipment, and if they prefer they can bring their laptop and link it to the projector. There are also some special activity classrooms (not the fixed classrooms where the

students stay) with larger space and extra ICT, such as Interactive White Board, or sound equipment. These special classrooms are often used for conducting open lessons or MOKE activities.

As for the online resources construction, this school used to invest an Intranet platform allowing the teachers to communicate and receive/exchange resources online. But up to the school visiting in 2015, they already abandoned it and the website was not available anymore. The head admitted that managing that platform was too time consuming and teachers seldom renewed actively the information on that website.

For the curriculum resource related aspect, the school distributes each mathematics teacher a set of textbooks (from grade 6 to grade 9), the corresponding teaching guidance books and exercises books along with the textbook. Teachers in this school have no choice to decide which textbook to use (neither the school nor the district), but they can decide the supplementary materials (such as learning-aid books). Each year, for each discipline, they have the budgets (from the school and the upper TROs) to purchase the teaching materials: the leader of LPG is in charge of collecting the demands of teachers in LPG, and submits the “shopping-list” to the TRG. The shopping list could contain the learning-aid books, teaching instruments, software or office working supplies.

There is also a school-based developed mathematics resource named school-based exercise booklet for all the students and mathematics teachers. It is a collection of eight books (Picture 4.2) for grade 6 to 9, one booklet for each semester.



Picture 4.2. School-based exercise booklets for grade 6 (left) and grade 7 (right)

These booklets are important resources for mathematics teachers, and also a collective resource working result of the whole mathematics TRG: during two years (2012-2014), teachers designed and produced the exercises in their own LPG, then they gathered and submitted to TRG and got them printed (not published but only used in this school). Each two years, the math TRG will arrange teachers to discuss and modify by deleting or adding.

Although there is no uniformed online platform organized by the school for teachers to share or work on resources, they have informal personal interactions. As introduced by the teachers, they can exchange the heavy digital documents with USB key, sending emails, or talk face to face owe to their common office and fixed office locations (teacher office locates the same side of each floor). Besides, along with the popularization of smartphone and social

communication software, they use WeChat (§ 1.2.2) as an important way for searching and sharing resources and information quickly. As Gao explained, she seldom used the computer (even it is a laptop), but more cellphone. We can see a new mode of teacher collective work: a local organizational collective work through face to face TRG activities, and an online supplementary way through WeChat group chatting.

4.1.4 Collective supports for mathematics teachers' documentation work

This section aims at presenting the collective working condition in this school from two aspects: regular TRG activities (see more detail in section 1.3) among teachers inside and outside the school (linking to teacher training) and cooperative projects with researchers from universities. Information mainly comes from the interviews with the head of the school, the leader of TRG (teacher Zhang), and the three teachers in the case.

In this school, exist the grade group (formed by teachers who teach the same grade) and TRG (formed by different LPGs in different grades). Teachers share the office and name their office as Office of Grade 6/7/8/9 (Figure 4.2). The leader of grade group (Gao is the leader of her grade) is in charge of classroom management administrative affairs, such as students' school performances and problems, meetings for head teachers or parents etc.

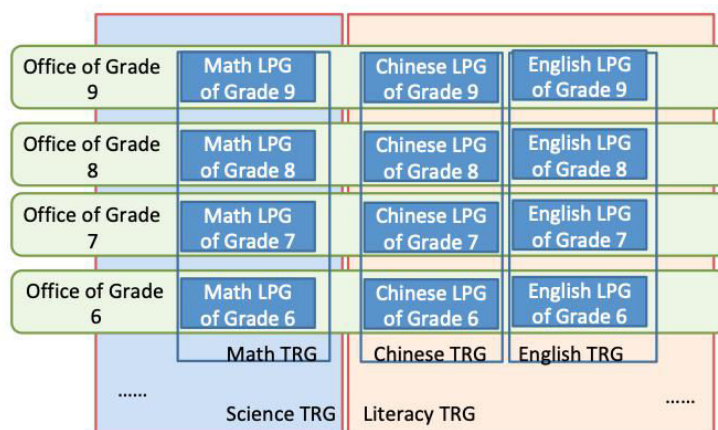


Figure 4.2. The structure of TRG and LPG in Gao's school

Each Tuesday afternoon is a fixed time for mathematics teachers to conduct teaching research activities: there is one mathematics TRG activity once per month organized by the school; one teaching research activity per two weeks organized by the district level of TRO; there could be also other teaching research activities by the upper TRO like city-level (Figure 4.3).

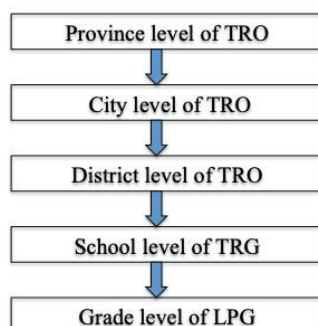


Figure 4.3. Teaching research system of teachers' collective work in Shanghai

The TRO (Teaching Research Office) (Miyakawa & Xu to be published) plays a role of administrator and coordinator, offering professional guidance, bridging the cooperation between researchers and local teachers, between education theories and teaching practices, and organizing teachers from different schools or cities to exchange:

Our school often organizes us to visit other provinces or cities observe lessons. For example, our schools used to arrange all the mathematics teachers go to Suzhou City for lesson observation. Also, teachers from other provinces and cities will come to our school to exchange. Next week, there will be a team of teachers come from Jiāngxī Province, they come here for full time training during one week. (Appendix_1.1GAO32).

Besides the regular activities inside school, there were also some cooperative projects between the school and some researchers from the university, or between the school and the upper TROs. The projects are generally for solving problems from teaching practice, proposed by the schools or teachers. The cooperation is generally based on the whole TRG or grade group but not on individual teachers, which means participation is not totally volunteer:

“Basically, we ask all the teachers in our grade to join this, because it is a collective activity, a team work. It is not the issue of teacher’s personal interest; cultivating students is every teacher’s job, right? It is an issue that every teacher has to face.” (Appendix1.1_GAO42)

In 2015, there were three collaborative projects in progress cooperated between this middle school with the TROs and my university. Gao was involved in one of them, a district-level project named “appreciation/encourage education”, which aims at improving students’ learning interests crossing disciplines by encouraging them and help them in their psychological problems. The specific actions and ideas on this research project actually evidence Gao’s student-centered conception, which will be discussed more in section 4.3.

4.2 Data collection strategy

This section presents the organization of the follow up (4.2.1), and then the organization of the analysis (4.2.2), complementing what has already been said in the chapter 3 dedicated to the methodological design.

4.2.1 Organizing the follow up

The formal follow up of the Chinese case started in November 2015 and ended in the end of October 2017 (Figure 4.4) in four phases, which corresponds to Gao’s work from grade 7 to grade 9.

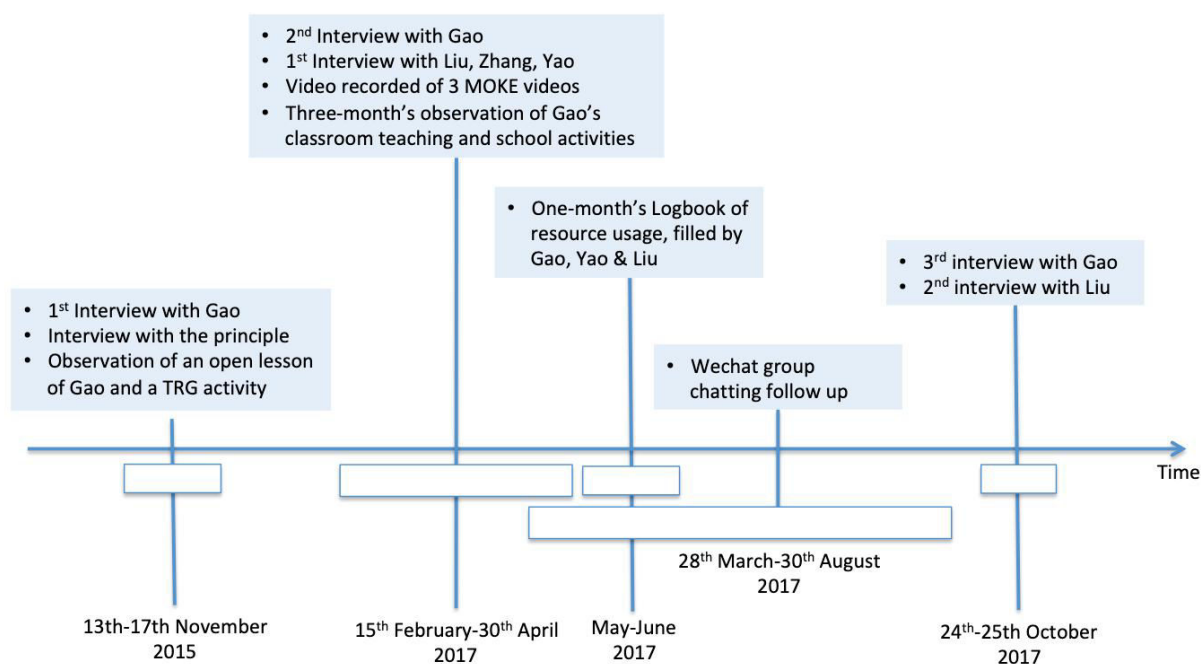


Figure 4.4. Data collection for the Chinese case

- (1) A first school visiting in November 2015, to learn the school information by interviewing the school principle, and to meet the potential targeted teachers, including an open lesson observation of the Gao and an interview with her. Gao and Liu were mathematics teachers of grade 7 this year.
- (2) A second intensive data collection during three months (from February to April) in 2017, including a in-depth interview with Gao for her resource work, and interviews with her colleagues who could be her documentation working mates, Yao, Liu, and Zhang. During these three months, a series of videos about MOKE activities were recorded, field notes on the observation of Gao's schoolwork (classroom teaching, school meetings and office working) were made. Gao and Liu were mathematics teachers of grade 8 this year.

For the video records of MOKE activities, the choice of the teaching topic “properties of inequality” was already explained in section 3.3.2: Yao, had as a task, to conduct an open lesson on this topic with the instruction of Gao. This is not a strictly “*collective lesson design*” (as the French case in Chapter 5), but it is a true “*collective work*” for lesson design. Gao also experienced the whole process that Yao experienced: “lesson plan - lesson implementation observed by collective - collective discussion - lesson revision” (see the MOKE procedure in section 1.3.1).

The videos recorded contain only the lesson implementation and collective discussion after the lesson. For a convenient analyzing, Jackson (1968) used to distinguish teachers' work along with a cognitive process: preactive phase (lesson plan and teaching method/materials evaluating), interactive phase (lesson implementation in classroom) and postactive phase (reflecting on the teaching effects and planning for the following work) (see in 2.1.3). This distinction emphasized also the importance of the two phases besides the implementation. As what Trouche, Gueudet and Pepin (2018 online first) emphasized in their principles of reflective investigation: the classroom is an important place, but documentation work also occurs outside classroom. The main battlefield for teachers' resource work is not only the classroom, but also out of it. And for a long-term follow-up and broad consideration of teachers' resources, the out-of-class aspect of teachers' work should be paid particular

attention. Back to the MOKE situation in the Chinese case, since Yao prepared and revised her lesson design during a period (not intensively in a chunk of time) through fragmented work, I did not record her individual and private preparation and revision work by videos, but through interviews about the resources she used, the suggestions she took and the modifications she made. In this way, the MOKE activities were recorded mainly the collective discussion part, which include an intense collective reflection on the lesson design and lesson implementation, and also the suggestions for revising for the following teaching.

- (3) A long-distance follow-up after the face-to-face data collection, including a logbook for their resource usage for one month during from May to June in 2017 (filled by Gao, Yao and Liu), and a five-months WeChat group chatting follow up.
- (4) A third school visiting and interview with Gao for her resource work, and a second interview with Liu in October 2017. They were mathematics teachers of grade 9 this year.

Not all data are kept in the appendix. The first interview (in 2015) and second interview (in 2017) for Gao's resource system were kept as Appendix 1.1 and 1.2 respectively; A lexicon of all resources naming by Gao based Appendix 1.1 and 1.2 was generated as Appendix 1.8; The logbook for their daily resource usage was kept in Appendix 1.9; the first and second MOKE collective discussions were transcribed and kept as Appendix 2.1 and 2.2.

4.2.2 Organizing the analysis

The case study analysis in the three following sections is conducted along with the conceptual DE framework proposed in section 2.4 and 3.1.5. Documentation work can be considered as teachers' integrating the resources in her/his resource system to the situations, and meanwhile obtaining feedback and developing the resource system. In this way, DE is to be evidenced in the process of (1) integrating the resources with schemes from the resource system, and (2) managing and developing the resource system.

In section 4.3, analysis will focus on the components and structure of Gao's resource system seeing from the six views proposed in DE framework (from a static view), meanwhile, part of the dynamic schemes are also included: scheme of searching for and selecting resources to develop resource system besides classroom teaching, the schemes of accumulating resources and reflecting through the resource system management and development.

In section 4.4, analysis will take the MOKE activities to explore the schemes shown in Gao's documentation work in specific situation: schemes in searching and selecting the resources from the resource system (whether it echoes the scheme found in 4.3), the schemes in adapting the resources (which factors were considered), the schemes in accumulating resources (compare with the schemes found in 4.3), and also the schemes of reflecting. The schemes evidenced in 4.4 are based on the MOKE activity video analysis. While the schemes found in 4.3 is from the interview description of teachers.

Section 4.5 will explore the collective aspect about how the teachers develop their DE through collective work. It is a reflecting and summarizing work because the collective is also discussed in 4.3 as one of the six views, and also the schemes in how to obtain, accumulate and share the resources in collectives.

4.3 DE evidenced through teacher's naming system

In this section, Gao's resource system is studied with diverse data (see in 4.2) following the perspective of analyzing teachers' naming systems (4.3.1); then analyzing the three most important resources seen from Gao's resource (4.3.2).

4.3.1 Analyzing teachers' naming system

This section takes a view from a linguistic language structure on studying the teachers' resource system. Cultural diversity is an opportunity to study the differences, especially from the linguistic aspect in a social cultural context, and relating to mathematics learning, the Chinese language and its syntactic-semantic structure, and its impact on algebraic thinking had been discussed (Spagnolo & Paola 2010).

In the Chinese language context, resource (资源, zī yuán) often refers to something abstract: 资(zī) could be necessities for producing and living, or materials as references, “expenses or money”, “qualification or endowment” (Hu 1991 p. 806; Fang 2000, p. 2960); while the character of 源(yuán) consist by two parts “氵” (water) and “原” (origin), which refers to “the source of water, with an extended meaning of source, cause, origin or principle of things” (Hu, 1991 p. 566; Fang 2000, p. 1859). In this way, exploring the specific terms about resources named by teachers provides a new view on seeing their conceptions on the resources. The analysis structure of this section keeps the same in our project of “*Contrasting naming systems used by teachers in describing their resources and documentation work: towards a deeper analysis of teachers' resource systems*” (Trouche, to be published). The preliminary results were presented in CERME 11 (Wang, Salinas & Trouche 2019) by contrasting Chinese and Mexican contexts, involving two cases of teachers' naming systems from their origin language to see teachers' resource system and documentation work.

To deepen this view, the analysis is based on data of interview transcription (see in appendix 1.1, 1.2, 1.8 and 1.9), and the observation field notes, daily logbook of resource usage (tools have been introduced in section 3.3.3 and 4.2), and the mappings of teachers' resource system (IMRS and R-IMRS) (see more in section 3.3.3). Some key resources are selected and analyzed combining with the conceptual DE model, including the six views and five sub-schemes, and three indicators for studying the specific resources (see more in section 3.1.5).

The reflecting results on the interview transcriptions showed that a most frequently mentioned term by Gao is: “题(tí)”. In Chinese language morphology, word is formed by a combination of characters. Seen from the interview transcription texts of Gao (see more in Appendix 1.1 and 1.8), by combining with other characters, “题(tí)” forms into diverse words like 题目(tí mù)(exercises), “习题(xí tí)” (exercise), 练习题(liàn xí tí) (exercises), “试题(shì tí)” (examination/test question), “例题(lì tí)”(example), 错题(cuò tí) (mistake), “问题(wèn tí)” (question/ problem/matter/issue) etc. (Figure 4.5).

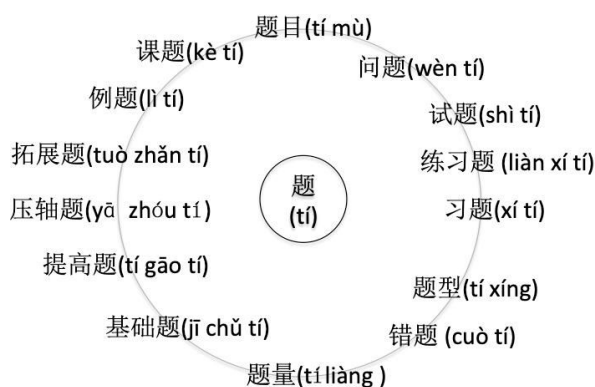


Figure 4.5. Syntactic-semantic links between 题(tí) and other associated characters

Gao had five different expressions on the same thing “exercises” (see the five terms sorted by the number of characters in Table 4.3):

Table 4.3. Five expressions on same term “exercise” by Gao

<ul style="list-style-type: none"> • 练习题 (liàn xí tí) (exercise) (Appendix1.1_GAO13) • 练习(liàn xí) (exercises) (Appendix1.1_GAO24) • 习题 (xí tí) (exercise) (Appendix1.1_GAO13; GAO19) • 题(tí) (exercise) (Appendix1.1_GAO16; GAO23) • 题目(tí mù)(exercise) (Appendix1.1_GAO2; GAO10; GAO15; GAO16)
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We can see a colloquial expression, either from 练习题 (liàn xí tí) to 练习(liàn xí), or from 练习题 (liàn xí tí) to 习题 (xí tí) (exercises), or from 练习题 (liàn xí tí) directly to 题(tí), the latters are always a less complete expression. Then from 题(tí) to 题目(tí mù), the latter is a more complete and formal expression than the previous one, and it was used much more often than the previous one by Gao. There could be several reasons behind, and one of them is the dialect. In the mandarin, 题(tí) is shorter than 题目(tí mù), thus in many regions of mandarin (such as the northern China), teachers might only say 题(tí). But in Shanghai dialect, 题目(tí mù) is easier to pronounce than 题(tí). A second reason maybe because this was the first and formal interview with Gao, which made her to be more conscious so she used a complete expression. Anyway, the different expressions referring to a same thing reminded me that when studying teachers’ resource work, only by what they say is far less enough, but also by what they refer and how they use. The different expressions reveal the function of the exercise: for daily practicing (练, liàn) and learning (习, xí).

Gao also used same word to refer to different things, such as 题(tí) discussed above, beside “exercise”, it was also used by Gao to refer to the exam questions: “our 题(tí) (exam questions) are become more and more flexible now” (Appendix1.1_GAO2). A second example is 问题(wèn tí) (Table 4.4), the meanings need to be understood in the specific situations.

Table 4.4. A same expression of 问题(wèn tí) referring to four different things by Gao

<ul style="list-style-type: none"> • 问题(wèn tí) (problem) (Appendix1.1_GAO5; GAO24) • 问题(wèn tí) (question) (Appendix1.1_GAO5; GAO23; GAO53) • 问题(wèn tí) (matter) (Appendix1.1_GAO5) • 问题(wèn tí) (issue) (Appendix1.1_GAO25; GAO31)

Gao used more “questions” and “problems” when she was talking about students (e.g. questions proposed by students) and learning/teaching, where the meaning of “problem” is more close to “difficulty” to be solved, three citations containing the four expressions are given below:

“They can bring their 问题(wèn tí) (questions) making them confused to the classroom...After I finish my lesson, I ask them (the students) to reflect ... they will find some 问题(wèn tí) (problems). For example our students can find, oh, I did not totally resolute (the factors) in this 题(tí)(exercise), right? Or to say, they only resolute the constant term, without considering the 问题(wèn tí) (matter) of sum of the first degree coefficients.” (Appendix1.1_GAO5)

“We do it (collective discussion) whenever we need. For example, when marking the 练习(liàn xí) (exercises), we find, ah, a common 问题(wèn tí) (problem) among the

students, then we will share it among the teachers, ask them whether this happened also in their class, or were there any similar phenomenon, etc.” (Appendix1.1_GAO24)

“... the 问题(wèn tí) (issue) concerned by different 教研员 (jiào yán yuán) (Teaching Research Officers) are different...” (Appendix1.1_GAO31)

“Matter” and “issue” were more used as more neutral expressions by Gao, such as the teaching contents (e.g. matter of some knowledge points). All these four expressions are indicating a common nature: 问题 (wèn tí) refers to something to be answered or solved, something important or valuable to be paid attention and efforts. It also reveals what were concerned by Gao in her daily teaching: questions proposed by students, problems appeared in students’ learning and teachers’ teaching, key mathematics teaching content (knowledge points) to be taught with more efforts, and the issues emphasized by her superiors, Teaching Research Officers (see in section 1.3.1).

4.3.2 Analyzing Gao’s resource system from her key resources

In the second interview with Gao for her resource work and resource system (see in section 4.2), two mappings of her resource system were obtained: an inferred mapping (IMRS) drawn by me based on the resources mentioned by Gao during the interview (see in Appendix 1.2), then with this IMRS, I invited her to reflect on it and make necessary modifications (with red color pen) for a reflective version (R-IMRS) (Figure 4.6).

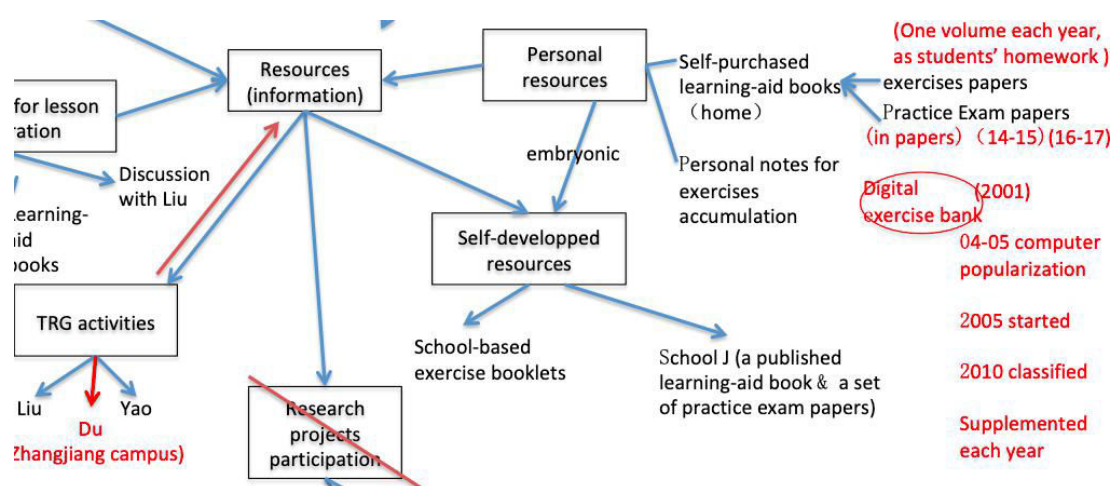


Figure 4.6. Part of R-IMRS by Gao (her changes were made in red color)

There are three differences between the two versions, evidencing the points that emphasized by Gao: firstly she added an arrow from the “TRG activities” back to her resources by announcing that she also obtained feedbacks and reflections when she was giving instructions to others; secondly she deleted the “research projects participation” because she considered that the research projects did not bring her feedbacks resources that can be used directly in her teaching practice; The last and most important change is her detailed explanation on her personal resources and the link to her self-developed resources. Gao’s personal resource contains two parts: the learning-aid materials she bought by herself (she put them at home) and her personal notes for accumulating the exercises. According to her explanation on the personal notes, there are the paper version and digital version (which was called by her as “digital exercise bank”). These three modifications evidenced two views of Gao’s resource system: collective view (her understanding on obtaining resources from interactions with TRG members and the researchers) and the design view (how to make personal resources).

Three important resources can be seen as re-sourcing for exercise (“题(tí)”: learning-aid materials, her personal exercise notes and school-based exercise booklets (Table 4.5).

Table 4.5. Gao’s three important sources for resourcing “题(tí)”

Naming in Chinese	Translated name in English	Description in English	Transcriptions examples
教 辅 材 料 (jiào fǔ cái liào)	Learning-aid materials	The commercial textual materials (e.g. books) for students, with exercises or exam questions or knowledge explanations (available in bookstore).	“Before the new semester, I will go (to the bookstore) to check the new learning-aid materials.”
习 题 笔 记 (xí tí bǐ jì)	Exercise note	The personal notes of Gao, in which she used for collecting the exercises she considered as valuable.	“I keep notes when I find valuable exercises, I made four (notebooks) last year.”
校 本 习 题 册 (xiào běn xí tí cè)	School-based exercise booklet	Booklet with exercises for the students, developed collectively by all the mathematics teachers inside Gao’s school (not for sell)	“This school-based exercise booklet was developed by me...which selected from my exercise notes.”

- **教辅材料 (jiào fǔ cái liào) (Learning-aid materials)**

Learning-aid materials was also named as “extracurricular books” (课外书籍, kè wài shū jí) by Gao in her first interview and third interview. But strictly to say, it is not “extra” from the curriculum, but a supplementary for curriculum. It is a kind of printed and bound materials for sell in bookstores, to “aid” learning and teaching. It generally contains examples, knowledge explanations and exercises. Gao knew the learning-aid material market well not only due to her working experiences as a teacher, but also her experiences working as an editor of a learning-aid book and a set of practice exam papers some years ago, when she was still working in Middle School J. In Gao’s memory, during that period, there was a trend that the secondary schools in Shanghai tried to publish their own learning-aid materials. As a promising and active teacher, Gao was encouraged to join, and published a learning-aid book and a set of exercises papers for mathematics. This experience brought her deeper knowledge on how the learning-aid materials were produced and maintained, meanwhile some expertise in choosing the best from the endless and still enriched learning-aid books.

Gao considered the ability to select the learning-aid books for helping students is a responsibility and necessary skill as a teacher. When asking Gao about “during your so many years’ working, which aspect do you think you get better”, Gao answered:

“The key point, is the ability in controlling the exercises, I feel I am stronger now, before, I just took others’ exercises and did it, but now I can search among them, and find out the suitable exercises for students, right? Then I adapt and verify it accordingly, then I integrate the available things together.” (Appendix_1.2GAO22).

She also explained her thought about the online resources and the learning-aid material market in her third interview (October 2017). The learning-materials also have a life cycle, and need to be updated regularly, but both the online resources and resources in learning-aid material market have the same problem: how to balance the updating speed and quality. The learning-aid materials in the bookstore could be updated slower than the online resources, but the quality is better than the online resources, because the editors are more careful. The only

problem in the learning-aid material market is that there are too many choices, they changed each year, and teachers have to be careful.

She has her own way to follow the trends of the learning-aid materials. She visited the bookstore each summer before new school year comes, to see if there is anything new changed in the books that she was using.

“I like to... each summer holiday before the new semester, t the bookstore, I go to the bookstore to check, because some of them have the 1st edition, the 2nd edition, and the 3rd edition, they are always changing. The change of editions means the exercises and the quantity of the exercises inside are changing.” (Appendix1.1_GAO10)

Besides the learning-aid books provided by the mathematics TRG and school (see the resource supports in 4.1.3), she also bought lots of learning-aid books as her personal resources (at home, as she emphasized), and she had an awareness of following the trends of the learning-aid material markets, selecting and accumulating the valuable ones:

“The exercises (in the learning-aid materials) will be updated each year; it changes continuously according to the exam questions of the high school entrance exams. Our exam questions are becoming more and more flexible now. So only using the textbooks, I often tell my students, only using the textbooks cannot help them to get a good score in the exam, because the things in the textbooks are only the very basic things.” (Appendix1.1_GAO2)

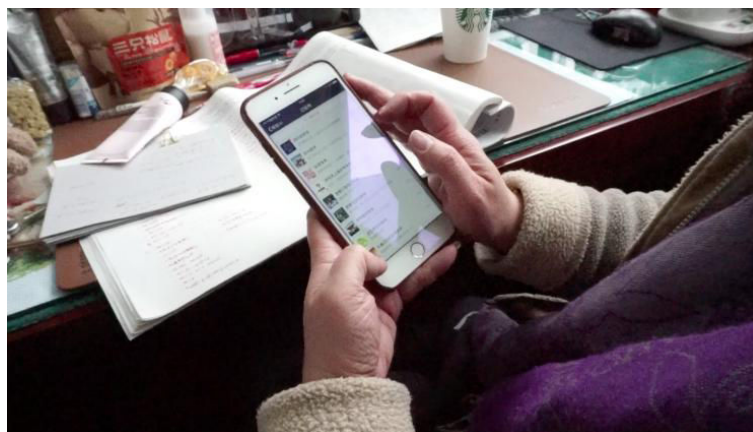
For Gao, tracing the trends of learning-aid materials is a way to keep up with the exam, because the different publishing houses and editors of the learning-aid books are actually interpreting the curriculum, the textbooks and the exams from different perspectives. She considered the ability of keeping up with the exams as a key responsibility for mathematics teachers. This echoes what Yang (2013) proposed in his research: Chinese expert mathematics teachers have to be an expert of knowing the exam well and prepare their students in succeeding the exam.

Gao also emphasizing knowing how to taking (selecting) exercises and resources is more practical than developing new ones. In her explanation of how to produce a learning-aid book, she admitted that the exercises from the learning-aid materials are mainly come from the high school entrance exam papers, and the practical exam papers produced by the Teaching Research Officers (§ 1.3.1) and seldom teachers develop new exercises, because (developing) new exercises need to consider the issue of rigor and correctness etc., which takes time and demands higher ability for the teachers:

“Our mathematics textbook, during the last decades, did not change too much, what had been changed is just the order and the blocks...anyway...the general framework did not change, but the improvement in resources locates in the development of exercises. Our exercises (and the exam questions) are more and more flexible, more and more...there is a lack of rigor if we design and develop the exercises by ourselves... our ability is not enough...so sometimes it is better to ‘take’, to borrow, take one exercise, change and adapt it.” (Appendix1.2_GAO20)

The source of the exercises is not limited to the learning-aid materials, either provided by the mathematics TRG and school (see the resource supports in 4.1.3), or those she bought as her self-purchased learning-aid books (were put at home, as Gao emphasized). Gao also got resources through Internet. Even though she emphasized that she was using the online resources less and less, it is not true. She was using the computer less but the cellphone more, which also builds a link to the collectives around her.

Besides the opportunity to exchange with her colleagues face to face either in her office or in school TRG activities, the mobile Internet provides her a supplementary way to exchange resources from the collective. As what Gao explained, from her cellphone: the apps developed by the previous professional teaching resources websites/forums, and the official account in WeChat (Picture 4.3), a popular social communication application in China since 2011 (see more in section 1.1.2).



Picture 4.3. Gao was showing her WeChat and the functions (Appendix1.2_GAO37)

WeChat is popularized that Gao and her colleagues used it as a “mobile working” space: with the chatting function, She shared resources (in texts, pictures, files, videos, audios) with other teachers either individually or in group chatting, and with the different official accounts, she received information about the exams, the new exercises or new solutions, analysis on mathematics knowledge, or even videos of other teachers’ lessons. She took all these as a “supplementary information”:

“On WeChat, now there are lots of official accounts about mathematics, inside there are some explanations about the exercises, like this, they often give some information about the practical exams...I feel it is good...there are also some explanations about the mathematics knowledge points...This is actually a supplementary information...I do not read every of them...the books have the limits and are more focus on the current teaching content...but their (the official accounts’) contents is more general.” (Appendix1.2_GAO37).

- 习题笔记 (xí tí bǐ jì) (Exercise note)

Besides the awareness of following the trends of exercises from the learning-aid materials and internet resources, she also shows an expertise in selecting and accumulating the valuable ones: her personal “digital exercise bank” (电子题库, diàn zǐ tí kù) and “exercise notes” (习题笔记, xí tí bǐ jì).

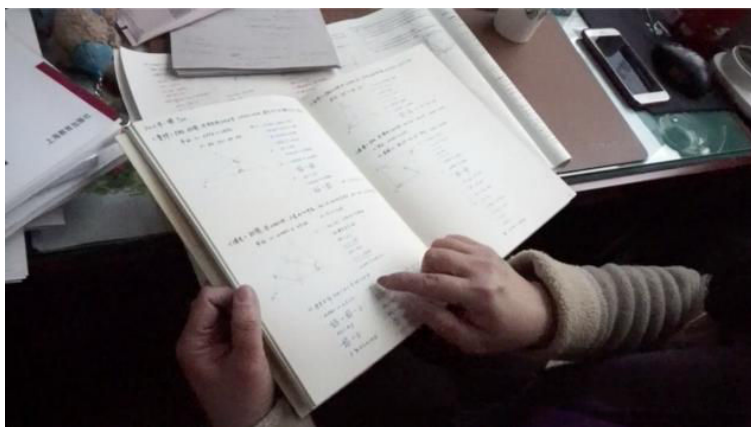
When explaining the personal resources, Gao situated her personal resources development into the context of technology development (Figure 4.8): Around 2004 to 2005, the computers started to be popularized and equipped at schools in Shanghai. She started to build her digital exercise bank based on computers since 2005. Then in 2007, she started to work in the current middle school and received her first personal working laptop in 2007 from the school. In 2010, she started to manage her “exercise bank” by making classifications. Since then, she made supplementary to her exercise bank every year.

Along with her digital exercise bank, Gao also kept the paper version, or to say, she seemed “turned back” to paper version notes and traditional resources since 2014, which also echoes her explanation about attitude towards digital resources and teaching technologies in teaching,

she considered resource as a kind of information, and technology as a “supplementary condition”:

“It (the technology) should be considered only when it is effective and adaptable in teaching, teaching is not using the technology. I use it only when it is necessary in my teaching. Few years ago our school also bought and try to popularize the digital white board, theoretically to say, it brings convenience, but actually I feel it is not practical, especially in geometry teaching. The computer, the white board and software can produce the graphs immediately and simplify the process of geometry graph drawing, but students learn by imitating (how to draw) in process, and (as a teacher) you cannot forget this, right? So I learnt how to use the white board, and promoted it also to other teachers, and I used to try to give lessons with it, but not anymore now.”
(Appendix_1.2GAO12)

For Gao, recently years (around 2017), her laptop was more used as only for writing digital reports or printing document. Like her other colleagues, she used her smart cellphone more, with which she often took photos, videos and audios as notes, and exchange with other colleagues through WeChat. She explained also the trends why teachers were using cellphone more than computers for resource searching. Along the development and popularization of smartphones and 4G, a lot of previous professional teaching resources websites/forums developed their own applications or WeChat official accounts. Like a house moving, teachers can access to their resources via the apps or WeChat with their cellphone anytime and anywhere. The problems appeared along with the convenience is that the cellphone enriched the way to exchange and store resources, but storing resources is not the same things as resource management, and Gao also showed her own way in organizing these rich but fragmental information and resources: her personal exercises notes (习题笔记, xí tí bǐ jì) (Picture 4.4)



Picture 4.4. Gao was explaining one example in her exercise note (Appendix1.2_GAO45)

Exercises note is a kind of paper-pencil note made by Gao. She kept such habits since 2014. From my observation, there were always some learning aid materials (books or papers) on Gao's office desk, and after a whole day's work, she always did exercises (e.g. from the learning-aid materials), and kept the notes. The note is not only accumulating exercises, she also did the category of these exercises according to the contents (e.g. functions) or types (e.g. drawing), and even made a table for the whole note (Picture 4.5):



Picture 4.5. The table of Gao's exercise note (Appendix1.2_GAO45)

Seeing from Gao's explanation, her exercise note is not merely a collection of exercises, even a well-organized collection with clear table, it is a "lived" note that is updated all the time:

"I had done this since three years...I have not finished it, I do it whenever I have time, actually even for the same exercise, there will be something new, when I re-read it the second time, sometimes I can find a better solution, then I will mark it with red pen, for a recording and supplementary. So you see, it is really a hard work, right? Sometimes I finishes a whole set of exercise papers, but I found nothing meaningful or valuable, so I it should continue along with our own needs, selecting the valuable ones and keeping it down...I can lost all these exercises papers or books, but I can not lose my notes, especially when teaching the grade 9, I need this note...We are still in exam-oriented education, we have to face the reality. We do more in the summarization work, then the students will get easier." (Appendix1.2_GAO48)

It should be noticed that Gao's personal notes contains not only exercises notes, she also had the notes for lesson observation (this will be used when she gave out comments and suggestions in MOKE activities, will be discussed in section 4.4), the notes for recording her reflections on classroom management (this became later her basic materials in participating the research project of "moral education for students", will be discussed in 4.5).

When situating the learning-aid materials, her personal exercises note back in a local view on Gao's R-IMRS (see in Figure 4.7), there appears a circle of her resources with an "input" (self-purchased learning-aid books), a "hub" (her personal notes for exercises accumulation), and an "output" (self-developed resources) with an example of school-based exercise books (evidenced by the red arrows).

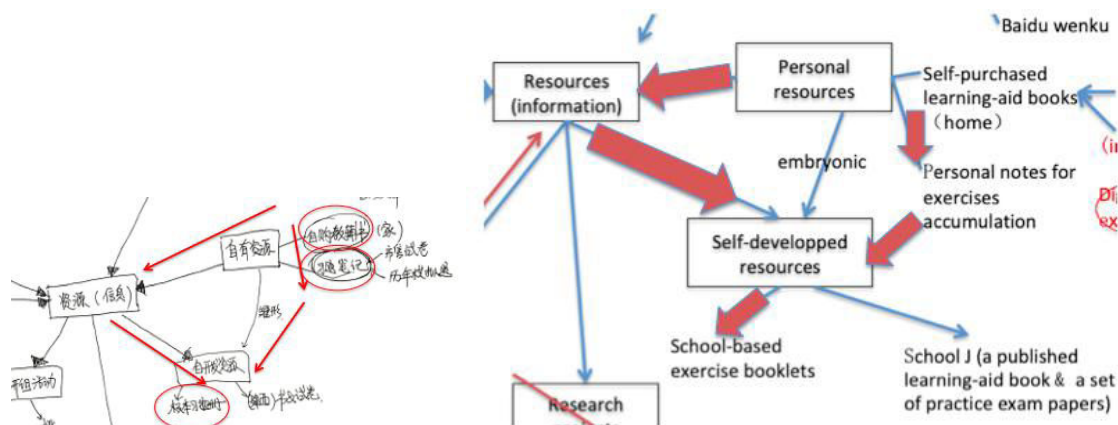


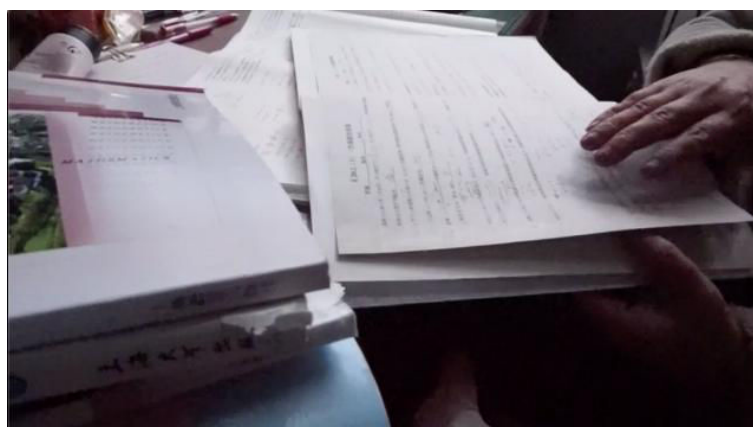
Figure 4.7. Part of R-IMRS of Gao (original left, digital transposition right, red arrows added by the researcher)

In the “input” part, the personal resources (or self-purchased learning-aid books) are only one part of all the inputs. In the third interview with Gao, she proposed more details about the rest resources (with her own categories) that re-source her teaching (will be addressed in 4.3.3). For the “output” part, she had a series of self-developed resources. Figure 4.7 shows her previous resource developing experiences (before 2007) as a learning-aid materials editor, and her latest experiences (2011-2013) in developing the school-based exercise booklets.

- **校本习题册 (xiào běn xí tí cè) (School-based exercise booklet)**

As introduced already in section 4.1.3, these school-based exercise booklets were collectively developed by the whole mathematics TRG in this middle school during 2011-2013. Gao was in charge of two of them. The booklets were printed but not published. They were sent to students as exercises or homework, consisted mainly with exercises. Each two years, teachers revise it. Up to 2017, there had been three editions, the edition (2015) shown in Picture 4.2 was already a “revised edition”. In 2017, a new revision of the whole sets (8 booklets) was charged by Gao, in which she made a lot of deep cuts and additions.

Gao explained the genesis for her school-based booklets development. She showed the earliest image (Picture 4.6), a printed A4 paper with exercises she assigned to students as their homework. She attached one paper in the textbook, each paper corresponded to one lesson she gave.



Picture 4.6. The printed exercise worksheet prepared as students’ homework pasted on Gao’s textbooks (Appendix1.2_GAO63)

As she already commented, the exercises provided by the textbooks and exercises books along with the textbooks were very limited. In this way, giving extra exercises to students is a crucial supplementary:

“Look, each day after we finish the lesson, we gave the students these as after-lesson exercises, it was forbidden to ask the students to buy the (learning-aid) books, then I, printed by myself, each day each lesson one A4 paper, one for each lesson. Then we had these school-based exercises. The mathematics TRG, basically, each LPG, basically followed this mode, in paper version, right? Printing it into paper versions as booklets is more easy to reserve, so...Look, my exercises on (school-based exercises books), they are all here, I made modifications, verify them, deleted and added...” (Appendix1.2_GAO63)

The school-based exercise booklet is an output for Gao to show and share her resources to the other teachers, but meanwhile, the booklet made by other teachers is also an input for Gao to her resource systems. More resources re-sourcing Gao’s resource system will be discussed in the following section 4.3.2.

4.4 DE evidenced through teacher's resource system

This section aims at analyzing the structure and components of Gao's resource system with the six views of studying teachers' resource system (introduced in section 3.1.5). The six views will be presented separately (4.4.1), before trying to bridge them (4.4.2), and concluding on what we learn from these 6 views.

4.4.1 Accessing the structure of resource system

The characters of Gao's resource system and resource usage will be explored by comparing her mappings with the other three teacher's mappings, especially of her DWMs, Liu and Yao.

As described in section 4.2, the interview for Gao's resource work and resource system was conducted in three moments (when she was teaching grade 7, grade 8 and grade 9). The first interview (in 2015) I did not ask for her mappings of resource system; the second interview I drew a IMRS based on our interview and asked her to reflect and modify for a R-IMRS (as discussed in 4.3.2). The last interview for Gao's resource work, Gao had started to teach grade 9, which was the final year in the middle school, and she had to prepare her students for the high school entrance exam. Gao re-drew by herself a RMRS (Figure 4.8) to describe her resource system.

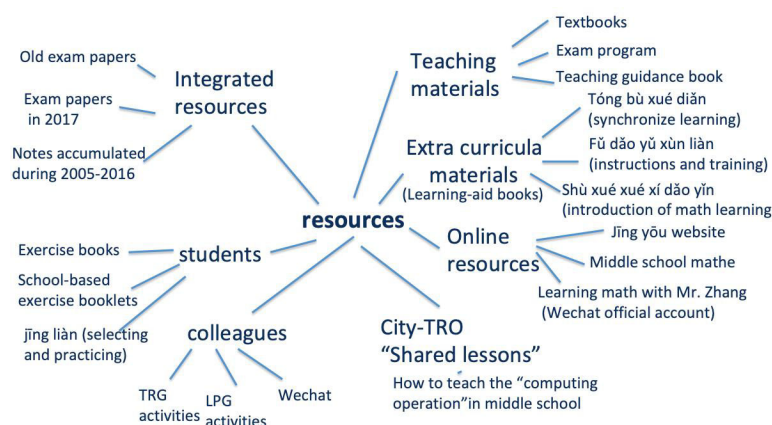


Figure 4.8. The RMRS of Gao (drew in October 2017)

In this RMRS, Gao explained in depth what could be her “resources” that can re-source her teaching practices. Compared with the previous two versions (IMRS and R-IMRS), she categorized her resources into seven parts:

- (1) Students. Gao proposed only three resources: exercise books along with textbook, school-based exercise booklets and a learning-aid exercise book named “(jīng liàn) selecting and practicing”, but she did not mention the textbooks. Her explanation was that the students had already finished the learning of textbooks, and the task of the final year is reviewing and preparing the high school entrance exam. The three resources were the most often used resources for the students.
- (2) Colleagues. Compared with the previous versions, Gao proposed three teachers as her “apprentices” including Yao and Liu, in this RMRS, she removed the specific teachers, and proposed three ways of interacting with her colleagues: the activities of TRG and LPG, and the social communication software of WeChat, where she had two chatting groups with all the other teachers in LPG and TRG.
- (3) City-TRO “shared lessons”, which was an in-service teacher training project organized by the Shanghai city TRO. It was a series of open classes given by the expert (or very

experienced) teachers as examples for other teachers. Gao gave an example of a session she obtained recently, how to teach computing operation in middle school.

- (4) Online resources. In the previous interviews, Gao had explained that she was using less and less the computers, but more and more her cellphone. In this RMRS, Gao did not mention the computer, and only kept three resources she often used in her cellphone: she had one app for looking for exercises (which was a forum and later proposed its own app), and two WeChat official Account (one was for mathematics in middle school operated by the Shanghai city TROs; the other was operated by a teacher who worked also part times as Teaching Research Officers (§ 1.3.1) and often shared his own lessons or teaching ideas through the official account).
- (5) Teaching materials, including textbooks, teaching guidance book and “exam program”. Exam program here is actually the summative evaluation guide for middle school mathematics published by Shanghai, which is also an explanation on what content will be addressed in the high school entrance exam.
- (6) Extra-curricular materials. To explain this, she added an annotation of “learning-aid materials” below (also discussed in section 4.3.2). Seeing from this annotation, we can infer that Gao held a microscopic definition of curricular materials: the learning-aid materials were not counted as curricular resources even they were produced and used for serve the curriculum implementation.
- (7) Integrated resources. In her previous mappings of resources system, she used to name these resources as her personal resources and self-developed resources, where she wanted to distinguished these resources with other teachers’. In this RMRS, she used the word “integrated” to emphasize that these resources were not only “accumulated” or “saved”, but also be well organized and categorized.

Back to the six views in the DE model (design view, student view, collective view, didactical view, curriculum view and mathematics view) (see more in section 3.1.5), it can be seen that Gao’s resources located more inside the school (the only one out-of school is the TRO shared lesson); although in this version, she did not mark the arrows of the resources, but there were some potential links among these seven categories: the extra-curricular materials were prepared for selecting exercises for students. Gao mentioned (in 4.3.2) that she had different learning aid books for different levels of students, some were for new lessons and some were for the review lessons. The three examples in the extra-curricular resources and also some of her integrated resources were for the students’ exercises, and also she shared with her colleagues via WeChat. In the following, the six views will be explored based on all the interviews and observations on her school activities.

Mathematics view

This view is not very strong in rich elements. One of the reason might be the middle school mathematics does not require too much pure mathematics knowledge (as the high school). Besides, it could be understood if it is only the case for Gao, because she did not major in mathematics education. However, it is also the same case for Liu (graduated from mathematics and computing science), and Yao (graduated from mathematics education), or even for Zhang (majored in mathematics education in a formal and good normal university). In their descriptions and daily usage of their resources and resource system, there were seldom the resources directly linked to mathematics. According to the literature the present secondary mathematics education programs in China emphasize providing the pre-service teacher with a profound mathematics knowledge foundation and highly advanced mathematics literacy and reviewing and studying of primary mathematics much more than

teaching practicum (Li, Huang, & Shin 2008; Liang, Claz, Defranco, Vinsonhaler, Grenier, & Cardetti 2013; Huang, Ye, & Prince 2017).

Curriculum view

The curriculum program was mentioned by Gao as her resources for lesson preparation, but in the second interview, when asking her how she used the program, she said she did not use it for a long time. Seeing from the logbook, she figured that she used the textbook everyday, but from my observation of her school work during two months, I did not see her using the textbook for her own lesson preparation, or at least she did not use it as often as she said. The learning-aid materials works as complementary of the textbooks, exercises books along with textbooks, and her teaching guidance books. She organized her resources in the perspective of preparing the exams.

Didactics view

When asking Gao about her most critical resources used for lesson preparation, she proposed “my experiences” (Appendix1.2_GAO29). She explained that in front of so many choices of learning-aid materials, the most critical part is making decision about which should be valuable, and adapting the resources based on teachers’ own understanding on the object of her lesson. All these decisions are made based on an intuition, which is formed through experience. Gao also emphasized to use teaching variation (Gu 2017) when adapting the resources. For Gao, as an experienced teacher who does not need to give open lesson as the novices, she had five main sources to gain the resources inspired her didactic expertise:

- Direct experiences through personal teaching experiences;
- Un-direct experiences gained through the instructions with her apprentices;
- The face-to-face discussions in the Teaching Research activities;
- The online exchanges through the Internet, especially with WeChat;
- The teacher training sessions provided by TROs.

Collective view

For Gao, the collective work in TRG and LPG activities inside her school worked as an “output” to share off her resources and teaching experiences. This can be evidenced that in Gao’s IMRS and R-IMRS, for the TRG activities, she gave her three apprentices as the examples of how she benefited from the TRG activities: she gave them instruction, and meanwhile reflected on herself. While for her two DWMs, Liu and Yao took Gao as part of their resource that they can ask for resources and help from, for example, in both the interviews and mappings of resource system of Liu and Yao, they proposed Gao particularly as a resource. Liu explained further what she learnt from Gao: the resources such as the selected exercises and courseware; the instructions on the ideas of the textbooks, how to design the blackboard writing in classroom teaching: “Gao often observes my lessons when she is free, she always remind me to pay attention on my blackboard writing and my oral expressions when explaining to students” (cited from the interview with Liu, 2017). On the one hand, she worked with Liu in the same LPG and was in charge of the mathematics teaching affairs as the leader of mathematics LPG in her grade, for example, each school year before the new semester, she had to make the school year teaching plan (similar like the “teaching progress” in the French case in section 5.3).

On the other hand, she instructed Yao in preparing MOKE activity as the mentor of her in the same mathematics TRG. She gave out her suggestions and instructions, and reflected on the implementing effects at the same time. Such a mentor-apprentice way echoes a traditional

tacit culture that “there are tutors among three people” (see in 1.3.1). As for the resources she learnt from the collectives outside her school, in some teaching research activities organized by the city-level or district-level TROs, Gao also observed the “demo lessons” given by other teachers who might have the similar expertise level as her, or some fragmentary teaching videos from the WeChat official accounts shared by other teachers. The demo lessons also could echo a cultural believe that there exists an adaptable model (Cheng 2004) or a prototype of expert teachers in the Chinese culture (Yang 2014).

Student view

Gao is a student-centered teacher: she selected exercises from diverse sources for students, and kept their feedback as new resources, which may be referred to her education background (education management), she paid more attention on the students’ interests and needs, and try to maintain good relationship with them, so that they will like mathematics if they like her. This could be evidenced in three facts:

-She selected the exercises carefully for students and traced the changes of the learning-aid materials, this is not easy because the Chinese learning-aid materials is a huge markets and the selection needs the teacher know the trends of the exam and the features of the press and even editors.

-She spent much of her work time in dealing with students’ homework. She prepared different homework for students including the pre-study homework (the students had to read the textbook before the lesson and finished the exercises in the textbook), the schoolwork (after the lesson the students had to finished the exercises on the exercise book along with textbooks), then the formal homework (exercises from the school-based homework), see Table 4.6.

Table 4.6. The different works assigned to students by Gao

•	预习作业(yù xí zuò yè) (pre-study homework) (Appendix1.1_GAO5 and GAO8)
•	作业(zuò yè) (homework) (Appendix1.1_GAO4, GAO18, GAO49 and GAO53)
•	学校作业(xué xiào zuò yè) (school work) (Appendix1.1_GAO4)
•	面批作业(miàn pī zuò yè)(face to face homework correcting) (Appendix1.1_GAO4)
•	错题 (cuò tí) (mistakes) (Appendix1.2_GAO19)
•	试题订正本 (shì tí dīng zhèng běn) (notebook for exam questions) (Appendix1.2_GAO19)
•	学生笔记 (xué shēng bǐ jì) (notes made by students) (Appendix1.2_GAO16)

The teachers, as Gao emphasized, must mark all these students’ work. Thus for Gao, although she had only 10-12 lessons each week, she had much of work in not only marking and pointing out their mistake, but also asking the students to come to her office and correct the mistakes face to face, and giving them more instructions if they are not clear about the knowledge. Based on my three months observation on her office working life, she seldom left her office during the break, even the toilet, so that she can wait the students who need help and come to her office. Besides, she also asked the students to make notes for mistakes and examination questions, sometimes she would collect and check the results of students’ notes.

-She spent much time in maintaining the relationship with her students. For the student’ view, it is not easy to distinguish that some resources are for students’ mathematics learning, the rest are for other things. In Gao’s case, she did not considered herself firstly as a mathematics teacher, but a head teacher: she thought that students’ research interests are more important, keeping a good relationship can improve the students’ interest in learning mathematics (“they will like mathematics if they like me”). Seeing from her

research project on “moral education”, she also shows an attitude towards students’ learning difficulties:

“I ... help the students from the moral education aspect, to improve their recognition. Actually many learning difficulties are not the problem of intelligence, but the learning attitudes and the family education. Most of us mathematics teachers are also work as head teachers, so we cannot only focus on the discipline teaching in classroom, but also other aspects. Learning attitude, family education, parents’ self-identity, etc. can all influence students. So even you teach very well in class, but the parents never cooperate and the students never learn after class, that will be useless, right?”
(Appendix1.1_GAO40)

Design view

The design view of Gao’s resources is not the richness of different resources especially the teaching technologies, but a well organized resource system management working habits.

As introduced in section 4.3.2, Gao has a conscious to select, accumulate and organized her personal resources, the most representative resource is her personal notebooks for exam questions and exercises, which work as her “exercises bank”, and the materials for her self-developed resources (the school-based exercise book and the learning-aid books she published before). Besides this, she has also a habits of writing down her observation notes when she attended other teachers’ open lessons, even though in her school, taking notes is not obligation for the experienced teachers like her, she still does it, and she tries to use her notes as teaching examples when she gives the instructions to her apprentices.

Gao experienced a process from “adapting teaching technologies” to “abandoning the teaching technologies”. In the interview about her past resource working experiences, she was the first teacher who built “digital exercises bank” with computers in her school; she was the first teachers who was sent by the school principle to attend the training sessions on how to use Interactive Whiteboard and then was in charge of training other teachers in her school; she learnt GeoGebra by herself and adapted it in some geometry learning activities with students. However, as she explained, she seldom used any modern technologies in her classroom teaching recently years (at least since 2014).

The results from the logbook (May to June 2017) evidenced her explanations, especially when comparing her with Liu (Figure 4.9).

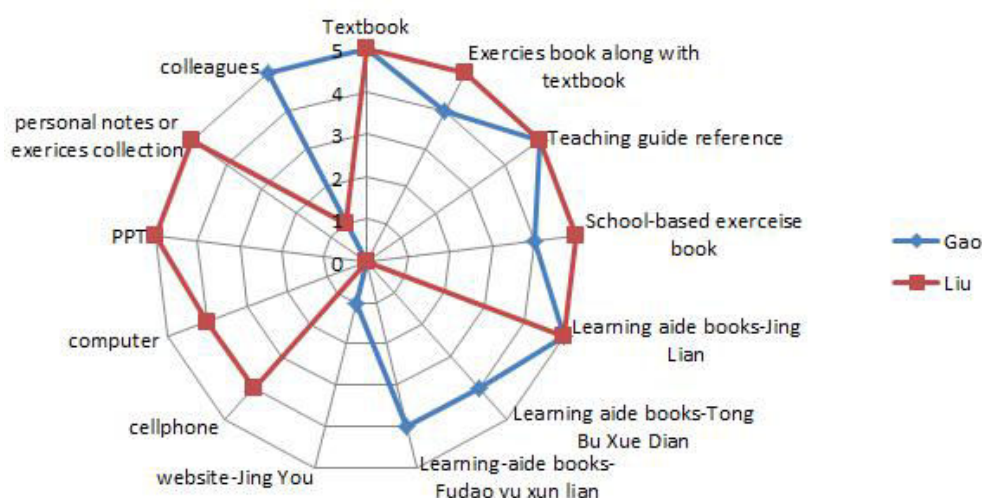


Figure 4.9. The logbook analysis results comparing Gao and Liu

Teaching the same grade and working in the same office, and keeping the same teaching schedule, it was assumed that she might used similar resources with Liu, but the results showed the differences and similarities: They both used textbooks, exercises books along with textbooks, teaching guide for teachers, school-based exercises booklets, one learning-aid book; but Gao used two more learning-aid books (quite often) and one website than Liu, and Liu used more PPT, computer and cellphone and her personal notes than Gao.

It should be noticed that the personal notes mentioned by Liu is not the same as the personal exercises note of Gao. Gao used to comment on Liu's resource work that she did not pay attention to make notes to collect and accumulate the exercises. The personal note used by Liu, as she explained, was her personal note made when she was observing other teachers' lessons, in which she kept how other teachers organized their lesson, especially the procedure, the examples and exercises, and how much time was spent in each step etc.

They all underline that they used textbooks everyday, but actually in my observation during the same period, Gao did not use the textbook, either in her lesson preparation in her office, nor in the classroom. She had her teaching guidance book, which contains the contents of textbook and teaching suggestions for teachers, and she wrote down her ideas and examples directly on the blanks next to the texts. She took this teaching guidance book with her notes on it when she was teaching in classroom.

Gao explained her attitudes towards technology and teaching: technology is only for helping to improve teaching and learning, and should not be used unless it is necessary. This echoes the distinction of "information technology" and "education technology" proposed by He (2007): the education technology is centered on integrating available technologies into teaching, which emphasized the competency of integrating and design.

4.4.2 Bridging the six views on resource system

Seeing from this analysis, Gao shows a way of bridging the different views on resources.

Between student, didactics and design

The students' pre-study homework (reading the textbook and finishing the exercise on the textbook) is cultivated as a learning habit demanded by Gao, this is a way of "inverted classroom" (students learn by themselves at home and bring their questions to classroom, and teachers spend the classroom teaching time to fix the problems proposed by students), and it is also her way of improving the efficiency of her classroom teaching.

The students are also asked to take notes of what Gao has written on the blackboard, it is also a reason why Gao emphasized the blackboard writing when she was instructing Yao: the position of the title, the example the exercises should be proper, and the contents should be correct, the final state of the blackboard writing after the lesson should be an art, at least the students can see the whole structure and the key concepts of this lesson.

The collection of students' mistakes in their exercises and exams is a win-win strategy. Gao only collects the mistakes appears in students' exams, and she asked the students to take "mistakes correction notes", but she did not collect these notes. In our pilot study (Pepin et al. 2016), one of the teachers, Jiang, kept a habit of collecting students' mistakes notes as his own resources when his students graduated from high school. With these resources, he sorted a set of exercises that students are easy to make mistakes under each topic, then when he was teaching the topics to his new students, he would pay more attention in his teaching and explaining.

Between student, collective, didactics and design

The discussion with TRG or LPG allows the teachers to learn the students' performances and learning difficulties, especially in other disciplines. Gao used to conduct a research project about the moral education. She considered that many learning difficulties of students were not due to the intelligence factors, but the problems of psychology or family. As a mathematics teacher, she emphasized to maintain good relationship with the students, and she cared not only the students in her own classes, she also knew well the problems of Liu's classes, and even the performance level of Yao's classes in grade 6 (Gao's classes were in grade 8). She paid attention on collecting students' common problems.

The exam paper analysis was a fixed work of TRG after each exam, teachers sit together to discuss the performances of students, their rankings in the city or district, which exam questions the students made more mistakes, and what knowledge was lack and needed to be re-emphasized in the following teaching.

The MOKE activities in TRG benefited the novice teachers a lot. The novice teachers (such as Yao) experienced the whole process under the careful instruction of her mentor and other teachers, from lesson preparation including deciding the teaching topic, the activity design and the exercises selection, to the implementation, the details of time management, the skills to call for students' attention, blackboard writing and speaking speed and voices etc. Meanwhile, for the mentor and other teachers, through giving the suggestions and listening to other teachers' reaction, they also designed and implemented the lesson in their mind.

Between curriculum, student, collective and design

For the experienced teachers like Gao, she had a good knowledge on the different requirement on textbook, curriculum program, the exercises in the textbook and the requirements in the exam. Curriculum works are the base of lesson design; personal resources can be a

complementation; in different moments, preparing different types of exercises with different difficulty levels for students. The personal resources can be shared, Gao often took photos of her notes and shared it in the WeChat group chatting, she also taught her mentors to make notes and organize the notes.

Gao has a clear classification on the type of lessons (the exercises lessons, the review lessons and new lessons etc.), the type of exercises (for basic, for improvement, for review etc.), the type of homework (used in classroom teaching, used as homework, used as pre-review), and the types of functions of different learning aid materials (for teaching new lessons, for students with higher performance, for the review and preparing the exams etc.).

Between students, didactics and mathematics

Gao emphasized that students should also have the reading literacy when doing mathematics exercises. This echoes students' reading comprehension of different types of mathematical texts, Österholm (2006) argued that the reading skills in understanding general texts and in mathematical texts with symbols were both important, and the latter should be treated differently from the former.

In this section, Gao's resource system was analyzed from the most frequently used resources seen from her resources naming system (4.3.1), three key resources of learning-aid materials, exercise notes and school-based exercises booklets were presented, meanwhile the schemes in resource system development and management were also revealed in her explanation on how she selected the learning-aid materials and built her personal resources (4.3.2). The components and structure of her resource system were also analyzed via the six views of DE model comparing with the resource mappings and resource usage logbook of her DWM Liu (4.3.3): her resource system shows a living flow of resources with input and output, and in her presentation about her resources, she also described her schemes in managing and developing her resource system. Gao's resources are well organized centering on exercises, with an orientation on "high school entrance examination" for students; she uses more paper or printed resources than digital ones; she holds a critical attitude towards integrating technologies into her classroom teaching; she emphasizes the habits of cultivating resources (exercises for her) and the consciousness of tracing the changes and trends of the learning aid materials markets for better balancing the requirements of the curriculum and the needs of exams. Finally in 4.3.4, we evidence the links between these different views.

4.5 DE evidenced through schemes in documentation work

Scheme (as introduced in 2.2.2) is considered to be the basic component of DE (announced in section 2.4.1). Among the four components of scheme (see more in section 2.2.2), two of them (rules of action and operational invariants) are used for the scheme analysis.

This section explores the schemes of Gao through her specific documentation work, namely a MOKE activity conducted in March 2017. In this MOKE activity, one of Gao's DWM, Yao, was asked to conduct an open lesson as her first reported lesson¹⁶ under the instruction of her mentor Gao. Six sections are included: schemes related to searching for resources (4.4.1), schemes related to selecting resources (4.4.2), schemes related to adapting the resources (4.4.3), schemes related to accumulating and sharing the resources (4.4.4), scheme related to reflection on documentation work (4.4.5), and a conclusion of this section in the end (4.4.6).

¹⁶ In their middle school, the novice teachers are usually asked to conduct a report lesson (an open lesson in front of all the teachers) in the school, one or two years after they start to work in the school. The process is considered as training for the novices, and the results (including the lesson plan and reports of the novices, as well as other teachers' comments will be considered as part of the teacher performance evaluation.

The schemes in documentation work include both those related to resource system management and those evidenced in specific documentation activities, namely MOKE activities in this case. MOKE, strictly to say, is a lesson design-implementation-refine and improvement for Yao, with the instruction of Gao. In this way, the schemes related to MOKE of Gao are mainly drawn from the interview with Yao, and a continuous reflection on what Gao said in the interview and what she did recorded in my observation field notes. This will obviously make the analysis results different from the French case.

4.5.1 Schemes related to searching for resources

The way of how to search for resources is closely linked to what resources users have accumulated. In the middle school of Gao, there is the budget for purchasing the learning-aid materials for teachers each school year. Through WeChat group chatting (seen from the WeChat group chatting follow up from March 2017 to February 2019), the leader of TRG (namely Zhang) asked the leaders of LPG in each grade to submitted the learning-aid materials they need for the following school year, then the school will purchase one set for each teacher, which form part of the collective resource system of all the mathematics teachers in this middle school. As one of the most experienced teacher and the only teacher who used to work as the author of one learning-aid book, Gao was considered as the expert of selecting the learning-aid materials by her colleagues. Thus it is often Gao who makes the decisions of the learning-aid materials choices, and the leader Zhang also takes her advices.

In the searching for and selecting resources for design a lesson in the MOKE activity, Gao showed her schemes in this phase through her instructions to Yao. Schemes will be presented with rules of action and the corresponding operational invariants (explained by Gao or inferred from her behavior).

- **Starting the resources searching from the previous lesson plan or lesson observation notes**

Yao was reminded by Gao to refer to her lesson observation notes she took in her internship year. In 2014, when Gao was teaching grade 6, and Yao worked as her apprentice, Yao was asked by Gao to observe each of her class and made observation notes. In this MOKE activity for grade 6, Gao proposed to Yao to “review” and check the lesson observation notes, especially the examples used by Gao. We could infer from this that Gao is confident for her lesson design and exercises she chose as examples. Meanwhile, starting from the previous experiences, or from other more advanced teachers’ experiences could be a first resources to refer when searching for resources.

- **Searching for exercises from the familiar resources (learning aid materials purchased by school)**

The second resource recommended by Gao was the learning aid book prepared by the school for each teacher (Gao also had this). Gao did not trust the online resources, and hold a critical attitude on learning aid materials. Such confidence could evidence that Gao had a good knowledge on the online resources and learning aid materials.

Comparing this resources searching way of Gao and her DWMs Liu and Yao, it could be seen that, Gao searched for resources from “inner-side” with reflection on “what I have”, while Liu and Yao started from “outside” with the first reaction of “I will check what others say on this issue”. In the interview with Yao for her lesson preparation, she explained that she selected some parts of the PPT slides from other teachers, and some ideas about the lesson plan online. While in the interview of Liu, she mentioned that she often used Baidu¹⁷ for search, which is

¹⁷ A search engine widely used in China: <https://www.baidu.com>

considered as “not professional” by Gao. Gao used to complain that the quality of most of the teaching resources online was not good and not as reliable as the learning-aid materials, because anyone can share their resource online.

- **Searching for complementary exercises from personal resources (exercises bank and notes)**

During the first MOKE activity, Gao checked the lesson plan of Yao before the open lesson, and she was not happy with the exercises selected by Yao. So in less than 10 minutes during the class break, Gao wrote down a list of exercises for Yao’s lesson on scene. Such a fact reveals that she is quite familiar with her personal resources. Besides, when searching for the activity for the summarization, she proposed to use a mini video that she used to watch online with her cellphone, she kept the links in her browser favorites.

4.5.2 Schemes related to selecting resources

The schemes related to resource selecting could reveal the elements cared by Gao in the lesson design, which also closely linked to resource adaption.

- **Choosing the teaching topics for students’ need**

Generally it is the teacher, who is going to give the lesson, who decides the teaching topic. In the moments of the MOKE activity, Yao was going to teach the “properties of in-equality” (content of grade 6). Gao suggested her to choose this topic, for two considerations: firstly, it will be easier to “borrow”¹⁸ classes from other teachers in the same grade without necessary disturbing their teaching schedules; secondly the teachers should not let any special tasks (here she refers to the open class) to disturb the students’ learning, because the teaching schedule for the whole year is already designed along with the logic of textbooks, and changing the order of learning may cause their confusion.

- **Deciding the teaching object (content quantity and difficulty) based on students’ level**

Gao holds a “dynamic view” on the lesson design of the MOKE activity, that is to say for her, the teaching objects need to be adjusted according to the levels of students, even in the previous stage she proposed that it is better teach according to the teaching schedule.

In the teaching content, there are three properties of in-equality to be taught, and Yao had two choices: teach one property or teach three in one lesson. She discussed with Gao, and Gao proposed three considerations: “which class do you want to use in your final report? What is the average performance of the students in that class? Which lessons do you plan to borrow and how about the students’ level in these classes?” After the three questions, Yao decided to teach only the first property and prepare different exercises for different classes: for the better classes where the students are supposed to learn faster, she will send them some exercises with higher difficulty levels.

¹⁸ Borrow classes, in Chinese “借班(jiè bān)”, a phenomenon that one teacher implements her lesson in her colleague’s classes so that she/he can try and implement the lesson several times with different students. This appears quite often among teachers who worked in the same grade and same disciplines, especially in MOKE activities.

- **Building the lesson structure with example and exercises for maximum the learning depth and class efficiency**

Gao holds an idea of “maximum utilization” of the lesson, which means she tries to reach the students’ learning limit points by adjusting the examples and exercises. In the interview with Yao, she explained how Gao reacted on her first version of lesson plan: “She read my lesson plan, and said that the examples and exercises I selected were too simple, not deep and representative enough.” Gao gave Yao directly a learning-aid book on Yao’s office desk (Gao knew this book because it was recommended by her to Yao), and told Yao to select exercises from it, and when Yao was reading the book, she wrote a list of exercises for Yao on an A4 paper, which was later used by Yao for students’ exercises in her classroom teaching. In the MOKE discussion after the lesson, Gao gave some advices in reducing the exercises based on her observation on students’ reaction. Thus, Gao showed her way of finding the limit points of those students she is not familiar with: starting from the most difficulty and maximum contents, then adjusting and reducing the contents according to the students’ reaction.

Meanwhile, the selection on exercise and examples also reveal the differences between Yao and Gao. Yao admitted that her examples and exercises were mainly selected from the textbooks and some online courses, where she found only on Baidu. While for Gao, she seldom used in her classroom teaching with the examples and exercises in the textbooks, because she generally assigned them as her students’ pre-study homework.

- **Designing the activities for introduction and for summarization from students’ view**

After the main structure of the lesson is built, Gao suggested Yao to prepare some activities for the introduction and summarization to increase the students’ learning interests. The first consideration is the time, to maximum the class efficiency, Gao emphasizes the time proportional assignment, so she suggested that the warming up should be no more than 5 minutes. The content of the activity is also need to be closely linked to students’ daily life. For example, Yao prepared an exercise for students to express the “speed limit signs” (in pictures) with in-equality. Gao proposed to change it, because the students may not familiar with the traffic signs, and also the speed limit signs picture given by Yao is not proper in reality, there is no speed limit sign of 50 in reality.

4.5.3 Schemes related to adapting the resources

The phase of adapting the resources is the core part requiring the spirit of MOKE, where the teachers adjusted the lesson design with diverse considerations. The MOKE activity (introduced in section 1.3.1) in Chinese “磨(mó)课(lè)” emphasizes the verb of“磨(mó)”, translated in English as “sharpen (the knife)”, which could be extended in meaning of “refine” or “carve” the lesson. The MOKE activity is generally refers to a process of refining a lesson design in several rounds of lesson preparation (by an individual teacher, Yao in this case), lesson implementation in public (in front of collectives, TRG in this case), and collective discussion on the evaluation and suggestions for improvement.

In the process of adapting, Gao shows her considerations in schemes related to adapting. And most important of this phase is her way of categorizing different type of exercises based on the type of the lessons.

As discussed in section 4.3, Gao’s resource system is featured in centering on exercises (题,tí). Taking a micro view on“题(tí)”, it refers both to exercise and exam question. Let aside the difference of the two terms, this section keeps only the meaning of exercise. About how to decide an exercise kept or ignored in her personal exercises notes, there are three issues

mentioned by Gao, not very often and obviously, but in very critical moments: quantity, quality and type.

- **Balancing the exercises quantity, learning depth with the lesson time and students' level**

The quantity of exercises is used as an indicator in three occasions: when Gao was commenting on resources of learning-aid books, especially compared to the curriculum resources of textbooks and students' exercise books along with the textbooks; when Gao was instructing Yao in MOKE activities; when she was talking about how to teach and learn mathematics. "...no matter in the 练习册(liàn xí cè) (exercises book along with the textbook), or in the 教材(jiào cái) (textbook), the 量(liàng) (quantity) is limited." (Appendix1.1_GAO15).

"The textbook...seeing from the exam aspect, it only covers 65% to 70%, only...actually if the students learn and finish all the exercises in it, all of them, the maximum (of their score) is 70%, or 65%. More efforts should be on the exercises books. The exercise in textbooks covers only part of the exercise types, right? But in the exam papers, there are choice questions and filling-up topics and problem solving, in different formats, or even some composites of questions mixed several question types. The students need to practice more through more exercises, so in daily exercises selection, each types (of exercises) need to be considered" (Appendix1.2_GAO30)

The quantity was also emphasized in lesson design. Finding the balance among quantity, type and quality within the limited time (45 minutes) and diverse students' levels, this seems to be a common concern by the experienced teachers (such as Gao and Zhang).

In the first MOKE discussion among Gao, Yao and Zhao (another experienced mathematics teachers who worked in the same grade as Yao), the first question concerned by Gao is: "Zhao, how do you think about the exercises quantity (of this lesson)?" (Appendix2.1_1GAO). And the answer of Zhao was also interesting:

"I feel the quantity is ok, but the format is too dull, (the whole lesson) is always doing exercises and explain, doing and explain, doing and explain, as an ordinary lesson it is ok, but it is too dull as an open lesson, no original things, the students lost their interests in the end. It should design again the exercises." (Appendix2.1_2ZHAO)

Gao agreed with ZHAO, and in their second MOKE discussion in the mathematics TRG, Gao reminded Yao that "the quantity is enough, do not add more" (Appendix2.2_172GAO). Zhang also mentioned the quantity in the second MOKE discussion:

"My opinion, about this type of exercises, you can reduce some, two exercises are enough, and then you can save the time to explain more about the knowledge. Or, you could reduce the quantity of exercises, but enrich the types..." (Appendix2.2_263ZHANG).

For Gao, the main change in the different editions of learning-aid books each year is the quantity of exercises (Appendix1.1_GAO10); the quantity of exercises in learning-aid books is larger and type is richer (Appendix1.1_GAO13); to control the quality of lesson, and to guarantee the information quantity transferred to students, the quantity of exercise is a crucial way (Appendix1.2_GAO14).

- **Making variations if necessary to keep the richness of exercises types**

The type of exercises is concerned by Gao as an indicator in selecting her learning-aid books. Besides the types of exercise in choice question and filling-up topic and problem solving etc.,

Gao also categorized the exercises along with the function, or the hierarchy of difficulties for different students and lessons (Table 4.7).

Table 4.7. Gao's categorization of exercises

<ul style="list-style-type: none"> • 例题(lì tí) (examples) (Appendix1.1_GAO5; GAO8;GAO13) • 课后习题(kè hòu xí tí) (after-lesson exercises) (Appendix1.1_GAO5; GAO8) • 基础题(jī chǔ tí) (elementary exercises) (Appendix1.1_GAO15) • 提高题(tí gāo tí) (exercises for improvement) (Appendix1.1_GAO15; GAO16) • 拓展题(tuò zhǎn tí) (exercises for expansion) (Appendix1.1_GAO15; GAO16) • 压轴题(yā zhóu tí)(final question in the exam¹⁹) (Appendix1.2_GAO14)
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These categories were also used as Gao's choice on learning-aid materials when she was trying to present the different features of learning-aid books she had. Besides adapting resources along with the category of exercises, she also shows some other rules of actions, such as adjusting the exercises during the lesson (which is not easy for Yao) according to the students' reaction; Varying the forms of exercises for attracting students' learning interests such as arranging the collective exercises into group competitions; and last rule, Gao walked around the classroom to see students' work during the whole lesson, which was not happened on Yao. Gao kept the students' work results as the references for her adjustment for the next step teaching.

4.5.4 Schemes related to accumulating (and sharing) resources

About how to accumulate the exercises had been presented with details in section 4.3, for example, she traced the trends and changes of high entrance exam, and combined the requirements of both curriculum and exam. This section mainly focuses on how Gao accumulated (and shared) the resources during the MOKE activity. Picture 4.7 showed the three resources Gao prepared for her MOKE discussion: the lesson observation notes, her cellphone, and Yao's lesson plan.



Picture 4.7. Gao's materials prepared for MOKE discussion

The three resources revealed how she accumulated the resources through TRG activities.

¹⁹ The final question in the exam paper, often appears in mathematics and physics exams, with characteristics of high score, high difficulty and require more comprehensive ability

- **Keeping the notes of lesson observation**

In this middle school, observing other teachers' lesson and making notes is a compulsory task for novice teachers like Yao. But Gao still kept such habit of taking lesson observation notes and she would like to observe Liu's lesson when she is free. How to make the observation notes is an "art" for teachers. It is quite often that the novice teachers do not know what should be taken as notes. Gao used to share her way of making notes in the interview: the valuable exercises or the interesting ideas of activities that can be used in her own classroom teaching, the structure and teaching procedure of the lesson, and the corresponding time arrangement. During the school activity observation, Gao paid a particular attention on the blackboard writing design, so she also used her cellphone to take photos of the final blackboard writing of lessons she observed.

- **Keeping the mistakes or disadvantages shown in others' classroom teaching**

Gao has a continuous of collecting the mistakes and takes them as counter case examples when instructing her apprentices (Gao considered it as "teaching them with their reflection"). One example is in the first MOKE discussion, she noticed Yao made a mistake on her blackboard writing (Gao emphasized the "accurate expression in teaching" in several occasions). She took a . and showed this to Yao (see in Picture 4.8).



Picture 4.8. A picture shown by Gao about Yao's mistake in her blackboard writing

She also paid attention on the details that were often ignored by the teachers who gave the lesson. As her DWM Liu explained, even she had worked for more than 10 years, she still obtained many instructions from Gao about the detail problems in her classroom teaching ("She always had the evidences from me"). Gao also showed her ways of sharing the resources with her lesson observation notes and her cellphone, within the collectives (through WeChat group chatting) or with individual teachers (face to face or individual WeChat chatting), and also her way of accumulating the resources related to teaching practice and experiences. Such a way in instructing her apprentices is also used by her with her students, she emphasized to cultivate students a good learning habit, so she asked her students to take notes (for classroom teaching, for mistakes in exams or homework) as a compulsory work, and she regularly checked these work by herself.

- **Sharing the resources with social communication software or cloud drive**

Gao had a shared group chatting named "mathematics TRG" with all the mathematics teachers. According to the records of her activity in this group, she often took photos of her notes (part of her personal exercises notes) or her solutions of exercises and sends them directly in the group chatting. Sometimes for the heavy files, she used cloud driven storage

and shared the download links in the group chatting.

- **Sharing the resource working tips for instructing the apprentices**

Gao had three ways of instructing her apprentice. For the novice teacher like Yao, she asked Yao to observe her lesson for half a year and take notes of the lesson observation. This helped Yao a lot in her later lesson preparation, because in her half year's follow up of Gao, she accumulated lots of examples and exercises used by Gao, which were also used by her in her own later teaching. Then for both Yao and Liu, she often send them the exam papers or some exercises she found in the bookstore, and ask them to do it as their "homework", or ask them to attend also the students' exam in the final exams. Gao also exchanged her ideas on the exercises after Liu and Yao finished them. She explained this as "training them to keep the sense of doing exercises". The third way is she asked Liu and Yao to take notes of exercises like her, and she often shared them her way of making categories of the exercises.

4.5.5 Schemes related to reflection on the documentation work

Reflection actually appears throughout the whole documentation work. However, for Gao, she performed a more deliberate on the reflection compared to her DWMs.

- **Reflecting on her own teaching practice by instructing apprentices in MOKE activities**

Gao had several apprentices, and among them, some became her apprentice since when they were novices (such as Yao), some started the relationship when they started to work in the school and not quite familiar with the school contexts (such as Liu). Gao took the chance of instructing her apprentices in MOKE activities as an opportunity to reflect on her own teaching. In her middle school, unless the novice teachers, the experienced teachers like Gao do not need to conduct MOKE activities, so for a long time (since 2015), Gao had no open lessons to give. The process of instructing others in lesson preparation, especially the MOKE activities with several rounds of lesson preparation, implementation and modification, she said "I also experienced the whole MOKE in my mind."

The instruction from Gao to her apprentices is not just giving out her own voices. As discussed in section 4.3.3, Gao is a teacher who cares much the students' view. This also happens in her interactions with her apprentices: She listens to her apprentices for their own feeling or impressions first. In Yao's case, the beginning of each discussion, she always started from a question of "how do you feel?" This reveals that Gao was instructing her apprentice not only by giving suggestions, but also in guiding them to reflect on both the lesson design and students' reactions, and reflection on how to improve.

- **Attending the collective discussion with other experienced teachers**

Besides giving out the suggestions to her DWMs, Gao also gained reflective ideas through the process of interacting with other teachers who have the similar level of expertise with her. In the MOKE activity, there's always a collective discussion after the lesson implementation, and during the discussion, all the teachers who observed the lesson proposed their own questions and suggestions to the teacher who gave the lesson. In Yao's case of MOKE, there were three rounds, namely there were three collective discussions, which happened respectively with her mentor of Gao in her own LPG (picture 4.9), with the teachers in mathematics TRG (picture 4.10), and with the teachers who teach science subjects in the whole school (picture 4.11).



Picture 4.9. First MOKE collective discussion in mathematics LPG



Picture 4.10. Second MOKE collective discussion in mathematics TRG



Picture 4.11. Third MOKE collective discussion in the whole school

Along with more and more teachers involved in the discussion (pictures 4.9 & 4.10 & 4.11), more voices from different aspects (such as from the physic teachers' consideration) with questions and suggestions were proposed to Yao. Then Gao sometimes needed to react for Yao, especially in the explanations on the lesson design and selection criteria of the exercises. During the process of “defense”, Yao sometimes accepted the different ideas of others, sometimes she “fights back” with her own evidences and ideas. Such interactions are considered as the “contradictions” in CHAT.

- Reflecting on the lesson quality with the completeness of the lesson

In the schemes in search for and selecting the resources, Gao already showed her emphasis on class efficiency and time management in the teaching procedure. When she was reflecting on Yao's lesson, the issue of time was also proposed in two occasions. The first time she proposed was during the first MOKE discussion with Yao, she found that Yao did not finished the exercises she prepared for the students, which means that the exercises were too

much or too difficult. The second time she mentioned the time was the second MOKE discussion with the whole TRG, she felt that the final conclusion and summarization made by Yao was too rush to gave the students a deep impression on this lesson, and she suggested to use a mini video as the conclusion, which could help her in both controlling the time (finish the lesson exactly within 45 minutes) and keeping the students' interests (attracting their attention till the last moments).

This section has presented the schemes of documentation work based on the MOKE activities involving Gao and her DWMs.

4.6 Conclusion and referring to the research questions

Based on the analysis of Gao's documentation work, three issues are addressed with the framework of CHAT, ATD and DAD: to which extent Gao' DE is linked to her specific profile (4.6.1)? To which extent Gao's DE reveals the institutional supports and constraints of Chinese mathematics teachers' documentation work (4.6.2)? And finally, to which extent this case study allows us to answer the questions of research and go further in refining the DE model (4.6.3)?

4.6.1 DE and its relation with Gao's profile

This section addresses the three issues DE (naming system, resource system and scheme) and its development by situating the individual teacher (Gao) with respect to her profile, and within the collectives with the activity system of CHAT (introduced in section 2.3).

Her training experiences and the history teacher education reform context: Gao's profile (both pre-service education and in-service training) is closely linked to the historical context of Chinese education reforms in both higher educational system and teacher education, and also the curriculum reforms. She had no university full time education background (with only junior college diploma), but she belonged to the top students in her generation (see more in section 4.1.1). She had no mathematics background, but her students always get the first rank among other classes in mathematics exams.

The naming system analysis showed a strong orientation on "exercise" in Gao's resource system. Her resources choice preferences and the influences from exam culture: She considers helping students succeed in exams as a basic job, she knows well the learning aid material market about how the books are updated and published; she knows how to trace the changes and trends of high school entrance examination by combining the information from teaching research officers and from the learning-aid material markets; since several years she has a working habit of taking notes for collecting and accumulating exercises and exam questions, and also her daily lesson observation and reflections.

The design view of her resource system especially her usage of technology could be explained by the development of educational technology and her ideas on mathematics and didactics. Gao experienced the process of "popularity of computers" in schools in Shanghai (since 2004); she learnt how to use different technologies mainly through in-service trainings; she used to be have a fever in adapting technology (she had already started to build her digital exercise bank since 2001 with her personal computer at home); she knows the technologies so well that she used to train other teachers how to use them, but since 2015, she started to stay away and try to avoid using any technological resources in her classroom teaching. She holds a very careful attitude towards integrating technology in classroom, and she can distinguish between teaching resources and teaching technology: she considered resource as a kind of information, and technology as only a mean to assist teaching, and "do not use it unless it is necessary".

The collective view of her resource system and her schemes related to sharing resources could be explained by the Chinese social-cultural expectations on the role of teacher: As a mentor, she is very generous to share her resources with others, either by sharing photos/documents/information via WeChat group chatting, or by instructing the apprentices (novice teachers or teachers who work in the same grade with her); As the leader teacher, she cooperates with the research projects and fulfills her tasks, even not in a very active way, and she does not consider the experiences in participating the research projects as her direct teaching resources. Each year, she hosts the student teachers from universities and instructs their internship (Yao was one of them and worked as Gao's apprentice in 2014). Her interactions in collective, especially with her DWMs, her role in the labor division is always the mentor, organizer (with the current leader of TRG) and representative.

The student view of her resources system and her schemes related to adapting and accumulating resources could be traced to her personal education background. She majored in "elementary education management", and this could explain why the student view is outstanding in her resource system, and in her schemes related to accumulating resources, how she selects and accumulates the exercises based on the feedbacks from students. This could also explain why in her research projects cooperating with researchers, she pays more attention on students' general problems (such as the issue of moral education she proposed as her research project), and she knows well how to maintain good relationships with students. We could also infer that, in her design view, when she said she was reducing the technology use, it is also because of her consideration more on student view, but less on mathematics and didactic view. For example, she prefers to spend more time to draw the geometry figure with chalks on the blackboard in front of students, rather than use ppt or GeoGebra to show the figure almost immediately, just because she thinks it is better to show the students the process of how to draw, "they cannot take the computer and GeoGebra in the exams, so they have to learn and practice how to draw it". Here we could also infer that in Gao's resource system, there should be an "exam" view.

The strong student view completes the weaker mathematics view. She did not show many resources related to mathematics. Her idea and method of enhancing students' learning interest on mathematics are by her personality charm, but not by thinking from the mathematics aspect. Her sentence "they will like mathematics if they like me" was evidenced by one of my school activity observation. It was in March 2017, the first MOKE activity between Gao, Yao and another teacher (Zhao). Their discussion was conducted in Yao's office during the lesson break. During ten minutes of the break, their discussion was interrupted twice by students who used to attend Gao's lessons and they came to talk with her. As she presented herself, she has two faces, one very serious and strict face in class, one smile and nice face after class.

In the TRG, she is the only teacher without university diploma and mathematics education background. But this did not influence her in publishing her own learning-aid books, it should be noticed that in that period, only the well recognized and experienced teachers could be invited or recommended to edit these books). And this did not influence her in becoming the best mathematics teacher in her school either. She worked as the leader of TRG since she started to work in the current middle school (2007), even after she quitted the position (2014), she is still considered by other teachers as the expert and mentor in school TRG activities.

In TRG, there are also other experienced teachers with similar expertise level as Gao, such as the current TRG leader and their vice president. With them, Gao often has some intense discussions, especially in MOKE activities, because each of them might have different but strong personal ideas. This echoes the fourth principle of CHAT (see in section 2.3.1): taking contradictions "as sources of change and development". For Gao, when she is exposed in an

environment (which could be regarded as a collective resource system) where she could exchange both resources (in materials form) and scheme (in form of ideas, information and knowledge), she is also holding the opportunity for resources accumulation via her interactions with others.

This section situates Gao's profile to reflect on DE, her naming system, resource system and schemes are closely linked to the cultural and historical contexts (the orientation of education and expected roles of teachers), her pre-/in-service training, and the level of technology development in her time.

4.6.2 DE and its relation with the Chinese situation

This section addresses the feature of DE and its development from the institutional level, with the framework of education noosphere of ATD (introduced in section 3.1.2), which includes the factors of pedagogy, school, society and civilization.

The characters of Gao's resource system and schemes are also her adaptation to the education noosphere.

The emphasize of exercises shown in her naming system is also evidenced in her design view in her resource system, and her schemes related to accumulating resources. As introduced in section 1.1.2, Chinese mathematics has a strong tradition in emphasizing "two basics" (basic knowledge and basic skill) (Zhang, Li & Tang 2005), and "teaching variation" (Gu, Huang, & Marton 2004). These two traditional characters can be evidenced in Gao's resource system and her schemes in her documentation work. Her resource system (in section 4.3) is well organized with resources containing different exercises. Her personal exercises back and exercises notebooks are all categorized according to types and difficulty levels. Her way of design the lesson is starting from selecting the proper example and exercises with enough depth to archive the lesson object. She also arranges different works for students such as homework, pre-study work and exercises for classroom and at school. She spends most of her working time in marking students' homework and instructs them to correct the mistakes. She emphasizes the flexible adaption of the exercises in classroom teaching, and she is able to make variations (on both form and difficulty level) on the exercises based on students' reaction.

The design view and the collective view of her resource system are also resulted from the supports of the national curriculum structure. In section 1.1.2, to support the curriculum implementation, the state launched the institutional system for teacher professional development, providing centralized large-scale teacher training and school-based teaching research activities. The national curriculum has a three level structure: national curriculum, local curriculum and school-based curriculum. Schools (including Gao's middle school) were encouraged to develop local curriculum and school-based resources. When Gao was still working in her previous middle school (before 2007), she used to edit together with a teaching research officer and published a learn-aid book. When working as the leader of mathematics TRG in her middle school, Gao organized the mathematics teachers to develop collectively a set of school-based exercises booklets (during 2012-2014). The materials (exercises) for producing the booklets were from her personal "exercise bank" accumulated by for many years.

The collective view of her resource system and her schemes related to sharing resources are supported and guaranteed by the institutional systems for teachers' collective work. In section 1.3.1, it evidenced the fact that collective working in China is not only a working culture, but also an institutional system with clear structure and regulations, such as the teaching research groups. In Gao's case, like other teachers, working collectively in regular TRG activities is a

compulsory task, which allows the teachers to have fixed time and fixed space to conduct collective activities. Besides, thanks to the regulations, the teachers have also the continuous, well-designed, high quality in-service teacher training sessions. For example, the last interview with Gao for her resource system, she proposed one training session she received from TROs as part of her teaching resources.

The views of design, didactics, students and collectives as well as her related schemes in selecting, accumulating and reflecting are resulted from a general culture orientation, which of course influences her own understanding about “which kind of teacher she should be”. As presented in section 2.1.2, the role of teacher in Chinese culture has a strong culture value orientation. Teachers have to play several roles to get approach to the experts, including being an expert in exams (knowing how to make students succeed in exams), being a researcher, being a mentor for other teachers, and other traits like noble personality with wide horizons, rigorous working way and strong social reputation etc. (Yang 2014). These expectations also have influences on Gao, on one hand, she is trying to take the responsibilities as much as she can, for example she tries hard to balancing the curriculum and exam (by tracing the exam trends and the learning aid materials and selecting exercises for students), she tries to mentor other teachers and sharing off her resources and her experiences, she also tries to cooperate with the research projects.

4.6.3 Enlightening the research questions and the DE model

This section reflects on the three research questions and the DE model based on the case study analysis presented above.

Three research questions:

- (1) What DE could be found in mathematics teachers’ documentation work? What are the components of DE and the corresponding performances of experienced teachers?
- (2) How DE could get developed through teachers’ collective work? What are the factors that could be supportive for DE development?
- (3) Through two contrasting cases, is there any similarity of DE in both cases? What could be borrowed and adapted for a mutual benefit?

Related to the first question

First of all, the case of Gao could represent a type of teachers in her generation.

Their DE development is closely situated in both the education “noosphere” and the technology environment. During the past seventy years since the establishment of the People’s Republic of China, the fast development of economy and technology brings great changes in people’s (including teachers’) working with resources and in collectives. The teacher education system including the teacher qualification system and pre-/in-service teacher training gets established and still is being refined since 1990s till now. All these contexts bring the tensions between the new and western education theories/ideas and the traditional local culture; between “what the teachers of the previous generations were trained” and “what the new curriculum requires”; between “the new education technologies” and “difficulties in adapting and changing the teaching ways” and between “the trends of competency-oriented education” and the reality of “university enrollment system and teacher evaluation mechanism” etc. Through the case of Gao, some myths about Chinese mathematics education could also be fixed, such as “how could Chinese teachers working so easy (with only 10-12 hours per week), comparing with the French teachers (18 hours per week) and the Brazilian teachers (32 hours per week)?”. Gao’s daily work description has

explained what work she has to do besides the time in front of students.

Secondly, through this case study, there are also some inspirations to improve the DE model from the views and the schemes.

- Gao's resource system, especially comparing with her two DWMs who are not in the same expertise level as her, fits Ruthven's "resource system" (2009): it is not a collection of resources, but a coherent system allowing the teacher to combine and adapt in a coordinated way aligned with the goals of curriculum and pedagogy.
- Among the six views, the design view works as a hub that bridges the views student, collective, didactics, curriculum and mathematics. The design view could be further developed into an "accumulation view" (exampled as Gao's personal exercises bank and her exercises notebooks), and a "usage view", which could be evidenced in the process of refining the lesson design through rounds of MOKE activities (design-implement- discuss- refine-implement...). I consider this as an extra view to differ it from resources collecting/accumulating and making categories in the "accumulation view". It is actually a view based on the resources that had been accumulated: Gao picked up some potential resources from her exercises notebook or some resources she recognized, and then refined the quantity, made variations on the form and the difficulty, adjusted the position and orders of these exercises etc.
- The collective view of Gao's resource system is more school-centered, mainly based on the TRG, but her close interaction is still one to one with her two DWMs. In this way, the collective view could be further developed in to a "school view" and a "DWM view": she obtained resources (could for other views of mathematics and didactics) through the teaching research activities and training sessions (the school view), and she shared her resources and the scheme of resource usage and meanwhile got the feedbacks and reflections by mentoring her DWMs one to one and step by step.
- The mathematics view should be studied in teachers' specific documentation work, rather than from the resource system. In Gao's case, she did not mention any special resources particularly for mathematics, but in her MOKE activities, especially when deciding the teaching object, designing the activities to introduce the notion of inequality, and refining the exercises, she performed her rules of action, and her own understanding on the teaching topic, the mathematics notion, its links with other mathematics contents, and its position and requirements in the curriculum program.

The five schemes along with the phases of documentation work needs to be re-thought:

- It is necessary to pay an extra attention on schemes of sharing the resources. In Gao's case, she shared her resources with her colleagues in TRG in two ways: face to face in TRG activities (a physical group), or via WeChat group chatting (a virtual group), and these two ways combine with each other perfectly for sharing different forms of resources. The follow up of the WeChat group chatting (4.2.1) showed that the WeChat group chatting often used to (1) exchange information for work schedules or tasks assignment (mainly sent by the leader of TRG); (2) share exercises, questions or papers in document/photo formats (mainly sent by Gao); (3) share online links of interesting articles related to mathematics teaching or exams (mainly sent by Gao); (4) collect the TRG members' opinions (as a kind of short meeting for making collective decision).
- The scheme of reflection should be associated with other schemes, because the action of reflection appears throughout the whole documentation work since the beginning

till the end.

- The components of scheme, especially the operational invariants, are to be deepened in being formulated in terms of theorems-in-action and concepts-in-action throughout interviews and teachers' activity follow-up.

Thirdly, the resource system is an entity developing dynamically, and can be studied in a static perspective through the structure of resources, and key components seen from teachers' naming system of resources. The schemes could also be able to be studied from the static perspective, from the structure of the operational invariants, and teachers' naming on the verbs of interacting with the resources. Finally, through this case study, the six views of studying resource system and the five schemes should be crossed and intertwined, in the perspective of studying, beyond her resource system, the teacher's *documentation system*.

In this perspective, the research will have to combine the analysis of different complementary data, such as teachers' resources, teachers' naming systems, teachers' usages, teachers words expression and gestures, teachers' knowledge in action she explained and we inferred.

Related to the second research question

First of all, the school-based MOKE activity supports DE development in a guiding way of "hand to hand" and "step by step"

The MOKE activity for Yao was consisted by three rounds with different hierarchy: the first time happened in her own LPG with teachers who taught the same grade as her; the second was in the school TRG with teachers who taught the same discipline as her; the third one took place in the whole school (science TRG) involving teachers from other disciplines close to mathematics, such as Physics and Chemistry.

In each round collective discussion, Yao received questions and suggestions from different perspectives. These questions and suggestions were all details with specific references based on the collective lesson observation, and many of them were unexpected or neglected by Yao or even unnoticed by her mentor Gao. For example, her speed and volume, the layout design of her blackboard writing, her clerical errors and slips of the tongue, her time allocation of the whole lesson, her design of activities, the difficulty hierarchy and question types in her exercises design etc.

For the novice teacher Yao, such a MOKE activity helps her to experience the complete process of "lesson design, implementation and revision through reflection": she got supports in each step, with constructive suggestions hand to hand.

Secondly, the "compulsory participation" of teaching research activity facilitates teachers in forming a habit of working collectively, sharing resources and reflecting

As announced in section 1.3, TRG is a compulsory school organization for teachers. Participation in TRG activities is part of their job, and this provides an institutional guarantees for in-service teacher training.

Teachers in Gao's school have fixed office for LPG discussion; they have fixed time (Tuesday afternoon) for TRG activities; they have traditional mentor-apprentice mode between experienced teachers and novices. Lastly but most importantly, there are many school regulations for teachers' school work: teaching in front of students is only part of their school work, for mathematics teachers, they have to mark the students' homework and ask them correct the mistakes (school regulations); novice teachers have to conduct open lessons regularly; each school year teachers have to observe others' open lessons (to a quantity required by the school) and submit their lesson observation notebooks (except the experienced

teachers like Gao in this case); they have to submit their comments and reflections after MOKE discussion (the TRG leader will collect these into the final reports); it is their job to join the research projects if their school has any cooperative projects with TROs or research institutes. All these activities were considered as part of teacher evaluation indicators.

Thirdly, the technology development is enriching the way of collective work, and the potential form of collective work

The development of technology and Internet, and the popularization of computer and cellphone also influence teachers' resource working and collective working. In our pilot study (conducted in 2014), the teachers interviewed were still using QQ for collective work and exchanging resources (more on computer), few years later (in 2017), teachers moved to WeChat (more on cellphone), which enlarges their working space out of their office and extends their working time after school. The development of apps proposed by the traditional forums and website allows teachers to check and obtain the latest resources or information whenever and wherever possible. In the time of "We Media", through the WeChat official accounts, teachers can receive the articles, ideas and lesson videos directly from teachers they are following (whereas before, they have to attend the lessons face to face or write articles from magazines). With the WeChat group chatting and strong multimedia recording functions of cellphone, the resources exchange and sharing became faster, convenient and fragmented.

Conclusion

This section spent the first two sections in reflecting the three issues of DE (naming system, resource system and schemes) from two levels: an individual level by linking her DE characters and performances within her personal profile and her roles development in collectives (with CHAT framework); an institutional level by linking her DE characters and performances to the Chinese mathematics education tradition, the curriculum structure, the school and institutions, the social expectations on teacher and the cultural orientation. The third section reflects on the enlightenment from this case study to the first two research questions, DE model and its development in collective work. The third research question on contrasting the two cases will be addressed in Chapter 6.

I would like to use one example as a conclusion to present the reflections in this section:

In the video of first MOKE discussion, Gao proposed her suggestions to Yao about her blackboard writing in her teaching. There was a fill-in-the-blank exercise for students:

If $m < n$, then $2m$ ___?___ $m+n$, fill in the blank with inequality sign '>' or '<'.

In Yao's teaching, she did not use blackboard writing, but only show directly the solving process on the ppt slide. Gao kept this in her lesson observation notebook, and pointed out to Yao:

"This, (you should) use a vertical format for contrasting. Yours is like this (she showed her notes to Yao by pointing to her notes, the picture on the left of figure 4.10)..."
(Appendix2.1_132GAO)

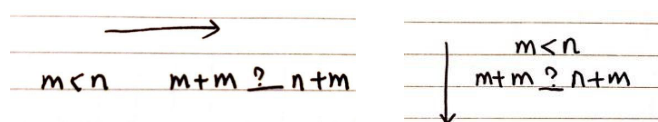


Figure 4.10. Gao's notes on Yao's blackboard writing (left represents Yao's way, right presents Gao's way)

"...Actually (if you) use one vertical format (she showed her notes to Yao, the picture on the right of figure 4.10), m is smaller than n , then $2m$ is ' m plus m ', then (you) let the

students to observe, what happens from m to $2m$? Actually it is ‘ m plus m ’, so they add m on the left side, add m also on the right side. In this way, at the same time, each side of the inequality adds a same m , (according to the property of inequality), the direction of inequality sign should be no change, the answer is ‘ $<$ ’.” (Appendix 2.1_132GAO)

Gao explained further the effects to students between the two ways of blackboard writing:

“This (vertical format writing) is actually a way to lead the students to think. But if you use your horizontal format writing with ppt slides, the students will think it in different way. But with the vertical format (she waved her left hand up and down to show the ‘vertical’ as gestures, Picture 4.12), the students will have a contrasting view on each side of the inequality, and see the process.” (Appendix 2.1_134GAO).



Picture 4.12. Gao’s gestures (waving her left hand up and down) in explaining the blackboard writing

In this short video clip, there are:

- A new resource naming “板书 (bǎn shū)” (blackboard writing), which was not emphasized in her resource system representation, but considered as an important teaching resource for students, and an important part in lesson design when instructing her apprentices;
- The resource of Gao’s lesson observation notebook, her gestures, which evidences the design view (Gao’s notes), the didactics view (how to organize blackboard writing to obtain better teaching effects), the mathematics view (showing process of mathematics solving), the students view (inferring their understandings with different blackboard writing); her schemes related to accumulating resources (paying attention on others’ blackboard writing), her schemes related to reflecting resources (considering the influences of different blackboard writing on students’ understanding), her schemes in adapting resources (using hand-written blackboard writing rather than ppt slides);
- The schemes in resources adapting (changing the blackboard writing format, taking profit of the traditional blackboard writing rather than technological ppt slides), the scheme in resources accumulation (keeping the observation of other teachers’ lesson performance to the notebook), the scheme in resources sharing and reflecting (instructing Yao to reflect on her own blackboard writing).

Chapter 5 Case study in France

This chapter works as a twin chapter of Chapter 4, aiming at exploring and refining the DE model (3.1.5) through a French case study, where two experienced teachers Anna and her DWM Cindy were involved.

As presented in section 3.2.3, the French case analysis takes profit of the AnA.doc platform (see the interface shown in picture 5.1).



Picture 5.1. The interface of AnA.doc platform for analyzing teachers' documentation work

Some analysis had explored from critical aspects with the French case with the structure of AnA.doc: a situation (an occasion for teachers to work for - on – with resources), and Webdoc (within each situation, a Webdoc is designed for an analysis for a given research question, there could be alternative Webdoc for different analysis perspectives). Table 5.1 below shows the situation and Webdoc designed for this French case.

Table 5.1. The situation and Webdoc for the collective lesson preparation analysis of Anna and Cindy

<p>Situation:</p> <p>Entitled “Anna et Cindy (mathématiques, collège), préparent ensemble une nouvelle leçon²⁰”</p> <p>(In English “Anna and Cindy (mathematics, middle school), collective preparation for a new lesson”)</p> <ul style="list-style-type: none"> ● Webdoc 1 <p>Entitled “Genèse d’une leçon sur l’algorithmique, produit d’une préparation collective par Anna et Cindy (mathématiques, collège) ²¹”</p>
--

²⁰ See the page of situation on: https://www.anr-revea.fr/anadoc/?situation=s4-sophie-et-s4-claire-enseignantes-de-mathematiques-dans-le-meme-college-preparent-ensemble-une-nouvelle-lecon&post_type=situation

²¹ See the page of webdoc1 on: <https://www.anr-revea.fr/anadoc/?webdocument=w10-relatif-a-s4-genese-dun-lecon-plan-en-algorithmique-par-anna-and-cindy>

(In English “Genesis of a lesson on algorithmic, the product of a collective lesson preparation by Anna and Cindy (mathematics, middle school)”)

- Webdoc 2

Entitled “Etude du schème de préparation collective d’une nouvelle leçon par Sophie et Claire (mathématiques, collège) ²²”

(In English “A study on the schemes of collective lesson preparation by Anna and Cindy (mathematics, middle school)”)

The following sections make a continue analysis based on the AnA.doc work with the situation and two Webdocs. Five sections were included in this chapter: Section 5.1 presents the context of the case including the information of the two teachers, their school and the supports for their resource work and collective work; section 5.2 described the procedure of data collection and the data analysis; section 5.3 explores Anna's resource system following the naming system perspectives; section 5.4 analyses the DE from the resource system views perspective; section 5.5 analyses DE following the documentation schemes perspective, taking profit of their collective lesson preparation and interviews; section 5.6 concludes with the reflections on the case study with the specific and generic aspects of DE seen from the case, for improving the DE model and exploring the collective influences on DE development.

5.1 French Case: Setting the scene

Keeping the same structure as 4.1 and following the “situation landscape description” model of AnA.doc (see in section 3.2), this section presents the context information of the French case in four parts: the two teachers (Anna and her DWM Cindy) involved in this case (5.1.1); the context of this case including the information of their school, the requirements from the new curriculum (5.1.2); their resource working conditions (5.1.3); and the collectives they involved in and their working roles in these collectives (5.1.4).

5.1.1 Anna and her Documentation-working Mate (DWM) Cindy

This section presents the two teachers involved in this case study: Anna and Cindy who worked together closely since 2006 in the same middle school B (see in Table 5.2). The choice of Cindy as Anna’s DWM had been discussed in section 3.3.3. The information of this section was obtained from the school website, interview with the school principle, interviews with the two teachers and their CVs, and also the RI-Box (see more in section 3.3.3 and 5.2).

Table 5.2. The profiles of the two teachers in the French case

Teacher	Teaching experience	Diploma	Major	Mark
Anna	1992-1995: Middle School G 1995-2005: Middle School L 2005-now: Middle School B	Bachelor (1989)	Mathematics	Mathematics CAPES ²³ (1990) 1991: Internship year
Cindy	2001-2006: Middle School C 2006-now:	Bachelor (1997)	Mathematics	Mathematics CAPES (2000) 2000-2001: Internship year (grade 10 in a high school)

²² See the page of webdoc 2 on: <https://www.anr-revea.fr/anadoc/?webdocument=w11-relatif-a-s4-scheme-du-travail-collectif-sur-une-nouvelle-lecon-preparation-par-anna-and-cindy>

²³ The qualification certificate for teachers in secondary education (Le certificat d'aptitude au professorat de l'enseignement du second degré, CAPES).

	Middle School B			
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Anna was graduated with a bachelor degree of Mathematics in 1989, then the following year (1990) she successfully got her qualification certificate as a secondary school teacher (CAPES). After one year of internship, she got her first job in a middle school in Paris suburbs, where many problematical students were studying. She worked 4 years there during 1992 to 1995, and this experience, as Anna explained, brought her much experience to deal with students' divers problems. From 1995 to 2005, she worked in a middle school L in Lyon. Then since 2006, she started to work in Middle School B. During 2015 to 2019, Anna worked half time in her school, three days in her school, and two days in the French Institute of Education (FIE) (see more in section 1.3.2), meanwhile, she also involved in different educational research projects (will be presented more in section 5.2).

Cindy obtained her bachelor diploma of mathematics in 1997. Then she did her master study for one year (1998) but later she quit. She started to prepare her exam for CAPES in IUFM in 1999, but failed for the first time (1999). In 2000, she passed the exam and got her CAPES, and spent one year for her internship part time in a high school (teaching grade 10), which was part of the program of IUFM. During 2001 to 2006, she worked in a Middle School C, since then she started to work collectively in resources design for the classes and students' activities, with another two colleagues in that school. From 2006, she started to work in Middle School B where she met Anna, and work closely with her since then.

In France, secondary teachers are public-sector employees through teacher-recruitment examinations organized by the Ministry of Education. To become a secondary teacher, one must pass a competitive public-entry examination, with a pass rate less than 20% (Tchibozo, 2005). The teacher-recruitment examination contains four categories with about 110 different examinations, CAPES is one of the four categories, and it is for the teacher candidates in general education. There are 30 specializations in CAPES, including mathematics. This is what Anna and Cindy got.

To sit for this exam, examinees must have a bachelors' degree (since 2010, the examinees need a master' degree). They can prepare by themselves, or by attending one-year courses provided by the Exam Preparation Departments of University Institutes for Teacher Training (Instituts Universitaires de Formation des Maîtres, IUFM). The IUFM system was born in 1990, and since 2013 it changed its name into ESPE (Écoles Supérieures du Professorat et de l'Éducation) (Higher Schools of Teaching and Education). To be noticed that the exam preparation departments of IUFM (ESPE) are also under assessment by their pass rate or the number of their successful candidates, and a department with poor performance might earn less funding or even be closed down (Tchibozo 2005). In this way, the departments generally will try their best to know how to help their students to succeed in the exam and seek for the strategies to improve the pass rate, like making the program contents and schedules, or choose the educators and lectures, or even the experienced teachers from the schools to teach in the departments, all the administrative and pedagogical organizations are in charged by the department heads, who are nominated by the director of IUFM (ESPE). Cindy worked part time as a teacher trainer in one of the departments in ESPE since 2014.

When situating the education background of Anna and Cindy to the development of IUFM (ESPE), it is interesting to find that the two teachers developed themselves along with IUFM (ESPE). Anna was one of the first generation students of IUFM, while Cindy was involved in IUFM ten years later than Anna. They received different trainings from IUFM (ESPE): Anna only received one year's training in IUFM (her internship year in 1991), and the main training course in her memory, was the collective discussions with other student teachers, not the courses given by external supervisors (from research institutes) like Cindy. Anna considered

her training in IUFM as a base for her later teaching career and documentation work.

“... I was in a moment where this had happened. So, I was in a, in an academia which later became IUFM. “(Appendix_1.6ANNA10)

“So, we (the student teachers) produced together. We did the lessons, we did... we explained how to generate a lesson etc. So, I think they were my courses then.” (Appendix_1.6ANNA11)

“You know the first year you are in internship. So you have fewer hours (in IUFM). And me I was in IUFM and in IUFM there were lots of changes and mixtures, several aspects and materials perhaps were mixed for some courses. So, we worked, we prepared (lessons), we had the lessons, and also the suggestions about didactics” (Appendix_1.6ANNA12)

The first school visiting in March 2015, their school principle recommended them as the most active and autonomous teachers. Besides working in the same middle school as mathematics teachers, these two teachers also participated several common collectives (Figure 5.1).

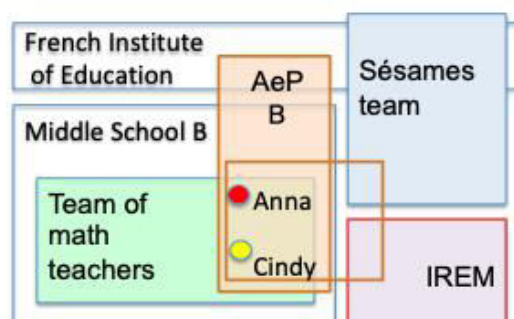


Figure 5.1. Anna and Cindy in the French case (in 2015)

They worked both as the coordinators of AeP Middle School B at FIE (see more in section 1.3.2); they were both the members in IREM and Anna worked as teacher trainer for IREM (see more details also in 1.3.2 and 5.1.4), meanwhile they worked as team members and teacher trainers of SÉSAMES (Situation d’Enseignement Scientifique: Activités de Modélisation, d’Évaluation, de Simulation) (Science teaching situation: activities of modeling, evaluation and simulation) (will be presented more in section 5.1.4).

This section presents the two teachers involved in the French case study. The relationship between Anna and her DWM Cindy are quite different from the relationship between Gao and her DWMs Liu and Yao. It is not easy to describe the two teachers’ profiles separately: on the one hand, Anna and Cindy worked together in a more equal cooperation way, as Anna marked in her RMRS, Cindy was her “teacher friend (prof amis)” (while Gao worked more as a mentor for Liu and Yao), for example, Anna trained teachers for IREM project, Cindy trained teachers for IUFM (ESPE), and they worked as teacher trainers collectively for SÉSAMES; On the other hand, they have several common collectives and they were involved (either as users or as contributors) in these collectives for a long time, and their professional development also intertwined along with the development of these collectives. What is more, these collectives are inter-crossed, and sometimes they cooperated and provided common tasks for the two teachers. This may reveal that in French context, there exists a different type of collective working culture for teachers: the closer cooperation and exchanges between researchers and research institutes bring the teachers more opportunities to work collectively. This will be addressed in section 4.5 after the detail description of the collective work between the two teachers. But there is one thing can be seen up to this moment: teachers’ documentation work, no matter individual or collective, is closely linked to their contextual

factors, including their personal education and training experiences, the institutional regulations and reforms, and also the institutional organizations. This is the aspect from the cultural-historical context in CHAT (see more in section 2.3).

5.1.2 The context of Anna's school

This section presents the school context from the history and the school size (location, teaching facilities, teachers and students, the cooperation with institutions). Information was obtained from the interview with Anna and the school principle, my observation and school websites.

The Middle School B where refers to the middle school part of secondary school B, and it shares a same building with High School B. Built in 1519 by the members of the religion organization, the school had a 500-hundred years' old history. In the first 200 hundred years, the school was lead by a religion organization. After the Revolution of France, it became a secondary school since 1848. Since then till 20th century, it worked as a public secondary school and there were many physicists and philosophers taught in it. In 1975, the original school was separated into 2 institutions: the middle school (collège) and the high school (lycée). The middle school and high school are now two independent schools, with corresponding principles. The French case was chosen from the middle school part.

Locating in the center city of Lyon, the school is surrounded with rich culture resources for teaching: the museums, the theatres, cinemas, architectures, literatures, and the opera. So the rich culture provides diverse resources for teachers in organizing activities for their students (photos of activities were regularly updated in the school websites). According to the school blog, the high school part carried on the prestige and reputation of the legitimate institution, while the middle school part did not have the same characteristics. For the middle school, it is suffering a poor facility shortage, especially the space (it is too small for four grades and five classes in each grade with about 600 students). For example, the classrooms spread over 4 floors in two different wings ("L"), with narrow hallways and exhausting internal stairs, and 2 metal stairs, which are very noisy. Some rooms receive little sunlight for some of them have only one single window. They are mostly too small to accommodate 30 students. Also, there is no room or laboratory for sciences disciplines. All the teachers share a common room since September 2008, and they borrowed 2 rooms from the high school part. But there is no more space for the students and the staffs, also for meeting with parents. The big problem is the outdoors facilities are inaccessible, and the premises of the "school life" are insufficient, due to the tiny yard, which is lacking of space. The middle school and high school share the same nursing room, housekeeping room, gym (an old chapel and not enough to meet the requirements for the teaching of physical education and sport) and canteen.

There are four grades (from grade 6 to grade 9) and five classes in each grade. Seeing from the data published on the school website, the students' number was relatively stable (around 560-580). Each class has no more than 30 students. For each student, there are 26 hours' disciplinary study (4.5 hours for mathematics), 3 hours' personal accompany and 0.5 hour for classroom activity. Generally one teacher was arranged to teach 3-5 classes in different grades, and approximately 18 weekly lesson sessions (55 minutes) in front of their students (while the Chinese teachers generally have to 10-12 lesson sessions with 45 minutes each session). Since Anna and Cindy worked part time in the school (Anna worked part time in FIE while Cindy worked part time in IUFM/ESPE), they had only 3 classes.

Seeing from the enrolment quality and performance levels of the students, this Middle School B is an ordinary one (like the Chinese Middle School A): the students choose this school more for social and cultural reasons, but not by their performance. Some of the students were

enrolled from some primary schools with priorities, and this, to some extent, makes the students in this school form a mixed entity. With the support of the principle, this middle school became one of the first 12 AeP schools (see more in 1.3.2) in 2011, involved in a project chaired by Sara, the researcher from the research institute of a university and she was also a teacher of Cindy in her IUFM study (see in 5.1.1). This project belonged to the algebra SÉSAMES team, entitled “resources for mathematics teachers and teacher trainers for teaching algebra in middle school”. Then in 2013, Anna and Cindy proposed to integrate the high school part to join the project in physics SÉSAMES team, since then, the AeP School B contains both middle school B and high school B, Anna and Cindy still worked as the coordinators. In 2014, AeP school B applied to renew the contract, and proposed to work in (1) producing resource for science and mathematics teaching in secondary school within the discipline and cross the disciplines; (2) developing the practice in formative evaluation, and linking it to summative evaluation, for better improve the role of evaluation and for support learning.

The situation of this school could be summarized as: This is an ordinary school with long history and limited teaching space, location of city-centered with rich materials for student activities; less pressure for teachers in preparing their students for high school entrance exam because the middle schools have no competition relationship; the last but most important (like the Chinese case), institutional supports for teachers to explore other professional development path, for example, for doing educational experiments, in school year of 2018-2019, Anna only kept two classes in grade 6, with the permission and supports from her school. All these factors have impacts on the supportive conditions for teachers’ collective work and resource work. In the following sections, the details about the institutional supports for teachers’ resource work and collective work will be addressed.

5.1.3 Mathematics teachers’ documentation work support

This sections aims at describing the institutional supports for the teachers’ resource work. Different from the Chinese case, the school in the French case adapted an Optional Class System, which means the students have no fixed classroom, but they have specific classroom for disciplines. In this middle school, there were three mathematics classrooms for all the students. Each classroom was carefully decorated with mathematics elements and equipped with the ICT instruments, including the projector, TBI (Tableau blanc interactif, “Interactive Whiteboard”) and a computer. The Mathematics teachers can hold meetings or prepare their lessons in these classrooms (Picture 5.2).



Picture 5.2. One of the mathematics classrooms

The school installed the TBI for each classroom since 2014, and teachers in the school had used the ICT equipment for several years. During our classroom follow up of Anna, she used

it almost each lesson, and she explained that she learnt the usage from her students, the students were very active with the TBI, many of them preferred to work on the exercises on the TBI than working on their own notebooks, and forwarded to help Anna when she met operational problems, for example, how to change the color of the digital ink, or how to switch among the screens or open a software etc.

Different from the Chinese case, the teachers in this middle school have no fixed personal working space. All the teachers in the whole school shared a common teacher office (Picture 5.3).



Picture 5.3 The common teacher office shared by all teachers in this school

In this teacher office, there were the sofa, the cabinets to store teachers' personal stuffs and the common printer (Picture 5.3left); there were also the notice board with information like the class schedules, a common space with long desks and chairs for teachers' work, a bar counter for coffee and tea (Picture 5.3 right). There were three desktop computers prepared as public computers in the corner of this office, teachers can prepare the lessons or documents with these computers, or with their own laptops, or with the computers in the computer classroom that located next to the office. Different from the Chinese case, the teachers in the French case had no need to stay a whole day in school when they finished their lessons so most of the teachers in this school prepared their lessons at home, and they performed very different working habits: Anna used more digital resources and often took her laptop everywhere with her backpack, while Cindy was often seen taking notes on her notebooks or on some papers.

The school provided funding for purchasing textbooks and other necessary resources (such as the IREM brochures and APMEP brochures, to be discussed more in 5.3). Teachers could decide collectively which textbook to buy for the school, and textbooks were not free for the students (this is different from the Chinese case). As Anna introduced, teachers can change the textbooks each year, and in her mathematics classroom, she generally prepared 20 copies of textbooks for each grade, and put them in the back of the classroom in case some students forget their textbooks at home. Their school also purchased the brochures from IREM and APMEP for the teachers, and these brochures were considered as important resources for Anna and Cindy (will be discussed more in section 5.3).

Besides the supports from their school, Anna and Cindy also had the access to other resources (such as the websites resources or reports, articles or books etc.) because of their part time jobs in FIE and ESPE, and their participations in different collectives like the Sésames group and APMEP. Working as “researchers” and teacher trainers, they also needed more resources than the other fulltime teachers.

This section presents the context of resource working supports for Anna and Cindy from the institutional level. Comparing with the Chinese case of Gao and her DWMs, there appear many differences in the French case of Anna and Cindy: students have no fixed classroom and they generally change teachers each year, but the disciplinary classrooms (such as the

mathematics room) were carefully equipped with instruments and elements related to the disciplines; teachers have no fixed space for either personal work or collective work at school, but they have the common teacher office allowing them to interact with other teachers who teach in different grades and disciplines; teachers have the right to decide the textbooks, which demands the ability to select the textbooks with the knowledge of curriculum, students and textbooks, and such a situation is similar to the Chinese teachers and their ability in choosing the learning aid materials (see in section 4.3). The resource work of Anna and Cindy is closely linked to their collective work, which will be discussed in the following section.

5.1.4 Collective supports for mathematics teachers' documentation work

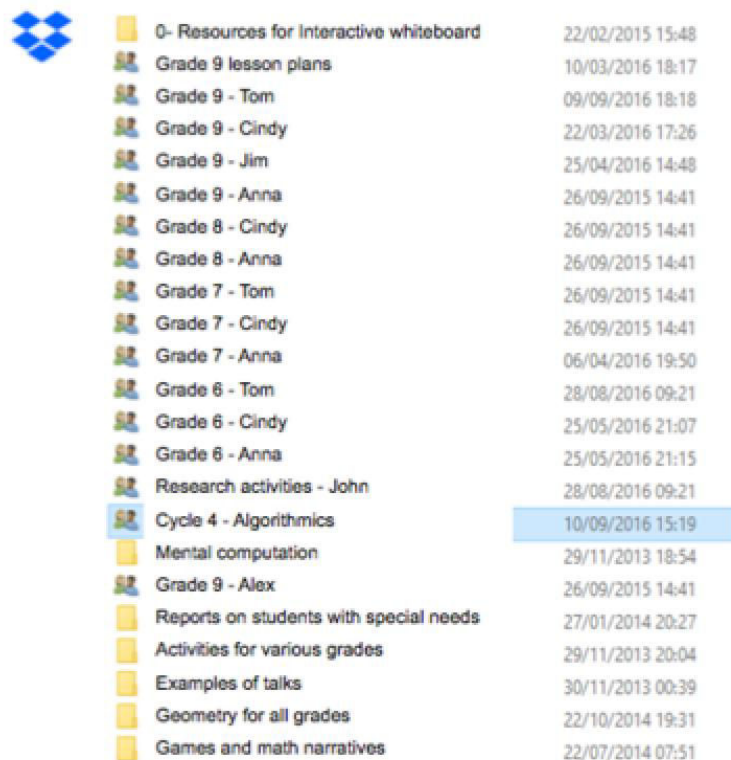
As introduced in 5.1.1, Anna and Cindy are two teachers with close working relationship in several common collectives (Figure 5.1). These collectives are independent collectives, but they are also complicatedly crossed through the teachers (members) and the projects. This section presents the collective working contexts of Anna and Cindy in the four collectives shown in figure 5.1: their school, Sésames group, IREM and AeP of FIE.

Middle School B

Even without the requirements from institutional regulations, the spontaneous collective work (sharing and discussing) is necessary for fulfilling the jobs for the mathematics teachers in this school.

For the mathematics teachers, they could change their teaching grades, classes and students almost each year according to the job adjustments. It was rare that the teachers could teacher the same students for continuous years in their school. During the four years' follow up, Anna changed her teaching grades and classes each year (with different students). As Anna introduced, even she changed the grade (for example in 2015 she had two classes in grade 6, and in 2016 she had new classes in grade 7), she did not teach the same students. Such a situation requires that the mathematics teachers to keep and share their teaching progress, teaching plans and related materials especially the students' information with all the other mathematics teachers, in case next school year, some teacher would take their classes.

As for mathematics teaching, the mathematics teachers who are going to teach the same grade hold meetings to discuss the teaching progress ("progression" in French), which was prepared not for specific lessons, but for the whole school year (including three semesters) in some specific grade. For example, in 2015, Anna had had 1 class in grade 9 while Cindy had two classes in grade 9, so they conducted a collective meeting with another teacher who also taught grade 9 in the following year. They discussed and modified the teaching progress and they also decided the textbooks for grade 9 for the coming school year. Since Anna had also classes in grade 6, she had also to attend the meetings to discuss the teaching progress for grade 6 with teachers who taught grade 6. The time and location for their meetings each year was not fixed. As the only two teachers who had taught from grade 6 to grade 9 (Figure 5.2), Anna and Cindy were often in charge of organizing teachers for meetings.



0- Resources for Interactive whiteboard	22/02/2015 15:48
Grade 9 lesson plans	10/03/2016 18:17
Grade 9 - Tom	09/09/2016 18:18
Grade 9 - Cindy	22/03/2016 17:26
Grade 9 - Jim	25/04/2016 14:48
Grade 9 - Anna	26/09/2015 14:41
Grade 8 - Cindy	26/09/2015 14:41
Grade 8 - Anna	26/09/2015 14:41
Grade 7 - Tom	26/09/2015 14:41
Grade 7 - Cindy	26/09/2015 14:41
Grade 7 - Anna	06/04/2016 19:50
Grade 6 - Tom	28/08/2016 09:21
Grade 6 - Cindy	25/05/2016 21:07
Grade 6 - Anna	25/05/2016 21:15
Research activities - John	28/08/2016 09:21
Cycle 4 - Algorithmics	10/09/2016 15:19
Mental computation	29/11/2013 18:54
Grade 9 - Alex	26/09/2015 14:41
Reports on students with special needs	27/01/2014 20:27
Activities for various grades	29/11/2013 20:04
Examples of talks	30/11/2013 00:39
Geometry for all grades	22/10/2014 19:31
Games and math narratives	22/07/2014 07:51

Figure 5.2. Part of the shared Dropbox among mathematics teachers in Anna’s school (captured in 2016)

This figure was proceed (translated and anonymized) based on the screenshot of Anna’s computer during her first collective lesson preparation with Cindy in May 2016 (see more in section 5.2). In this figure, we can see that each mathematics teacher in this school shared their own resources with others, even with those who were not teaching the same grade. They used the same format to store their resources, and name the folders as “grade + name of the teacher”. From grade 6 to grade 9, Anna and Cindy were the only two who have folders in each grade. This can evidence that they knew better the curriculum, teaching and students than the other teachers, and thus able to play the leader roles for planning the teaching, and work as the teacher trainers for other middle school teachers.

SÉSAMES Group

SÉSAMES is a research group aims at producing guidance for teachers and students on how to teach and learn sciences. All the contents and resources of SÉSAMES were put on the website of PEGASE (pour les Professeurs et leurs ÉLèves: un Guide pour l’Apprentissage des Sciences et leur Enseignement²⁴) (for the teachers and their students: a guidance for science learning and teaching). For Anna and Cindy, they still used the name of SÉSAMES when they referred to the collectives, but they used PEGASE when they wanted to refer to the resources. The most important resource from PEGASE is “Mise En Train (MET)”, a collection of activities designed for students (will be discussed more in 5.3).

Mathematics teaching (algebra) was a sub-project under SÉSAMES. Aiming to build resources for mathematics teaching, especially for algebra teaching in middle school, SÉSAMES algebra group consists of eight members including one researcher (Sara) and seven secondary school mathematics teachers. Each of the 8 participants has their own expertise, the teachers were selected with rich teaching experience and practical knowledge,

²⁴ Website : <http://pegase.ens-lyon.fr>

while the researcher (also teacher trainer) had plenty experience and expertise in research and theoretical knowledge. The cooperation formed a circle of “resource development – implementation – improvement and modification – diffusion through teacher trainings”. They complemented between theory/conception and practice/reality.

Anna and Cindy started to involved in since 2006. Their participation in SÉSAMES is also closely linked to their profiles: The leader of SÉSAMES (Sara) was a researcher of university, and she also worked as the teacher of Cindy in her IUFM study. Cindy re-met Sara in 2002, and then joined SÉSAMES projects with Anna. Their jobs in this team include resources development for teaching/learning and also assessment (formative assessment and summative assessment). The team had regular meetings once each month.

SÉSAMES brought Anna and Cindy to the world of teacher-researcher-teacher trainer, which worked as a very crucial collective and resource for both Anna and Cindy: based on the experiences in SÉSAMES, they continued and joint other projects and research teams such as the AeP coordinator between their school and FIE (already presented in section 1.3.2, and will be explained more in their school’s case in 5.1.2); the resources they obtained and accumulated in SÉSAMES worked as the base for their later resource work (such as the PREMaTT²⁵ project). Meanwhile, as Cindy introduced, in SÉSAMES group she learnt diverse ideas from people with different horizons, the new activities for her teaching, and the theoretical ideas. SÉSAMES was a collective with research components for them: During their participation, they cooperated with Sara, and published papers based on their work in the projects in SÉSAMES, they attended different conferences or seminars and make presentations, they diffused what they had obtained in their teacher training jobs.

AeP at FIE

As introduced in section 1.3.2, AeP at FIE (LÉA in French) network was first set up in 2011, aiming at hatching educational research projects by providing platforms for school teachers and researchers. The middle school where Anna and Cindy work was the first AeP members (had been introduced in 5.1.2). Since then, Anna and Cindy worked as the co-correspondents. Their participation was recommended by Sara (from SÉSAMES), who invited them to join and work as the correspondent between their school and AeP at FIE. As the researcher who is in charge of AeP network introduced, “most of the time, the leaders or some excellent and experienced teachers will be the correspondent”.

There are regular national conferences and seminars of AeP held in FIE. The correspondents need to make presentations to report their project progress. Generally, Anna and Cindy presented together, and joint the reports writing collectively. Since 2013, Anna worked part time in FIE, and joint in several projects related to mathematics education, such as a MOOC project (2015-2016)²⁶, a PREMaTT project. The PREMaTT project evidenced the complexity of the collectives that Anna and Cindy worked in: it is epitomized by members with different roles from different collectives: there are the researchers, teachers, teacher trainers, PhD students, post doctors, and the pedagogical engineers, who come from the schools (including primary schools and middle schools), the IUFM (ESPE), FIE, AeP of FIE and SÉSAMES.

²⁵ PREMaTT (Penser les Ressources de l’Enseignement des Mathématiques dans un Temps de Transitions) is a project (2017-2018) of FIE, see more on <http://ife.ens-lyon.fr/ife/recherche/groupe-de-travail/prematt>

²⁶ MOOC Enseigner et Former Avec le Numérique en Mathématiques (eFAN Maths), see more on <https://www.fun-mooc.fr/courses/course-v1:ENSDeLyon+14003+session04/about>

IREM and APMEP

Anna became a loyal customer of IREM and APMEP (had been introduced in section 1.3.2 and 5.1.1) since she graduated in 1990. APMEP and IREM have their own brochures as commercial publications for teachers. These brochures were considered as important resources for both Anna and Cindy (will be presented in details in 5.3).

Since 2010, Anna joined the IREM group of Lyon city, and worked in the project of “evaluating by competence, the geometry in middle school, the decimal number in primary and middle school”. In this group, she got a part time job as a teacher trainer, for the topic of “towards an evaluation by competence in middle school”. In 2014, with the other 2 teachers in her IREM group, she worked and proposed a competence lists based on the Curriculum Program 2008²⁷. This experience allowed Anna to obtain and accumulate many exercises and activities for her later classroom teaching. In this group, teachers have to meet twice a month and reflect on their teaching in geometry, teaching assessment skills.

The APMEP is a professional organization for public school teachers, and it is totally voluntary and independent of politics and trade unions. The issues it concerns are: syllabuses contents; skills required from students; teaching and training methods; timetables and class sizes, and especially class splitting; the harmonization between key stages; the improvement of the mathematics status as a training tool rather than a selection tool. Anna registered as a user of APMEP since 1990, then since 2012, she worked as the secretary of the regional APMEP; from 2014, she became the representative of Lyon branch of APMEP in the APMEP national committee, and each spring she attends the national annual meeting Paris. In 2016, she worked as one of the organization committee members that in charge of organizing the national meeting of APMEP.

The participation way in APMEP to Anna is similar like IUFM (ESPE) to Cindy. They both joined as users and were influenced by these collectives. Along with their professional growth, they approached step by step as contributors, and finally they join the collectives and diffused their ideas to benefit others in two ways: teacher training and writing papers (see more in 5.3.2). Their professional development is embodied with their roles in the collectives and the development of these collectives, which evidenced the activity system of CHAT (see 2.3).

5.2 Data collection strategy

The French case data collection is different from that of the Chinese case. The reasons was explained in section 3.2.3, on one hand, the constrains of long-distance locations of the two cases do not allow me to collect the data in a symmetrical way: during the four years in France, I spent most of the time in France, and the working manners of the teachers are quite different in the French case and Chinese case. In this way, this section makes a more detailed presentation based on the methodology and tools of section 3.2 from two sections: how the follow up was organized with specific tools adapted in different moments (5.2.1); how the data will be analyzed (5.2.2) in the following sections of 5.3, 5.4 and 5.5.

5.2.1 Organizing the follow up

The formal follow-up of the French case started since the end of March 2015 (see in Figure 5.3). Considering that there are many differences in the institutional regulations for teachers’s work between China and France, the data collection organization adapted in France is not as the same way as the Chinese one.

²⁷ The curriculum program 2008 is the previous version before the new curriculum program released in 2016.

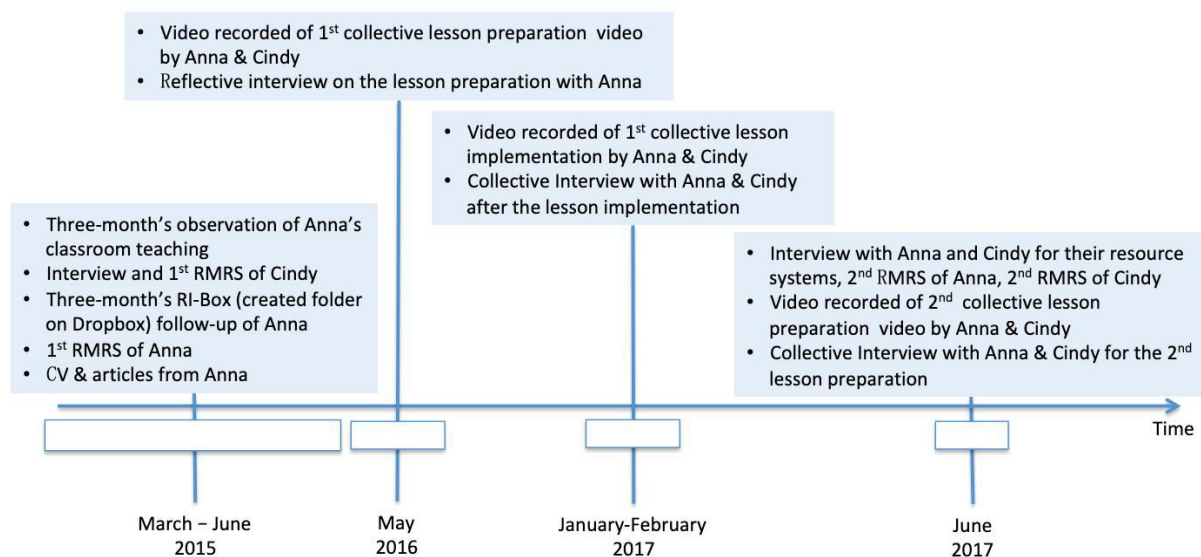


Figure 5.3. Global data collection for the French case

For better understanding the French education system and teachers' practice in schools, after a school visiting in Middle School B in March 2015, Katiane Rocha (see our common presentation on page 16 in this thesis) and me started to follow Anna's class and schoolwork for three months. As explained in 1.3.2, in France, teachers' lessons are not open to visitors without permission, so we cannot stay in Anna's school for the whole day (this is different from the Chinese case, where I could stay the whole day with Gao in and out of her class), because she had no fixed office place (explained already in 5.1.2, and this is also different from the Chinese case, where I had a fixed office desk next to Gao in her office). During these three months, we observed only her classroom teaching in one of her classes in grade 6 four times a week, and also some school meetings, . During the follow up, we met Cindy who worked with her in the same middle school, and I conducted an interview with Cindy for her resource work and collective work, then she was decided as Anna's DWM in my case study (see the criteria in section 3.2.4), and her first RMRS was drawn based on this interview. Meanwhile, an RI Box (3.2.3) was created and shared between Anna, Cindy and we two researchers. The French RI-Box was a folder based on Dropbox, because the teachers used it more often. In this RI-Box, there is an online doc for exchanging questions with the two teachers. During this period, we took the RI-Box as an important complementary way to interview Anna and Cindy for learning the contextual things in French education system: we wrote down our questions, either for their lesson or resource work, and they wrote their answers regularly (most of the time they were answered by Anna). Then in the end of the follow up, without demanding, Anna proposed her first RMRS (in 2015) (see in Figure 5.9), which was actually more about her collectives rather than her resource system (will be analysed in the section 5.4). Some other documents, such as the CVs of Anna and Cindy, their articles published and their working blogs at school were also taken as information for our consideration.

One year later, in May 2016, before the new school year for implementing the new curriculum in September 2016 (the new curriculum reform had been introduced in section 1.1.2), Anna and Cindy were facing a task to prepare a teaching plan of algorithm, meanwhile they had to decide from 13 different textbooks, which one to be purchased and used in the coming school year because several publishing houses sent their textbook samples to the teachers. This teaching plan was not for one specific lesson or for one grade; it was for the whole theme of algorithm, for the whole school, and for each grade. Anna proposed to work together with Cindy, with a first object of "introduction of algorithm". We recorded the videos of their

lesson preparation for one hour (Picture 5.4). This situation was put on AnA.doc platform (as announced at the beginning of this chapter)



Picture 5.4. First collective lesson preparation conducted in May 2016

After transcribed their discussions into texts, we conducted an extra interview with Anna for the resources appeared in their collective lesson preparation discussion.

Half year later, in January 2017, we visited Anna and Cindy for their lesson implementation on algorithm teaching in grade 7. The lesson was conducted as an EPI practice (see in 1.1.2) with the technology teacher in their school, so it contained two parts: a first half in mathematics classroom for the activity of Nim Game (a matchstick take game between two players), second half in information computer room for Scratch programming. An interview with them was conducted after the lesson.

In June 2017, a second round of interviews with Anna and Cindy for their resource work and resource system were conducted, and we invited them to prepare collectively on algorithm teaching for the coming school year. The collective lesson preparation were recorded and transcribed, and an interview with the two teachers about their reflections on the past year's teaching on algorithm was conducted with three issues: the new resources or methods obtained and improved; the exchanges (contributions and benefits) from collectives; the difficulties met in teaching practices and the plan for the following work.

Besides the follow up presented above, we also conducted some informal follow up with the two teachers in their work life out of school in many occasions, such as their presentations in the annual meeting of APMEP (see in 1.3.2), in the seminars of AeP (also see in 1.3.2), or even lunch talk (because Anna worked part time at FIE where we worked).

Not all data are kept in the appendix. The second interview (in 2017) with Anna and first interview with Cindy (in 2015) for their resource systems were kept as appendix 1.4 and 1.5 respectively. The videos of their first collective lesson preparation (in 2016) and second lesson preparation (in 2017) were kept on AnA.doc platform, the transcription of the first collective lesson preparation work is in appendix 2.4.

5.2.2 Organizing the analysis

The French case study analysis in the two following sections is also conducted along with the conceptual DE framework proposed in section 2.4 and 3.1.5: DE is to be evidenced in the process of (1) integrating the resources with schemes from the resource system, and (2) managing and developing the resource system.

In the Chinese case study, Gao and her DWMs work in a mentor-apprentice relationship, and they have different working experiences (Gao since 1993, Liu since 2002, Yao since 2015),

corresponding to different teacher education reform periods (see more in section 4.1); while in the French case, although Anna and Cindy also have different service years (Anna since 1991; Cindy since 2001), Anna and Cindy hold a similar level of expertise (recommended by their school principle and the researchers who cooperated with them). A most distinctive character of their relationship is their intertwined collective work. In this way, the analysis of the French case is organized different from the Chinese case.

In section 5.3, analysis will focus on the components and structure of Anna's resource system seeing from the six views proposed in DE framework (from a static view), especially its links and overlaps with Cindy's resource system. Meanwhile, part of the dynamic schemes are also included: scheme of searching for and selecting resources to develop resource system besides classroom teaching, the schemes of accumulating resources and reflecting through the resource system management and development.

In section 5.4, analysis will take the two collective lesson preparation activities (by Anna and Cindy) to explore the schemes shown in Anna's documentation work (Cindy's work is also paid an attention) in specific situation: schemes in searching and selecting the resources from the resource system (whether it echoes the scheme found in 5.3), the schemes in adapting the resources, the schemes in accumulating resources, and also the schemes of reflecting. In this way, the schemes evidenced in 5.4 are based on the video analysis of this section and the schemes evoked in 4.3 is from the interview descriptions and related documents, such as RI-Box documents and mappings drawn by teachers.

Section 5.5 will explore the collective aspect about how the teachers develop their DE through collective work. The reflecting and summarization are based on what had been discussed in collective view of teachers' resource system (in 5.3) and schemes in interacting within collectives (in 5.4), and also the schemes in how to obtain, accumulate and share the resources in and from collectives.

5.3 DE evidenced through teacher's naming system

In this section, Anna's resource system will be analyzed with diverse data, and data from Cindy is considered as complementary information for understanding Anna's resource work (see in 5.2), following the perspective of their naming systems (5.3.1), and three important resources seen among her resources (5.3.2).

5.3.1 Analyzing teacher's naming system

Along with the project of *“Contrasting naming system used by teachers in describing their resources and documentation work: towards a deeper analysis of teachers' resource systems”* (also introduced in 4.3.1), this section made an exploration of the French case.

From the aspect of language origin, the distance between Chinese and English is much larger than that between French and English, because the latter shared an origin of Latin, and many English words are from French. This makes it necessary to analyze the French teachers' naming system differently from the Chinese one, especially the differences on the resources in the French contexts. The analysis mainly based on the interview transcriptions with Anna and Cindy, and also the documents in the RI-Box.

The reflecting results on these data showed that a most frequently emphasized term by the two teachers is: *activité* (activity in English). Seeing from French, the “*activité*” is for “*activer*” the students, which means for making the students be active. Pepin and Haggarty (2001) analyzed one of best-selling mathematics textbook series from English, French and German, and results showed that the structure of French textbooks were featured with activities,

essential exercises, and accommodating exercises, aiming to guide students to new notions.

For the other colleagues' better understanding on the shared resources, all the mathematics teachers including Anna and Cindy shared their resources for classroom teaching in a common Dropbox folder and tried to keep the resources in a uniformed way (see in section 5.1.4). The folders were organized on different themes containing lesson plans, activity sheets to be used in classroom (either printed and sent to students or in digital version and shown to students by projector), and the documents about evaluation. As Anna's DWM, Cindy described the lesson plans in their common folder and the resources for constructing the lesson plans in her first RMRS (in 2015), where the position of activity was evidenced as an important part in their lesson plans (Figure 5.4).

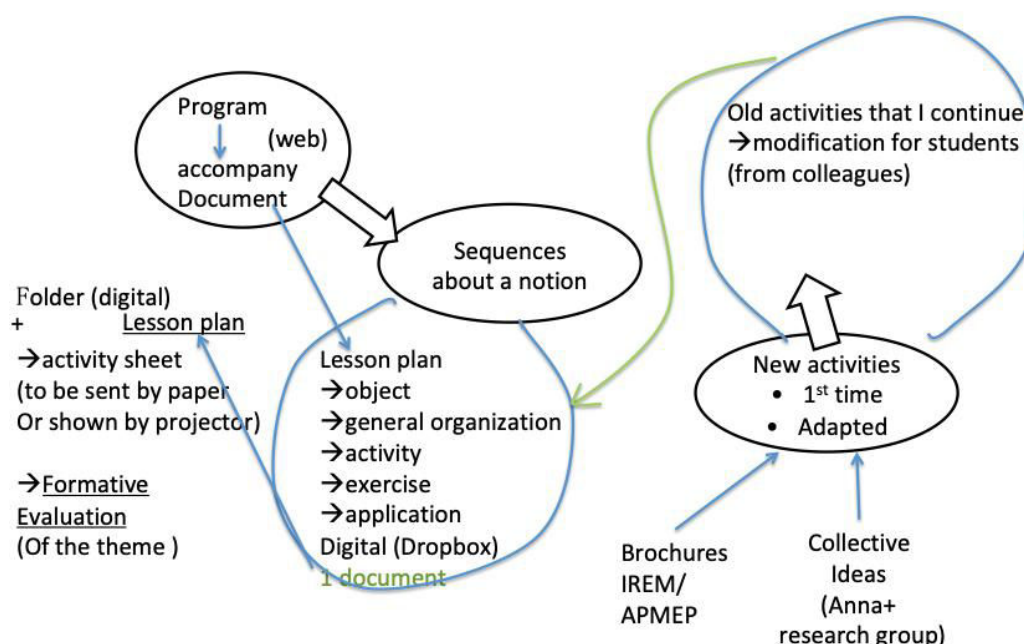


Figure 5.4. First RMRS of Cindy (drawn in 2015)

The way of drawing the mappings of resource system is quite different between Anna and Cindy. Figure 5.4 actually was drawn by Cindy to explain the “sequence” (or lesson plan), including what elements are contained, where the elements come from and how these lesson plans are stored in the Dropbox. She emphasized that they (Anna and also other teachers in her school) used “sequence” more than “lesson plan”. The sequences are designed for one notion to be taught, so for one notion, teachers developed a series of sequences (named as sequence 1, 2 etc.), and one sequence works as one lesson plan for one or two teaching hours. In the lesson plan document, there generally contains the teaching object, the teaching procedures organization, the activity, exercises and some application. Among these components, Cindy particularly explained the activity: she obtained the activities and modified for students, then designed activity sheet and sent/shown to students.

Figure 5.4 also showed a “flow” of Cindy’s resources: She got the resources about “new activities” from two sources: the brochures of IREM and APMEP, and ideas from collective interactions with Anna and others. Her way of using the resources is adapting and modifying these resources based on her trial implementation. These improved resources were named as “old activities” and worked as references for her lesson design. Meanwhile, she also emphasized the importance of the curriculum program and the accompany program (published along with the curriculum program by the Ministry Education) by putting them firstly at the beginning of her RMRS drawing.

The development of a year teaching progress is a process of enriching the sequences. During their first collective lesson preparation in May 2016 to the end of our data collection in December 2018, five moments of their common teaching resources folder states were kept (Figure 5.5).

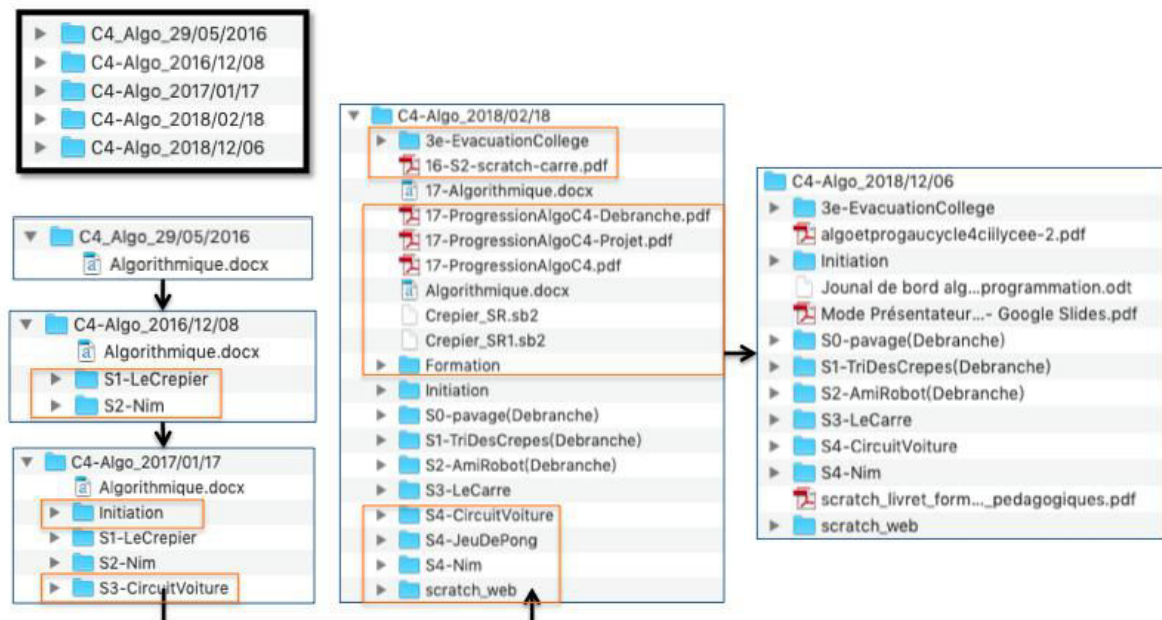


Figure 5.5. Five moments of “algorithmic teaching” folder states during 2016-2018

The folder was named as Cycle (C4) + theme abbreviation (Algo), Sequence (S) and the dates were added by the researcher. The five moments showed the changes in this folder: at the beginning, there was only one teaching progress (May 2016), then four sequences were added (January 2017), and three teaching progress documents with more sequences (February 2018), and in the end, it was reorganized and simplified (December 2018).

The structure of lesson plan (or sequence) might be explained by the influences of the French textbooks. The textbooks arranged their contents in different names. Taking one textbook of Delta Maths (Figure 5.6) (which is one of the textbooks for Anna and Cindy to choose) as example, the chapters were organized by the sequences according to the mathematics notions, and below each sequence, there were specific activities for the sequence: there is a hierarchy from cycle – theme – sequence – activity.

Sommaire	
Programme de mathématiques Cycle 3	10
Le cycle 3 dans le manuel	11
Suggestions de progressions Cycle 3 en 5P	12
Cartes	
Scratch	1
Le langage	12
Cartes	13
Tableaux de multiplication - Unités de mesure	14
Tableau	15
Nombres et calculs	
SÉQUENCE Nombres et calculs	16
1 Lire des nombres décimaux	16
2 Décomposer un nombre décimal	18
3 Repérer et placer des décimaux sur une droite graduée	19
4 Calculer des décimaux	20
5 Fiche de synthèse	21
Tâches complexes	22
SÉQUENCE Calcul mental et instruments	23
1 Multiplier et diviser par 10, par 100 ou par 1 000	23
2 Découvrir des stratégies de calcul mental	24
3 Choisir les bonnes opérations pour résoudre un problème	24
4 Fiche de synthèse	25
5 Fiche de synthèse	26
Tâches complexes	27
SÉQUENCE Calcul posé : addition, soustraction, multiplication	28
1 Additionner et soustraire	28
2 Multiplier	29
3 Découvrir la propriété de la multiplication sur l'addition et la soustraction	30
4 Fiche de synthèse	31
5 Fiche de synthèse	32
Tâches complexes	33
SÉQUENCE Calcul posé : division	34
1 Effectuer une division euclidienne	34
2 Utiliser des critères de divisibilité	35
3 Effectuer une division décimale	36
4 Fiche de synthèse	37
5 Fiche de synthèse	38
Tâches complexes	39
SÉQUENCES Fractions	40
1 Effectuer un partage	40
2 Découvrir les fractions en tant que nombres	41
3 Relever des fractions égales	42
4 Prendre une fraction d'une quantité	43
5 Calculer un pourcentage	44
6 Fiche de synthèse	45
7 Fiche de synthèse	46
Tâches complexes	47
SÉQUENCE Proportionnalité	48
1 Découvrir le sens de la proportionnalité	48
2 Calculer le passage à l'unité	49
3 Calculer et utiliser un coefficient de proportionnalité	50
4 Calculer et utiliser un coefficient de proportionnalité	51
5 Fiche de synthèse	52
6 Fiche de synthèse	53
Tâches complexes	54
SÉQUENCE Représentation de données	55
1 Lire et interpréter un tableau ou un diagramme	55
2 Représenter des données	56
3 Représenter des données	57
4 Fiche de synthèse	58
5 Fiche de synthèse	59
Tâches complexes	60

Figure 5.6 Part of the tables Delta Maths textbook

In the Chinese case, Gao did not mention “ti (exercise)” in her resource system, but the resources in her resource system were centered on it. Similarly, “activité” was also not mentioned by Anna in her resource system, but related to “activité”, there are several resources: SÉSAMES, IREM brochures, lesson plans, year teaching plans etc. Activity is a term often mentioned by Anna in the second interview for her RMRS (in 2017), especially when explaining what she obtained from the collectives of IREM, APMEP and SÉSAMES (see more in 5.1.4).

“And we did, we have a lot of activities that we re-worked, which were come out of the (IREM) scientific brochures (see in picture 5.5).” (Appendix 1.6 _ANNA28)

SUIVI SCIENTIFIQUE 1985-1986	
BULLETIN INTER-IREM PREMIER CYCLE	
Nouveaux programmes de sixième	
SOMMAIRE	
Préface	
Avertissement	
Introduction	
I. RÉFÉRENCE	
IREM Lyon	1 - Aide pédagogique
IREM Lyon	2 - Repérage dans le plan à l'aide d'un ordinateur
IREM Lyon	3 - Course d'orientation (activité pluridisciplinaire)
II. REPRODUCTION DE FIGURES PLANES SIMPLES	
IREM Paris Sud	1 - Construction de triangles dans une situation de communication - compte-rendu
IREM Rennes	2 - Le Cercle, Programmes de construction (compte-rendu)
IREM Rennes	3 - Le Cercle au bout de sa chaîne
IREM Rennes	4 - C'est pas rond, mais ça tourne
IREM Lyon	5 - Vers la médiatrice (une situation-problème)
III. SYMÉTRIE ORTHOGONALE	
F. MARTEL	1 - Aide pédagogique
IREM Dijon	2 - Exemples d'activités
IREM Poitiers	3 - Une proposition complète d'enseignement
IREM Poitiers	4 - Difficultés rencontrées par les élèves
IREM Poitiers	5 - Visionnement du film "l'effet miroir"
IV. LES AIRES	
IREM Paris	1 - Aires de surfaces planes
IREM Paris	2 - Variation de l'aire d'un rectangle
V. REPRÉSENTATION ET ORGANISATION DES DONNÉES	
B. COSTE	1 - Aide pédagogique
IREM Nice	2 - Proposition d'activité
VI. NOMBRES ET CALCULS	
G. ANFRE	1 - Utilisation de calculatrices
R. DOUADY	2 - Aide pédagogique
R. DOUADY	3 - Les fractions
M.J. PEREIRA	4 - Proportionnalité
M. PHILIPPON	5 - Sports et Musique (compte-rendu d'activité)

Picture 5.5. One example of IREM brochure given by Anna (now the “suivi scientifique” has ceased to exist)

This is similar to the backward design proposed by Wiggins and McTighe (2005): teachers are coaches of understanding, not mere providers of content or activity. They should focus on ensuring learning, not just teaching and assuming that what was taught was learnt, they always aim- and check for – successful meaning making and transfer by the learner. The different between backward design and traditional design is: the traditional design focuses in assuring to cover all the topics suggested either by governmental policies such as standards or programs, or concentrate more on the type of activity to be carried out by students, but paying less attention to the real purpose, usefulness and impact on students’ understanding of the

topic. They proposed a backward design tool as a template for curriculum planning, with a framework for designing a sequence of lessons that will lead students to deep understanding of the teaching content. A sequence of lessons can refer to a curriculum unit or a sequence of learning experiences aimed at producing a particular learning objective, goal or intension. Three stages were proposed: (1) identifying the desired results, what should students understand, know and be able to do? (2) Determine acceptable evidence, what will be the evidence of the desired results? (3) Plan learning experiences and instruction; what learning activities could promote students' understanding, knowledge, skills and interests? In section 5.4, this topic will be discussed.

5.3.2 Analyzing Anna's resource system from her key resources

This section presents three important resources selected from the mappings of Anna's resource system: Dropbox, MET and brochures of IREM and APMEP.

Anna performs like a “fan” of digital resource user. In her RMRS drawn in 2017 (Figure 5.7), she spend 1/3 space (on the left) in describing her shared platforms with different collectives, 1/3 space (on the middle) to explain how she trace the available resources and where she stored the resources, 1/3 space (on the right) for figuring out the rest three resources she mainly used: brochures from IREM and APMEP, MET (for arranging activities), and a digital textbook (for selecting exercises).

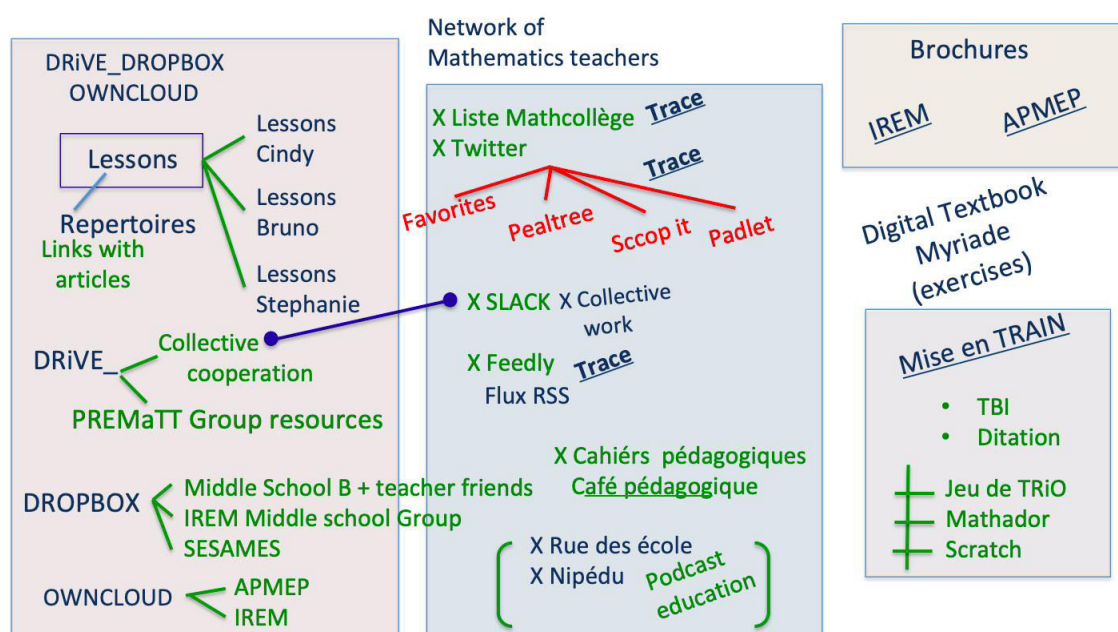


Figure 5.7 RMRS of Anna (made in 2017) (the colored blocks were added by the researcher)

In the following parts, three selected resources were presented: collective working platforms represented by Dropbox, brochures from IREM and APEMP, and MET from SÉSAMES.

Dropbox: a collective working repertoire

Dropbox is not the only a cloud drive application for Anna, but also a platform for collective work. The figure 5.2 (in section 5.1.4) has shown part of the Dropbox interface of Anna's computer, where the common folder for sharing lesson plans in her school was well and systematically organized. She also had the folders shared with IREM group and SÉSAMES group.

For her personal use, Dropbox is a local backup disk installed in her computer, besides her personal resources, she had a special folder in Dropbox as her own “lesson plan repertoire”,

where she saved all the lesson plans shared by other teachers and she named the folders with the author's name, for example, she had all the lesson plans shared by Cindy, and she put them in to the folder "Cindy lessons".

Anna shows an ability of well adapting herself to different collectives with different technology using habits. For example, besides Dropbox, she also used another cloud drives, such as Google drive for sharing and exchanging resources with members in FIE (for PREMaTT project), Own cloud²⁸ for exchanging with groups of APMEP and IREM. In front of new resources or new technology, she holds an open attitude to try and learn.

MET: a critical meta resource

MET is the abbreviation of Mise en Train (MET), in French "Travail de Recherche ou d'Approfondissement avec prise d'Initiatives". Resources of MET are created for "warming up" teachers' lesson for exploring one notion in a progressive way, and are generally used at the beginning of the class in the first fifteen minutes. The introduction was also discussed in Rocha & Trouche (2017). I kept what Prieur (2016) defined in her work, a meta resource is "a resource guiding the design of other teaching resources, and supporting a reflective attitude of teachers both on the design and on the usage of these resources".

Anna and Cindy considered MET as a meta resource. In many occasions (no matter for lesson preparation or teacher training or to present something for research seminars), MET was always proposed as the original material or their representative work.

The initial aim of MET was not as widely used as the current MET resources collection. From the activities for calming down the students and arising their interests to the lesson, MET slowly grows into a kind of "warming-up" model for classroom teaching activities (Trouche et al., 2019). At the beginning it was for the introduction of algebra notions, then along with the development and popularization of the model, the function of MET was enriched also to other topics. Later till now, it was not only used as warming up model for introducing notions at the beginning of the lesson, but also could work as the main activity throughout a whole lesson, or worked as a summarization activity in the end of the lessons. All the resources were results of SÉSAMES project and were put on the website of PEGAME²⁹.

Users' appropriation of the resources and the involvement in the resources design provide the possibility of communication between the designers and users of an online resources, encompassing the potential for creating virtual communities (Pepin et al., 2015; Trouche et al., 2013). This is the case of Anna and Cindy, and through their spreading work (in their school meetings, in their presentations in different seminars, and most importantly through their teacher training work), their other colleagues in the school also adapted MET resources as a model. Actually, MET worked not only as a resource element for constituting a lesson, but a already model for organizing the lesson structures. One example is given by Anna and Cindy (they shared this example in many occasions to explain how they design their teaching with MET resources), their "teaching progress (for year 2014-2015) of grade 9" (Figure 5.8).

²⁸ <https://owncloud.org>

²⁹ <http://pegame.ens-lyon.fr>

Title: Teaching progress of grade 9	
Main Lessons	MET activities
Lesson 1 3. Savoir calculer le PGCD de deux nombres en utilisant un algorithme 4. Savoir rendre une fraction irréductible 5. Savoir résoudre des problèmes relevant de la division du PGCD	Activity 1 ... Activity 2 ... Activity 3 ...
Lesson 2 1. Réactiver les connaissances de géométrie 2. Quadrilatères 3. Triangles - droites remarquables	Activity 4 ...

Figure 5.8. The Teaching Progression based on MET activities

The teaching progress is prepared for the whole school year and shared by the whole school mathematics teachers who teach grade 9 (but actually any mathematics teacher can access to this). Its function is similar to the “teaching schedule” in the Chinese case, but different in details (the Chinese teaching schedule is shared in the LPG with the specific teaching topics arranged in each week and each day).

Figure 5.8 shows the structure of this document. The whole teaching progress contains two columns: Each lesson or sequence (on the left) corresponds to the MET activities (on the right). Such a “teaching progress” mode was also diffused by Anna and Cindy in one of their papers for APMEP brochures, in which they introduced their working experiences in SÉSAMES and how they adapted the MET mode in the schoolwork.

Another evidence of the importance of MET is shown in their first lesson preparation for algorithmic. After they read through the curriculum program and textbooks, they knew that both the national inspectors and programs/textbooks recommended teaching algorithmic with Scratch. But Anna did not want to spend a whole mathematics lesson to teach only a software Scratch, so she proposed to Cindy to reflect on MET, combine MET with Scratch, and cooperate with the computer teacher for conducting the inter-disciplinary teaching practice (required by the new curriculum practice, introduced in 1.1.2):

*“In fact we should think about how to adapt MET here...Because, I think, perhaps it is good, to give them a block like that (MET way), and propose or ask them (to reflect) what is going on, what is the lutin³⁰ doing, they can work on Scratch at the same time...but, you see...Anyway, we have two choices, either we do the inter-disciplinary teaching practice, or we do not do it. If we do it, we could spend a half lesson and they (students) can learn how to use Scratch, but we let them try and explore. If we do not do it, we have to teach it in computer classroom, but then it will be more complex, because we have to prepare each two student one computer, and we will not be able to know if they really know how to use it or not...” (Appendix2.2_*ANNA)*

In this moment, MET for Anna was more than a model of warming up activities for introducing the mathematics notions. It was used to trade off the requirements and expectations from curriculum programs, inspectors, textbooks, schools, and other teachers: MET is the stone to kill five birds.

Brochures of IREM and APMEP

³⁰ the “Lutin” is the role in Scratch, a hobgoblin in French folklore and fairy tales.

The brochures of IREM and APMEP were mentioned and emphasized both by Anna (see figure 5.6 and figure 5.3). For Cindy, the brochures brought her the activities that could be used in her classroom teaching. Anna used to explain how she obtained pedagogical ideas from the brochures:

“The scientific follow up (IREM brochure), it was (for) the textbooks, in small books, it contained some notions, it explained and gave examples of comments that how we can teach (the notions). So, it was...there you had the textbooks with the lessons and exercises you used in the class. And then, in the scientific follow up, it was more a reflection of some chapters, which reflects on how to implement, how to take it into consideration etc.” (Appendix1.6_ANN47)

These brochures worked as a complementation or extension of the curriculum program and textbooks. Anna used to explain why she chose these resources: “I want to know not only what to use, but also why it is suggested to use”.

The articles in the brochures were written with relative high quality with the involvement of teacher educators and educational researchers. For example, based on the work in the projects of IREM and SÉSAMES, Anna and Cindy published three papers together for brochures of APMEP and IREM during 2010 to 2015, they also wrote articles about how they use MET resources and their reflections in the pedagogical magazines (the middle part of figure 5.6)³¹.

This section presents three key resources for Anna and Cindy, The main characters of these resources are: they are all from or for collective work; the contents of the resources were mainly activities; the resources are crossly adapted in different collectives and projects for different working roles. These resources also play important roles for us to obtain better understanding the structure of their resource system, which will be addressed in the following section.

5.4 DE evidenced through teacher’s resource system

This section aims at exploring structure and components of Anna’s resource system with the six views in the conceptual DE model (introduced in section 3.1.5). In the following sections, the six views will be presented separately (5.4.1), and then a section for bridging the six views (5.4.2), and a conclusion for reflecting on the Gao’s resource system characters the six views.

5.4.1 Accessing the structure of a resource system

The overall structure and characters of Gao’s resource system and resource usage is explored in this section by combining her mappings with her DWM, Cindy’s mappings.

As introduced in section 5.2.1, the first mapping to represent the resource system was provided by Anna in 2015 at the end of our follow up, but without our demanding (this is different from the Chinese case). This might be explained by her long-term cooperation with researchers (she started to work in SÉSAMES with researchers since 2006), and she knows what the researchers are expecting (during our three months’ follow up, we proposed many questions about her resources and her collectives). Her explanation was that “I am used to preparing things before, so I draw this for you”.

Seen from this IMRS (see in figure 5.9), a most typical character of Anna’s resource system (compared with the Chinese case) is the complex links among the collectives she joined and the different working roles she played in these collectives.

³¹ They had one paper in Cahiers pédagogiques (<https://www.cahiers-pedagogiques.com>), a magazine about pedagogical actions and researches, many articles are written by the teachers.

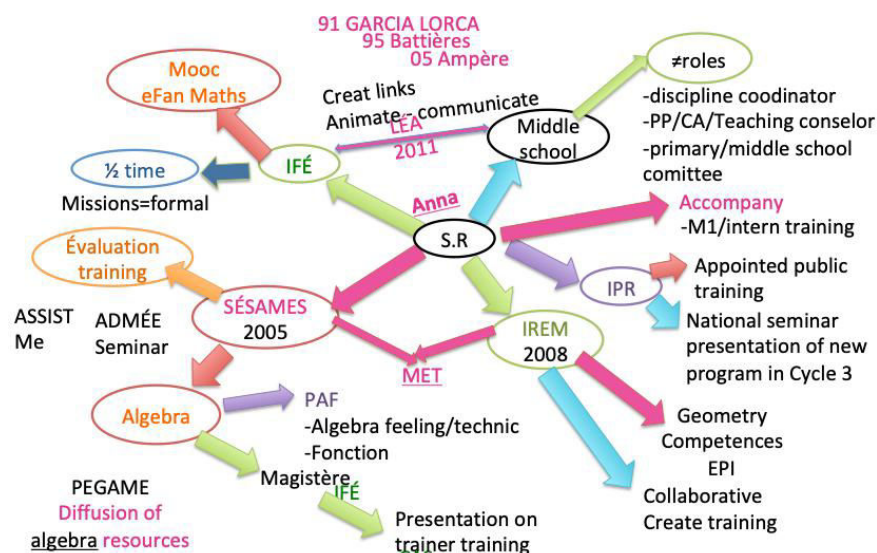


Figure 5.9. A mapping drawn by Anna (2015) for representing her collective work

- (1) Her middle school where she worked as the discipline coordinator (organizing meetings to discuss on teaching progress), teacher consolor for students (she worked as the head teacher for one class in grade 6), and member of primary and middle school committee (the issue of “liaison”, transition between primary school and middle school).
- (2) FIE and AeP at FIE, where she worked halftime in joining the projects of FIE, and the coordinator between AeP and her school.
- (3) SÉSAMES group, where she worked in two project themes, evaluation and algebra, she was involved in both the resource development and diffusion (by teacher training).
- (4) IREM group where she worked for theme of geometry, and teacher training work.
- (5) The training sessions from the regional pedagogical inspectors, IPR (Inspecteur d'académie - inspecteur pédagogique régional, IA-IPR³²) where she obtained the trainings about the draft of the new program (to be released in 2016).

This mapping also reveals the complexity of teachers’ way in categorizing resources. There is some resource working as technological instrument for sharing and storing resources (such as Dropbox), there is also some resource working as contents providing the knowledge of pedagogy and curriculum (such as the brochures of IREM and APMEP, the curriculum program and the accompany program).

The links among these collectives are complex and intertwined. The following sections present the analysis on Anna’s resources on her resource system from the six views proposed in DE model.

Mathematics view

Similar like the Chinese case, Anna and Cindy did not emphasize the resources special for mathematics when they were introducing their resources and describing their resource system. However the mathematics view was evidenced in their later lesson preparation for algorithmic, even it is not obvious to see: They showed their way on how to reflect on the notion by distinguishing it from the mathematics aspect and information aspect.

The first evidence is shown when discussing the suggestion of “using Scratch to teach algorithmic” from the curriculum program, Anna argued that “algorithmic for me is more a

³² <http://www.education.gouv.fr/cid49942/inspecteur-d-academie-inspecteur-pedagogique-regional-ia-ipr.html>

(type of) thinking rather than knowing how to use a software (of Scratch)”, so she disagreed to take the suggestion. She showed her own understanding on the notion of algorithmic, and criticized the curriculum program in a very decisive way: “I do not want to teach Scratch”.

The second evidence is shown when they reflected on their working experiences in SÉSAMES team (they worked specially in algebra group), they regarded teaching algebra as “teaching programs of computation for problem solving”, and they decided to teach algorithms with the idea of algebra. This evidenced that their participants in research projects (with researchers) brought them not only the resources that could be directly adapted in their classroom teaching, but also the higher and deeper understandings on the mathematics notions.

The third evidence is when they were reading the texts of the curriculum program “encourage the students to archive the idea about what are variables”. Anna proposed her confusion on why the curriculum proposed the notion of variable, because it will confuse the students the notions of ‘variable in algebra’ and ‘variable in information’:

*“Especially if the first notion of variable they met is the variable of computer science, once they met this, if we use the term variable in grade 7, in algorithmic...then we almost never speak of variable in algebra, we almost never give them the term...I think this is a real problem in terms of vocabulary, (if we propose variable here), we will have a real big problem in terms of vocabulary...” (Appendix2.2_*ANNA)*

Although for middle school teachers like Anna and Cindy, there is not very high requirements on the depth of pure mathematics knowledge, they still obtain some mathematics resources through their learning experiences, their participants in research collective teams, their reading and reflection (by writing articles) from the brochures, and the influences from these resources are generally tacit and incorporated in other resources.

Curriculum view

For learning about the knowledge about the curriculum, generally the resources are also embodied in the resources that provide pedagogical instructions. For example, the brochures from APMEP and IREM, to give the pedagogical instructions to teachers, they have to explain the notions as well as the position and requirement in the curriculum program). Even the textbook, there is often considered as the representation of the curriculum and the bridge between curriculum and pedagogy.

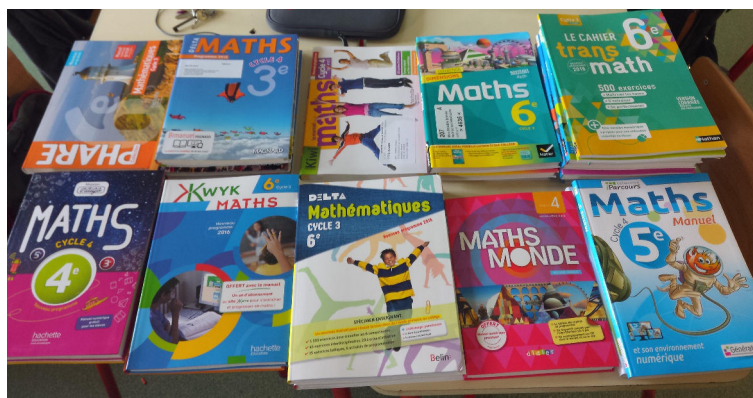
In their first collective lesson preparation, Anna and Cindy were not familiar at all with the curriculum program and the new textbooks at the beginning, but they performed their way on how to learn the curriculum with these unfamiliar resources: They started from reading the curriculum program, they marked the key notions, the suggested activities and final requirements from the accompany program (a document along with the curriculum program sent by the Ministry of Education). Then they started to check in the different textbooks, to see which textbook took the suggestions of curriculum program and which proposed new things. Generally, the textbooks are representing the ideas of curriculum program, but for Anna and Cindy, they used the representations of textbooks for better understanding the ideas of the curriculum.

Textbook is considered as a major conveyor of the curriculum and plays a dominant role in modern education scenes across different school subjects (Fan, Zhu & Miao 2013). Particularly in mathematics, the dependence upon textbooks is more characteristic in mathematics teaching than other subjects (Robitaille & Travers 1992). It is “part of technology in the educational system” (Charalambous, Delaney, Hsui & Mesa 2010, p. 119), and an “environment for construction of knowledge” (Herbst 1995, p. 3). Textbooks introduce readers to worlds that are not immediately obvious or cannot be experienced directly,

providing an organized sequence of ideas and information to structured teaching and learning (Sosniak & Perlman 1990).

“Textbooks are designed to translate the abstraction of curriculum policy into operations that teachers and students can carry out. They are intended as mediators between the intentions of the designers of curriculum policy and the teachers that provide instruction in classrooms.”(Valverde et al., 2002, p. 2)

The “manuel” in French origins from Latin word “mānuālis”, referring to “of hand, which we hold/have in hands (de main, qu’on tient dans la main)” (Gaffiot, 1934, p. 947). In the narrow sense, “manuel” refers to the things hold/have in hands, with a function of instructions, similar like a guide or handbook. In the French case, Anna and Cindy used “manuel” to refer to “manuel scolaire”, namely the textbook. In the French context, the “strong national instructional guidance” (Gueudet & Trouche, 2009, p. 203) is embodied in the national curriculum and “curriculum guides” with additional commentary and advices, but textbook is a commercial product, and there exist a great variety of textbooks (had been discussed in section 1.2.1). In the first collective lesson preparation of Anna and Cindy (May 2016), there were 13 different versions of textbooks sent by different publishing houses (see picture 5.6), and choosing one from them is the job of school teachers.



Picture 5.6. The textbook sent by publishing houses for Anna and Cindy’s choice (May 2016)

The French meaning of textbook could help us understand Anna’s (and also Cindy’s) usage and attitude towards textbook: in their recent expertise level, they took it more as a “reference” rather than a “bible”. Textbook (in French “manuel”) was not often mentioned when Anna and Cindy were describing their recent resource work and resource systems, but it was proposed as a crucial resource when both of them were recalling their memories on the key resources at the early teaching career:

“... I think that at the beginning you are obliged to have...you rely on some thing. I think you rely on something that you knew well for the lessons. Or you rely on your textbook, and this is why I bought a textbook. I asked myself many times whether I should buy a textbook or not? I didn’t have any textbooks. But at the same period, there are the colleagues who come to (help) the new colleagues about which textbook and on which points (they) love and they rely on it in doing their lessons.” (Appendix1.7 _ANNA240)

“So, in terms of resources, in my previous middle school, in fact...we used the textbook Triangle³³ a lot, and then we work a lot among colleagues for lesson preparations, but, in general, we based (se baser) on the textbooks that we had in the middle school...I met a new colleague (2006), Anna... and, so, she used a lot of different resources from IREM and APMEP and so on, and since then, really I started to separate myself (se séparer) a

³³ A collection of textbooks quite popular in France <https://www.editions-hatier.fr/collection/triangle>

bit from the textbooks and then mainly used that type of resources. ”
(Appendix 1.8_CINDY)

Different publishing houses compile textbooks in different ways, especially these new versions based on the new curriculum program: Some (such as Sésamath textbook, see in section 1.3.2) proposes one textbook for the whole cycle and arranges the contents with the structure of curriculum program (see in Figure 5.10 left), while some arranges the contents in different grades (see in Figure 5.10 right).

Figure 5.10 Part of the tables of Sésamath textbook (left) and Delta Maths (right)

Sésamath Textbook Structure (Left):

- Theme A: Calcul littéral** (Chapters 1-7)
- Theme B: Équations, inéquations** (Chapters 1-3)
- Theme C: Proportionnalité** (Chapters 1-3)
- Theme D: Statistique et probabilité** (Chapters 1-3)
- Theme E: Fonctions** (Chapters 1-3)
- Theme F: Géométrie** (Chapters 1-3)
- Theme G: Nombres et calcul** (Chapters 1-3)
- Theme H: Proportionnalité** (Chapters 1-3)
- Theme I: Statistique et probabilité** (Chapters 1-3)
- Theme J: Fonctions** (Chapters 1-3)
- Theme K: Géométrie** (Chapters 1-3)
- Theme L: Nombres et calcul** (Chapters 1-3)
- Theme M: Proportionnalité** (Chapters 1-3)
- Theme N: Statistique et probabilité** (Chapters 1-3)
- Theme O: Fonctions** (Chapters 1-3)
- Theme P: Géométrie** (Chapters 1-3)
- Theme Q: Nombres et calcul** (Chapters 1-3)
- Theme R: Proportionnalité** (Chapters 1-3)
- Theme S: Statistique et probabilité** (Chapters 1-3)
- Theme T: Fonctions** (Chapters 1-3)
- Theme U: Géométrie** (Chapters 1-3)
- Theme V: Nombres et calcul** (Chapters 1-3)
- Theme W: Proportionnalité** (Chapters 1-3)
- Theme X: Statistique et probabilité** (Chapters 1-3)
- Theme Y: Fonctions** (Chapters 1-3)
- Theme Z: Géométrie** (Chapters 1-3)

Delta Maths Textbook Structure (Right):

- Chapitre 1: Nombres et calcul**
- Chapitre 2: Proportionnalité**
- Chapitre 3: Statistique et probabilité**
- Chapitre 4: Fonctions**
- Chapitre 5: Géométrie**
- Chapitre 6: Nombres et calcul**
- Chapitre 7: Proportionnalité**
- Chapitre 8: Statistique et probabilité**
- Chapitre 9: Fonctions**
- Chapitre 10: Géométrie**
- Chapitre 11: Nombres et calcul**
- Chapitre 12: Proportionnalité**
- Chapitre 13: Statistique et probabilité**
- Chapitre 14: Fonctions**
- Chapitre 15: Géométrie**
- Chapitre 16: Nombres et calcul**
- Chapitre 17: Proportionnalité**
- Chapitre 18: Statistique et probabilité**
- Chapitre 19: Fonctions**
- Chapitre 20: Géométrie**
- Chapitre 21: Nombres et calcul**
- Chapitre 22: Proportionnalité**
- Chapitre 23: Statistique et probabilité**
- Chapitre 24: Fonctions**
- Chapitre 25: Géométrie**
- Chapitre 26: Nombres et calcul**
- Chapitre 27: Proportionnalité**
- Chapitre 28: Statistique et probabilité**
- Chapitre 29: Fonctions**
- Chapitre 30: Géométrie**
- Chapitre 31: Nombres et calcul**
- Chapitre 32: Proportionnalité**
- Chapitre 33: Statistique et probabilité**
- Chapitre 34: Fonctions**
- Chapitre 35: Géométrie**
- Chapitre 36: Nombres et calcul**
- Chapitre 37: Proportionnalité**
- Chapitre 38: Statistique et probabilité**
- Chapitre 39: Fonctions**
- Chapitre 40: Géométrie**
- Chapitre 41: Nombres et calcul**
- Chapitre 42: Proportionnalité**
- Chapitre 43: Statistique et probabilité**
- Chapitre 44: Fonctions**
- Chapitre 45: Géométrie**
- Chapitre 46: Nombres et calcul**
- Chapitre 47: Proportionnalité**
- Chapitre 48: Statistique et probabilité**
- Chapitre 49: Fonctions**
- Chapitre 50: Géométrie**

Figure 5.10 Part of the tables of Sésamath textbook (left) and Delta Maths (right)

The are named with “theme + number of chapters below the them”, for example chapter A7 refers to the seventh chapter of theme A, from theme A to theme E.

Didactics view

The resources to obtain the pedagogical knowledge for Anna can be seen partly in her RMRS in 2017 (Figure 5.6), where she listed several names of the resources, and next to the resources she added a remark of “tracing” (in French “veille”). She had the brochures of IREM and APMEP where she learnt the theory and principles about how to design her teaching; she used the publication of “Cahiers pédagogiques”³⁴ and the website of “Café pédagogique”³⁵, where she could receive the articles, news and reports related to mathematics teaching and general pedagogical issues. She used the social communication software like Twitter, and forum for mathematics teaching resources especially for middle school (“mathématiques au collège”³⁶) etc., to collect the information. She also paid attention on collecting and accumulating the fragmented online resources and information (for example from the website of Education Ministry) as her personal collection, with some online tools such as Pearltrees³⁷, Scoop-it³⁸ and Feedly³⁹.

As both teachers and teacher trainers, Anna and Cindy also received the pedagogical knowledge and instruction through the national trainings given by the inspectors (for example the trainings on teaching algorithmic given in 2016), or through the discussions with the educational researchers in the research projects (such as how to introduce algebra notions to students in SÉSAMES group), because diffusing the ideas of the projects to teachers through

³⁴ See the official website on: <https://www.cahiers-pedagogiques.com>

³⁵ <http://www.cafepedagogique.net/Pages/Accueil.aspx>

³⁶ See the website of the forum on: <http://www.maths-college.fr>

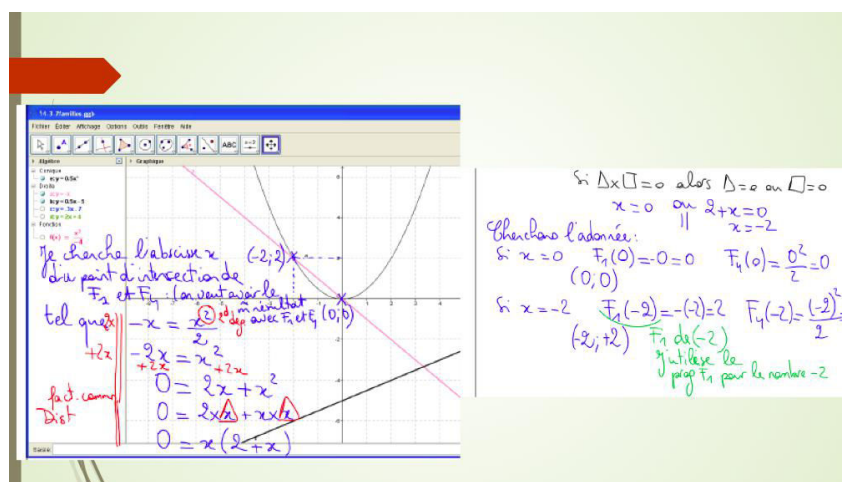
³⁷ See the online tool at: <https://www.pearltrees.com>

³⁸ See the online tool at: <http://scoop.it>

³⁹ See the online tool at: <http://feedly.com>

teacher training is part of their job in the projects. Some of the educational researchers were involved in producing or revising the national curriculum program, which also allows them to provide information related to didactical issues.

Besides, Anna also exchanged her didactical reflections (including the lesson design and students' reaction) with other teachers. She had a personal habit to collect her blackboard writing records and students' work, either through TRI or taking photos with her cell phone. Picture 5.6 shows an example given by Anna and Cindy in their teacher training session:



Picture 5.6 An example of Anna's blackboard writing record given in the teacher training session (in 2015)

Anna took these records consciously as the resources for her teacher training sessions for other middle school mathematics teachers. In their training lectures, they gave these as examples and exchanged also the students' reactions and learning difficulties with the other trainees. This could evidence that for both Anna and Cindy, the results of interacting with students were taken as a new resources for their teacher training work, and meanwhile, the exchanges with other teachers also brought them back new reflections and inspirations on these resources' usage and improvement.

Collective view

The resources considering on the collectives are very rich in the resource system of Anna and Cindy, as discussed on Dropbox in 5.3.2. The collectives work as the carrier of the other views of resources. The IREM and APMEP brochures provides them the resources about pedagogy and curriculum, they diffused their ideas (reflection on pedagogy, on curriculum and on the teaching effects with students) to other teachers through their articles in the brochures and teacher trainings. Their participation in SÉSAMES helped them produce the meta resource of MET, which is an important resources for the design view.

But comparing with the Chinese case, the collective view of Anna (and also Cindy) had a special emphasis on the research component. Such components of "research" could be evidenced in three parts: (1) roles of teacher-researcher, they both participated in the research projects that led by researchers from research institutes and universities, and Anna worked part time in the research institute; (2) work for research articles, they wrote papers with the researchers, and the contents are based on their teaching practices combining the theoretical ideas; (3) roles of resources designer, developer, implementor and diffuser go between researcher, teacher and teacher trainer, Anna and Cindy kept their classes for trying out the resources they designed and developed, which allows them to work in real educational experimental researches.

This differs the French case with the Chinese case. In Gao's case, she performed a relatively

negative attitude towards joining the research projects with researchers and universities; at least she did not take the resources she “touched” from the researches as the resources for her school teaching.

Student view

Students are also considered as an important resource for Anna, even it is not the same way as the Chinese case Gao. She did not spend much time in marking students’ homework. She had a cautious to keep students’ outstanding work or typical mistakes through the TBI records.

In Anna’s class, she often organized her students to do exercises on TBI, and the TBI has a function to save all the TBI blackboard-writing records into pdf format in the end. To cooperate with our research, Anna kept these records consciously in our RI-Box during our follow up in 2015, but she also admitted that generally she did not save all of them, except that there were some students absent, then she saved the records for them to study alone at home. Anna also kept some of the students’ answers, especially those with typical mistakes or unexpected solutions. In April 2015, Anna and Cindy used to give one teacher training session⁴⁰ and they introduced an example from Anna’s blackboard-writing record in her classroom teaching.

Anna used to introduced the interface of her Evernote, in which she organized her personal notes and records, she organized her notebooks according to her different collectives, one of them is the notebook group of “middle school B”, In this notebook, she had a particular notebook for “liaison CM⁴¹ (links with grade 4 and 5 in primary schools)”, which was related her meetings and work in the committee of “primary school and middle school”. During 2015 to 2019, Anna always kept classes in grade 6, and she had the occasions to discuss with the primary school teachers through the project PREMaTT (had been introduced in 5.1.4).

In the lesson preparation work, as Cindy introduced the components of their sequence folder, they always prepare a “working sheet” for students, sometimes printed, sometimes shown in PPT format by the projector, the contents could be some exercises or some activity (see in figure 5.11 below).

⁴⁰ The session was given collectively by Anna and Cindy in a mathematics classroom of their middle school, where 16 mathematics teachers from different middle schools attended. The French name of the whole training project was “L’algèbre entre sens et technique (the algebra between sense and technique)”. It was the third and also the last session (each session lasts one day) of their 2014-2015 school year teacher training of Sésames, and the topic was “how to introduce the algebra conceptions related to functions”.

⁴¹ According to the French education system, in cycle 3, there are the CM1 (cours moyen première année) and CM2 (cours moyen deuxième année), corresponding to grade 4 (students of 9 years old) and grade 5 (students of 10 years old) in primary schools, and grade 6 (students of 11 years old) in middle schools

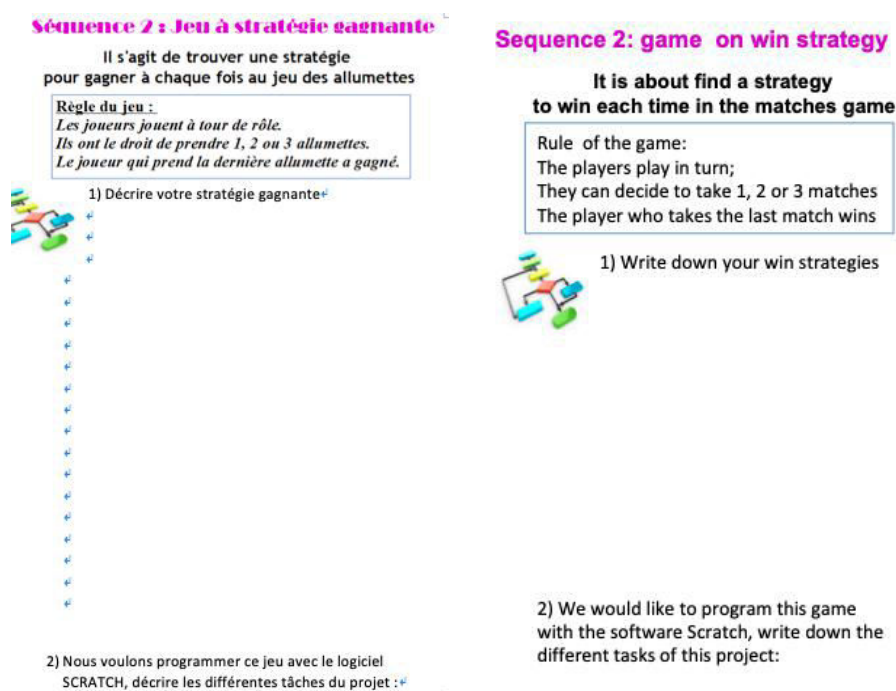


Figure 5.11. The lesson plan of sequence 2 for grade 8 in a co-implemented lesson by Anna and Cindy (left the original version in French, right the translated version in English)

This is quite close to the “learning plan” sent by Yao in the Chinese case: the learning plan is designed for students’ learning with knowledge points and exercises, some of them are in detail some of them contains only exercises.

Design view

If the design view of Gao’s resource system can be seen as reflected in her personal resources (exercises notebook and digital exercise bank accumulated through her yearly teaching experience and accumulation), then the design view of Anna can be considered as more complex than Gao from the form and technology supports: Anna has very rich online resources bridging among her working roles in different collectives and working occasions.

In 2016, when Anna was preparing to join in MOOC eFAN project at FIE (introduced in 5.1.4), she was invited to provide a list of 10 resources (1) with the websites links, and short explanation of usage. Anna proposed a list of resources with a one-page word document. The number of resources in her list was of course far more than 10 resources, and the more interesting part (especially compared with other answers from either teachers or researchers) appears as she categorized these resources into 8 types according to different functions. This list was drawn into a dendrogram by me (Figure 5.12), where the names of the resources and the categories were kept, but her explanations on the categories were translated into English.



Figure 5.12. “Ten favorite online resources” of Anna (in 2016)

In this figure, Anna described her online resources as: (Type 1) for sharing resources (documents, notes and links) including the Dropbox and Evernote discussed in section 5.3.2; (Type 2) for managing and sharing the favorites; (Type 3) publishing for showing where she listed her school work blog (on browser) and two apps for cell phone (IOS and Android operating system); (Type 4) for her TBI in classroom teaching with students; (Type 5) for teaching dynamic geometry where she put both the links of GeoGebra and the forum to learn how to use GeoGebra; (Type 6) for teaching function in grade 9 with a website to draw function graphs; (Type 7) for making mental cards with students where she proposed two online products (free and paid app), Anna explained also that the free app was enough to use, but the paid app produces more pretty graphs⁴², and Anna often assigned activities for students to review the whole chapter with mental cards, she took these as arts from students and shared the results in her school work blogs (the type 2 above); (Type 8) for collective working where she proposed two websites. One of them, Padlet⁴³, was quite often used by Anna with her colleagues in her school and also in the research projects. She also proposed a new link of “real time board⁴⁴” next to Padlet and marked that she “has not tried yet but it seems good to me.”⁴⁵

If her RMRS in 2015 (Figure 5.9) shows her collectives, then this figure 5.11 explains how she interacted with these collectives in a working condition: she had two of five working days in FIE and three rest working days at school, she had no fixed personal working space, she had with 2-3 classes to teach each year and the classes were not from the same grade, she had the meetings with her colleagues at school, in FIE and in different research projects, she had reports to do for the projects etc. She moved here and there from this collective to that

⁴² Her original expression in French “Payant ou en format limité, mais bien plus joli”

⁴³ Padlet is an online platform for both personal and collective resources collection and creative, in the case of Anna, she use Padlet mainly for personal resources collection, see <https://padlet.com>

⁴⁴ <https://realtimeboard.com>

⁴⁵ Her original expression in French “Pas essayé encore, mais me semble bien”

collective, with her laptop in a backpack. We could infer that all her resources were backed up through these online resources.

Among the 8 types of resources shown in figure 5.11, we could further category these 8 resources into four types: resources for working with students in classroom (Type 4 and Type 7), for teaching special mathematics contents (Type 5 and Type 6), for sharing, exchanging and working with others (Type 1, Type 3 and Type 8), and for her personal online information collection and accumulation (Type 2). The first three for students/mathematics teaching and collectives had been discussed in the previous views. But for “managing and sharing the favorites” (Type 2), we could refer this to her RMRS in 2017 (figure 5.7 in section 5.3.2), where she spend 1/3 space in explaining how she *trace (veiller in the origin mapping)* the resources (Figure 5.13). “Veiller” in French contains the meaning of “trace, follow, care, watch over” which emphasizes an active attitude with deliberate.

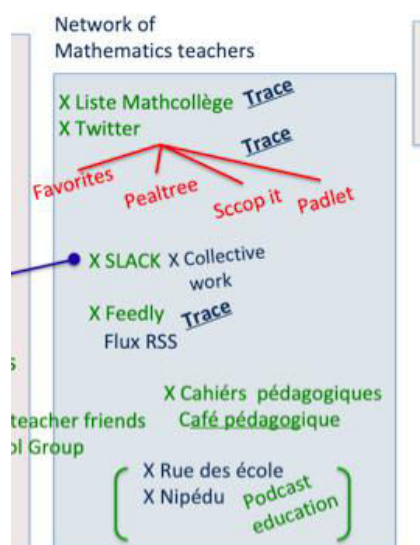


Figure 5.13. Part of RMRS of Anna (in 2017) with resources for “tracing”

Besides the technological aspect, Anna also holds the meta resources (with similar function of the exercises notes of Gao): the MET resources for Anna. Each time when they have to prepare for new tasks, they started reflecting from MET resources. Anna had a working habit to accumulate the resources in a fixed place (on line or fixed folder). She holds an open mind towards new technologies such as “real time board” discussed above, and she also moderately gives up. One example, when she was introducing her resources in 2015, she used to say that she would like to try Evernote, then in 2016 she started to use but in her RMRS in 2017 Evernote was not mentioned at all, she seems already abandoned it.

5.4.2 Bridging the six views on resource system

In section 3.1.5, it is announced that the resource system is a dynamic entity, and there is no hierarchical order among these views. Reflecting Anna’s resource system from the six views, there appears a close link among these views.

Between design, collective and student

Details about how Anna integrates the online resources to share, exchange and work in collectives had been presented in the design view section in 5.4.1. But behind such links between collectives and technological tools, there is a deeper inner link among the roles of Anna. Figure 5.14 shows the results of the analysis on the RI-Box resources.

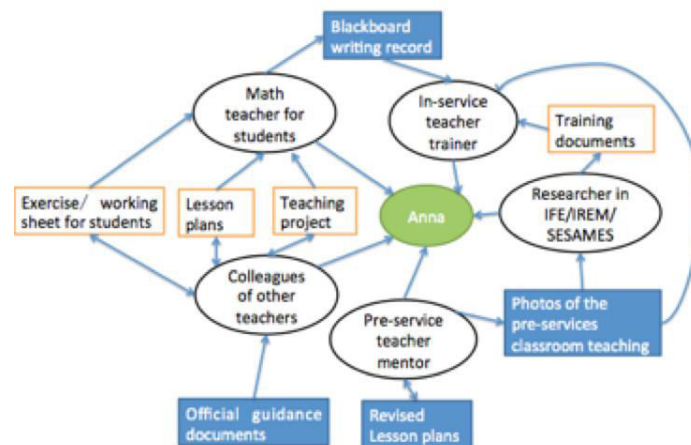


Figure 5.14. Links and flows among Anna's working roles and resources

As introduced in 3.2.3 and 3.3.4, this RI-Box was created on Dropbox as an extra folder shared by Anna and us researchers (me and Katiane). During three months' follow up, she updated each day her resources used *for and in* classroom teaching, including the worksheets for students (either exercises or activities), the lesson plan used by herself, the teaching project (the school year teaching progress), and her blackboard writing records. She also shared her resources used in other school activities such as instructing the student teachers in their lesson plan design (she shared her revised lesson plan in this RI-Box), training the other in-service middle school teachers (part of her job in SÉSAMES and IREM). She played five roles (in white circle with black letters): mathematics teacher; colleague of other teachers; mentor for pre-service teachers; teacher trainer; and researcher in IREM and SÉSAMES.

Anna shows an ability to take profit of her resources and make them "lived". Among all these resources, she designed resources for students and shared them with her colleagues, she kept her blackboard writing (with also the students' writing) and shared with us (for cooperating with researches) and she selected some of them as examples in her teacher training. She instructed the pre-service teachers as their mentor and reflected on their lesson design and took these experiences also as examples in her teacher training and researches in SÉSAMES and IREM. This could evidence how she crosses her resources in different collectives.

Between design, collective, didactics and mathematics

For Anna, she had her own meta resource MET, which is used by her as the base and origin to develop other resources. Different from the Chinese case where Gao accumulated her personal exercises notebooks by herself, Anna's MET resource was not developed by herself, but developed collectively with SÉSAMES group. Her relationship with the collectives such as IREM, SÉSAMES and APMEP is not one way, she also diffused the ideas and resources (represent also herself) to others, which could be evidenced in her roles transition in APMEP (from member in 1990 to core members as organizer in 2016). In her interactions with collectives, she developed and also diffused her resources (both materials and ideas) about didactics and mathematics. During her working with researchers and teacher educators in IREM and SÉSAMES through projects, she came into contact with the education theories and the views on mathematics teaching contents and mathematics notions from a higher level. This is quite critical in her schemes on dealing with the resources, because she started to use a "meta" thinking with critical awareness on seeing the resources provided by teachers. As what she explained, in front of resources, she does not only want to know what is the resource and how to use it, but she also want to know why to use it, either from the regulations of didactics or from the mathematics notions.

This section analyzed the resource work and resource system of Anna by combining with her DWM, Cindy's explanations and mappings of resource system. Results show that Anna's resources are more digital, online shared and centered on the activities that from the different collectives she participated. Anna had a very structured resource system operated via diverse technological online tools, which bridging her working roles in different collectives. The views of collective (especially the research collectives) and design (especially the MET resource) are more core parts in her resource system: the experiences working as researcher or with researchers allows Anna to hold a deeper understanding on both didactics and mathematics, and to reflect her whole work in perspectives of teacher (how to teach students), teacher trainer (how to train teachers to teach), researcher (how to provide supports for teachers trainers to train teachers how to teach). Both Anna and Cindy hold a reflective attitude on resources, like the Chinese case Gao, they started their resource design from the resources related to design view, and the resources are also accumulated through their long-term working experiences. The difference is the resource systems of Anna and Cindy are more open than the three Chinese teachers in the aspect of connecting with research fields.

5.5 DE evidenced through schemes of documentation work

This section explored the schemes of Anna and Cindy in their specific resource activities of collective lesson preparation.

As a cross-filed between mathematics and information, the position of algorithmic is awkward especially in mathematics, and was considered as undervalued in France (Modeste, Gravier & Ouvrier-Buffet 2010). As introduced in section 1.1.2, the French curriculum reform in 2016 introduced algorithm as an independent theme to be taught in the lower secondary school, and it was the first time of algorithmic appeared in the middle school curriculum program. This provides a chance to see how the two French teachers integrated the ideas from the curriculum, how to select the proper textbooks, how to combined with their previous resources and experiences.

The collective lesson preparations were recorded in two moments: May 2015 and June 2017 (introduced in section 5.2). The analysis takes mainly the first collective lesson preparation, because it was the moment that Anna and Cindy had no direct teaching experience to refer and they had to "create" or "design", which is considered as a best moment to see their schemes in resources integration. The analysis on the first collective lesson preparation had been analyzed in our paper (Trouche et al. 2019) with three different theoretical framework (DAD, CHAT and ATD) (also discussed in section 6.3.1). A particular interest on schemes was also explored in the Webdoc on AnA.doc platform. This section will also take part of these results. Figure 5.15 below shows the seven stages of this collective lesson preparation work along with their different usage on resources.

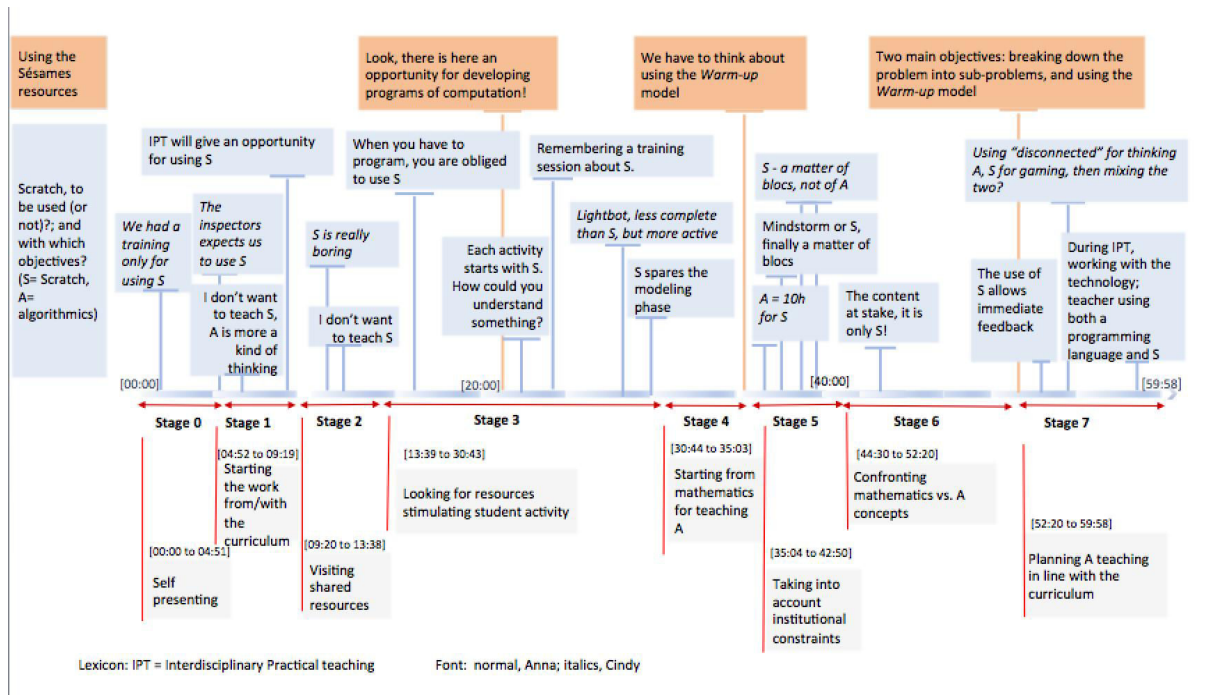


Figure 5.15. Stages of the collective lesson preparation of Anna and Cindy (Trouche et al. 2019)

Stage 1: structuring their work through a careful analysis of the curriculum program;

Stage 2: visiting the available resources (e.g. the 13 textbooks, the online resources on their laptops and mobile phones), evidencing the design view of their resource systems;

Stage 3: selecting the resources expected to stimulate student activity, evidencing the didactics view of their resource systems;

Stage 4: trying to integrate *algorithmic* teaching in their teaching progression – evidencing the mathematics view of their resource systems;

Stage 5: reflecting on the requirements and ideas of the curriculum – evidencing the views of collective and design of their resource systems;

Stage 6: confronting mathematics and *algorithmic* concepts by making some compromises (e.g. the use of Scratch). This stage could be considered as an epistemological deepening of stage 4. They started to bridge the mathematics, curriculum, didactics and student views in their resource system.

Stage 7: deciding practically on an *algorithmic* teaching plan with respect to the curriculum. This stage appeared to be the achievement of the previous stages, particularly stages 1 and 4.

In the following parts, six sections are included: schemes related to searching for resources (5.5.1), schemes related to selecting resources (5.5.2), schemes related to adapting the resources (5.5.3), schemes related to accumulating and sharing the resources (5.5.4), scheme related to reflection on documentation work (5.5.5), and a conclusion of this section in the end (5.5.6).

5.5.1 Schemes related to searching for resources

Different from the Chinese case (Yao was to prepare a lesson that she never taught by herself before, but had already observed how Gao conducted this lesson and her lesson design and following refinements were under Gao's instruction), the French case is actually from “zero to one” without any previous experience and resources to refer. The resource searching is not only closely linked to the resource accumulated (what the teachers have), but also to the reflection (what should be search).

Before started the resources searching, they made a decision for the aim of this lesson preparation “introduction of algorithmic” for a teaching plan (not for specific lessons) in the following school year. Then they drafted with some key elements to be specified in this collective work. The key element they concerned can be seen in Figure 5.16 below.

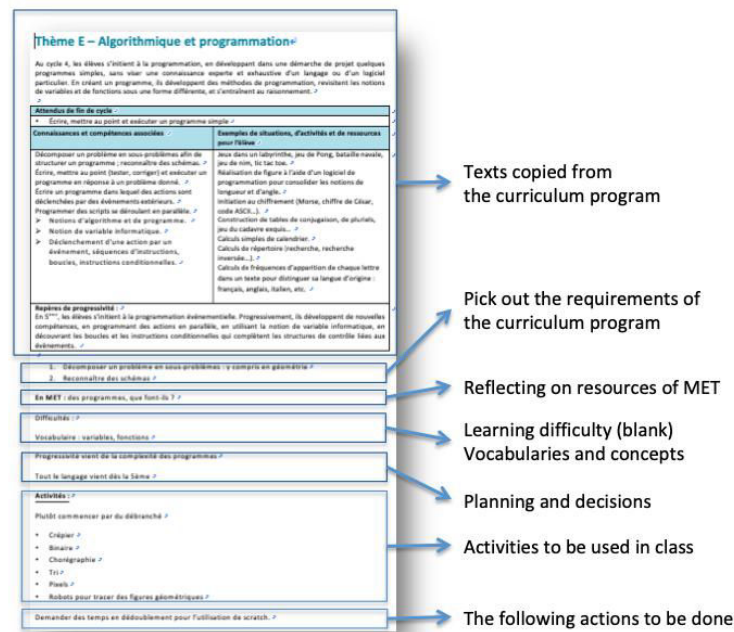


Figure 5.16. The teaching plan produced in the first collective lesson preparation in May 2016

The product of lesson preparation shows 6 key elements concerned by the two teachers:

- (1) The requirements of the curriculum for the students to achieve;
- (2) The new vocabularies and concepts for students;
- (3) The potential difficulties for students' learning;
- (4) The plan and decisions: conduct the algorithm teaching from which grade? (Because no students in either grade had learnt this before);
- (5) The available activities could be used in classes seen from the diverse resources such as the textbooks or the program etc.,
- (6) The following step work to be done.

We can infer that the process of lesson preparation is actually the process of searching for and selected resources for these elements. Anna and Cindy spent much time on the fifth element about the available activities can be (and to be) used.

- Starting from the teaching experiences of both one's own and of others

Anna explained her different ways of dealing with teaching resources between her current way and the beginning of her career:

"...You know when you are in a level, you have so many textbooks you see here, you have all the textbooks collections that exist, so you read all their exercises, how do they make lessons in other books. At the beginning when you have no lessons. Then now, when I'm going to do something, I'll go to see what I did. Do I have any other ideas? Does Cindy have other ideas? Does Bruno have other ideas? On those people who can share with. But before, at the beginning you have nothing." (Appendix1.6_ANNA16)

This scheme echoes the collective view on her resource system, and also the schemes related to reflection. In Chinese culture, there is also an idea of “understanding the present by reviewing the past” (温故而知新 wēn gù ér zhī xīn) from Confucius.

- **Reflecting on experiences of teacher training (being trained and training others) and personal learning**

When presenting the reflections on the available resources and working difficulties, they showed an order on reflecting: they do not have the teaching experiences on algorithmic; they do not have been trained how to teach algorithmic; Anna’s only working experiences related to this was a half day voluntary work on algorithmic and coding with students and she did not know what to do; Cindy’s only training session was about using software but not about how to teach algorithmic; Cindy had courses on program and information in her university study, but she knew they were not the same thing as algorithmic.

The multi-roles of teacher, teacher educator and researcher provide them multi-views to reflect. For example, Cindy took her experiences of teacher trainer as references in teaching students:

“I think it will be nice to ask the students to work and experience the meaning of the operations, you know, like the primary teachers that I used to educate.”
(Appendix2.3_*CINDY)

- **Collecting the previous working results on the collective working platform**

In Anna’s case, to observe a relatively complete process of developing from “zero to one” as much as possible, we asked Anna to do nothing but take the resources that are likely to be used in this lesson preparation. Thus Anna brought 13 different kinds of textbooks sent by the publishing houses (they have to choose one from them for the coming school year) and her personal laptop; while Cindy brought her own laptop, her cell phone and her paper notebook.

However, the preparation work still happened before the formal lesson preparation, and this reveals a working habit of Anna. When they started to work on the lesson preparation, Anna explained her preparation for this collective work: In the common Dropbox folder where all the mathematics teachers share their lesson plans (introduced in section 5.1.4), Anna created a sub-folder and named it as “C4-Algo”; in this sub folder, she put the curriculum program, the accompany program in it, and she creates a word document named as “algorithmic” and make a copy paste of the “algorithmic” text from the curriculum program on this word document; She collected her available online resources and transferred them to Padlet platform (introduced in 5.4.1) where she could share the online resources with Cindy; she brought all the textbooks (13 kinds) provided by the publishers, and a word document with a copy of the contents on algorithmic in the program, and she put it in their common Dropbox folder.

To be noticed that Anna mentioned two new collaborative platforms when she was collecting information to Padlet platform: Pixees⁴⁶ and Viaeduc⁴⁷. This means besides the different cloud drives (5.3.2) that Anna used to share resources and work collectively with others; she had also extra resource exchanging space that not expressed in her resource system.

5.5.2 Schemes related to selecting resources

The schemes related to resource selecting were not particularly explained by Anna and Cindy, but they could be evidenced in their ways of selecting the activities for the teaching plan. They showed a cortical attitude when selecting resources.

⁴⁶ <https://pixees.fr>

⁴⁷ <https://viaeduc.fr>

- **Selecting from personal resources rather than from search engine**

For the activities selection, even Anna had no ready resources for teaching algorithmic, she still started to collect her available resources from her previous collective working experiences, and also what she collected and accumulated as her personal favorite links and webpages, onto Pixees for working on it with Cindy. She did not start from Google, like what Yao did when preparing the new lessons without previous teaching experience.

- **Taking the curriculum program as the basic principle**

They know the relationship between curriculum and the textbook: the textbook authors interpret the curriculum program through the textbooks.

*“It (the curriculum program) is really the first thing that we look because this is...then, in the textbooks, there is an interpretation of the textbooks authors, the curriculum program, but in the contrary, the curriculum program, it is in fact the base of what we should look at.” (Appendix2.3_ *CINDY)*

As explained in 5.4.1 and 1.2.1, French teachers have many choices in textbooks, and selecting textbooks is part of their yearly job. This could infer that they have some knowledge on textbook compilation, like Gao’s knowledge on learning-aid materials market.

- **Selecting the resources from textbooks by combining with the curriculum program and accompany program**

This could be considered as a further application on their knowledge about the relationship between curriculum program and textbooks. At the beginning of the lesson preparation, they announced that they had not started to read the curriculum program. However, seeing from the whole lesson preparation process, they were learning the curriculum program with the textbooks (from the knowledge explanation and activities arrangement in the textbooks). For example, they took Sésamath textbook (introduced in 1.3.2) and compare the suggestions in it with those from the program and accompany program. In the end, they found that “it is boring, because it is always following the suggestions from the program”. Here a new evidence of critical attitudes is found: they were expecting new things.

This section presents the two considerations on selecting activities in the lesson preparation work for teaching algorithmic. Without any previous experiences to refer, Anna and Cindy showed their schemes in selecting the resources: taking the curriculum program as the basic reference, but use the related interpretive materials for deepening their understandings on the curriculum requirement, and selecting the resources in a critical way.

5.5.3 Schemes related to adapting resources

The resource selection of Anna and Cindy shows strong critical attitudes, no matter the official curriculum program or the textbooks. During the process, they showed also their knowledge on mathematics, students and didactics.

- **Adapting critically the suggestions from curriculum program based on the mathematics understanding**

Their critical attitude on curriculum program is supported by their knowledge on mathematics, on didactics, and on their rich experiences in working with students, teachers and researchers. For example, the curriculum program suggests to teach algorithmic with the software of scratch, and many textbooks also arranged activities based on this software, but Anna disagreed:

“But, me, I do not want to teach a lesson of scratch, so algorithmic, for me is more a

(kind of) thinking rather than knowing how to use a software (of scratch)”
(Appendix2.3_*ANNA)

-Holding a critical attitude to the textbook

As presented above, they used the contents of textbook to understand the requirements of curriculum program; meanwhile, with the task to choose one textbooks from 13 ones, they had to criticize the textbooks also with the curriculum program and their own ideas. In fact, their attitudes on using textbooks are quite different compared with the beginning of their carrier.

Anna explained her different ways of dealing with teaching resources between her current way and the beginning of her career:

“...You know when you are in a level, you have so many textbooks you see here, you have all the textbooks collections that exist, so you read all their exercises, how do they make lessons in other books. At the beginning when you have no lessons. Then now, when I’m going to do something, I’ll go to see what I did. Do I have any other ideas? Does Cindy have other ideas? Does Bruno have other ideas? On those people who can share with. But before, at the beginning you have nothing, so.” (Appendix1.6_ANNA16)

The most important scheme she mentioned is “when I’m going to do something, I’ll go to see what I did” followed with a series of reflective questions for her self: the ideas from herself based on the reflections on her previous experiences, then consider the other colleagues’ ideas. This scheme echoes the collective view on her resource system, and also the schemes related to reflection.

- Making variations on the meta resources

Even without any previous teaching resources and experiences to refer, in the middle of their lesson preparation, Anna still proposed to consider MET resource. As presented in section 5.3, MET resource in the moment of this lesson preparation was not only a warming-up activity model for introducing algebra notions, but a model to organize the lessons. They finally kept the MET model and combined it with the requirements of the curriculum program: one is for inter-disciplinary teaching practice; the other one is for using Scratch. They made a compromise between their own idea (learning algorithmic is not learning software) and the curricular idea (teaching algorithmic with Scratch): they decided to spend a half lesson for a MET activity in exploring the algorithmic ideas (decomposing the problem into sub-problems) with Scratch in computer classroom, under the instruction of computer teacher. In such a way, they killed three birds with one stones: they save a half lesson, they teach the Scratch and they conduct the inter-disciplinary teaching practice.

This section presents Anna and Cindy’s schemes related to adapting resources, the core part is the critical attitude on the suggestions from the curriculum program and the textbooks, then taking their meta resource, MET for achieving the balance point among them.

5.5.4 Schemes related to accumulating (and sharing) resources

This section presents the schemes related to how they accumulate and share resources. Actually like what appears in the Chinese case, the resources accumulating include also the work of re-organizing, which links closely to their working habits.

- Organizing and sharing while creating the resources

Anna holds a systematic naming habit. When she was planning to prepare the lesson, she created the folder of “C4-Algo” directly in the common Dropbox folder, and they both proposed it was the time to re-structure the common folder. This revealed that this common

folder is not merely a collection, but a small “lived ”collective resource system, which was well structured in a given logic, with uniform naming way (see figure 5.2 in 5.1.4), and it was maintained and updated regularly. This could be considered also a kind of collective working rules shared among these teachers.

- **Keeping the records of blackboard writing in daily classroom teaching**

In Anna’s lesson plan folder she shared in the collective lesson plan Dropbox folder, a special element (compared with Cindy’s) is the blackboard writing records, which could be made automatically by the Interactive Blackboard Table. She explained that she did not keep all of the records except that (1) there are some students absent for the lesson, then she kept the records and shared it with the students; (2) she found something interesting, either a representative feedback from students (she often invited the students to solve exercises on the blackboard), or she was happy for her examples or activities selected. She kept these as the cases and examples in preparing her in-service teacher training sessions.

This section presents Anna’s schemes in accumulating resources. Similar like Gao, Anna also pays attention on students’ feedbacks, and she accumulates for supporting her other working roles.

5.5.5 Schemes related to reflection on the documentation work

This section presents the schemes of how the two teachers reflect on their documentation work. Actually, reflection appears in each phases of resource work, especially when they were selecting and adapting resources critically.

- **Reflecting on the resources/ideas/experiences from professional collectives**

When preparing a new topic teaching, where to reflect could distinguish the experienced and advanced teachers from the others. MET resource is not the first main reference in this lesson preparation. Anna and Cindy reflect on the resources or ideas they obtained from other professional collectives, such as IREM. As Anna explained, she obtained many inspirations from the IREM brochures (5.3.2): they revisited the activity of “the danse” from a document of “creative thinking” from IREM of Grenoble; Anna remembered the idea of “fraction addition” from IREM Clermont; they were inspired by IREM Paris the activity of “robots”. This could infer that they (especially Anna) have a good knowledge and memory on the resources from these IREM networks. It could also be explained by Anna’s position in IREM: She was in charge of commission of inter-IREM in middle schools in school year of 2018-2019.

- **Building links between the current plan and the following work**

During their planning work, they had to combine the requirements and suggestions from curriculum program, the interpretations from the textbooks, the related inspirations from their collectives, all these with their own understanding on the mathematics notions, and the conditions to carry these activities and ideas out. The results showed that they had such knowledge on curriculum, on mathematics, on students and their school, and on pedagogical references to carry the lessons out.

One example is their attitude towards the usage of Stretch. At the beginning, Anna opposed the suggestions of curriculum program to use Scratch to teach algorithmic, but Cindy reminded her with the curriculum and the inspectors’ ideas. Then when checking the interpretations of the textbooks and finding most of textbooks provide Scratch activities, Cindy changed her attitude and considered teaching with Scratch was boring. But Anna made compromise: *“It does not matter to use Scratch, but what embarrasses me is spending a whole lesson to teach it...”*(Appendix2.3_ *ANNA). In the end, they decided to use half of a

mathematics lesson on teaching with Scratch, and the rest half work with the technology teacher for inter-disciplinary teaching practice (1.1.2).

This section explored the five schemes (section 3.1.5) along with the different phases of documentation work, but actually the schemes can not be distinguished into the following five with clear boundaries, and each schemes could be linked and crosses, for example, a scheme in accumulating resources is preparing for the searching for resources and also for sharing resources; while sharing and exchanging resources is also a process of accumulating resources. In the following sections, schemes in five phases will be discussed separated, then put together in the conclusion part.

5.6 Conclusion and referring to the research questions

Based on the analysis of Anna's documentation work presented above, this section draws the conclusion of this case study from three issues with the framework of CHAT, ATD and DAD: to what extent Anna's DE is linked to her specific profile (5.6.1)? To what extent Anna's DE reveals the institutional supports and constraints for French mathematics teachers' documentation work (5.6.2)? And finally, to which extent this case study allows us to answer the questions of research and go further in refining the DE model (5.6.3)?

5.6.1 DE and its relation with Anna's profile

This section addresses the three issues DE (naming system, resource system and scheme) and its development by situating the individual teacher (Gao) with respect to her profile, and within the collectives she evolved with the activity system of CHAT (introduced in section 2.3).

Seeing from the teaching experiences of Anna, she is a traditional teacher: she had a bachelor diploma of mathematics ; she obtained the pre-service training in national teacher education school (the predecessor of IUFM); she passed the competitive teacher recruitment exam (concours). However, seen from her other experiences from her CV, Anna is not a typical but a very special case comparing with most of other French teachers (and even with the Chinese case). Among her several roles, teacher is only one of them:

- *A mathematics teacher in her middle school (Half-time formal position, 3 days each week working at school)*
- *The coordinators of AeP Middle School B at FIE (need to join research AeP project)*
- *A teacher-researcher in FIE (Half-time formal position, 2 days each week working at FIE)*
- *A teacher-researcher in SÉSAMES group (working with researchers)*
- *The committee member of national APMEP (Paris), the representative of the APMEP site in her city (Lyon)*
- *A Teacher-researcher in IREM, the committee member of inter-IREM (middle schools)*
- *A teacher trainer (for diffusing ideas of SÉSAMES and IREM)*

She started to work half time in FIE since 2013, the same year when her school joined the AeP network. She has worked in SÉSAMES group since 2006, and through her years of working, her role in SÉSAMES turned from a member (like any other teacher participants) into a leader in charge of the teachers' part (e.g. PREMaTT project). In APMEP, her role turned from a user (since 1989) into the core members (the national committee member, the representative of APMEP in her city, and one of the organizers for the national annual

meeting (e.g. Journées Nationales APMEP 2016). Also in IREM, she turned from a user (of the IREM brochures) into the committee member in charge of inter-IREM for middle schools.

The work in SÉSAMES turns Anna from a teacher into a researcher, step by step. Evidences could be found in their publications. In the articles published by Anna and Cindy (during 2010 to 2013), two of them were for APMEP bulletins⁴⁸, one about reflections on their teacher training session on algebra (2010, for SÉSAMES), the other about MET design and use (2013, also for SÉSAMES). But compare the two articles from the structure and contents, a great improvement could be evidenced: the former looks more like a lesson plan containing brief descriptions with diverse examples; while the latter looks more structured with (1) the introduction of the MET and why it helps to solve the problems raised from teaching practice, (2) the content, the organization and feedbacks from students, and (3) the contributions to the curriculum, followed by (4) an application case and appendix. In the same year 2013, they wrote a paper with Sara for Repères-IREM⁴⁹. The paper is well structured in standard academic paper format with references.

Teasing her profile above makes the features shown on her naming system, resource system and the schemes easier to be understood.

The analysis on her naming system reveals that activity works as the “circulating currency” in her resource system, among her roles in different collectives. Seeing from the common Dropbox folder for sharing teaching plans and lesson plans between Anna and her school colleagues, activity works as the core element for constituting a lesson plan, which constitutes to a sequence, which constitutes a notion, then a theme. The follow up (from May 2015 to December 2018) on their common folder on algorithmic teaching also evidenced that the development of their lesson plans is the process of enriching sequences (with activities) along with sequences.

Among the six views, there is a strong link between her design view and the rest views, especially with the collectives. Due to her special position (half time at school and half time in FIE), she almost worked with her laptop everyday, which means she had a very strong online resource-working network, linking her personal resource work and the collective work. In her design view, a particular attention on the technological tools she used should be interesting to be paid.

In her schemes related to resource work, she also performed a strong links between resource sharing and accumulating: she prepared the shared document in the common space, and sharing while creating.

5.6.2 DE and its relation with the French situation

This section addresses the feature of DE and its development from the institutional level, with the framework of education noosphere of ATD (introduced in section 3.1.2).

If we consider Gao’s DE and DE development are more situated in the school-based collective, and she tried to adapt herself to the education noosphere by conducting the roles of teacher, mentor and expert in exams, the expectations from the insitutions, society and culture.

⁴⁸ Le Bulletin vert: <https://www.apmep.fr/-Le-Bulletin-Vert->. Free for the members. To become an APMEP member, it has to pay membership dues each year. Anna paid this since 1990. The requirments of the articles in bulletin is not as high as the academic journals (with peer reviewers). The authors are mainly the teachers.

⁴⁹ Repères IREM is a journal runned by IREM <http://www.univ-irem.fr/spip.php?rubrique23>, articles are mainly from researchers, some are from teachers, the aim of this journal is to reflect between teaching practice and researches. Repères-IREM is considered by Anna as part of IREM brochures.

Then in the French case, Anna is featured by her critical thinking on resources and the schemes in interacting with the resources. No matter these resources are from some authoritative sources, such as the national curriculum program. A support for Anna's DE from the education noosphere is the complex but well intertwined collectives that Anna worked in.

APMEP and the brochures produced by APMEP are collective consisted only by teachers. IREM is a section in universities (in each city), leaded by researcher, and teachers are recruited as part in the IREM team for both project participating and diffusing through teacher training tasks. SÉSAMES is just a local project, although it is not for the whole nation, but through this project, Anna (and Cindy) stepped into the research field, which allows them continue their work in AeP at IFE and other research projects such as MOOC and PREMaTTECT. These collectives are not some random choices for them. In section 5.1, their personal experiences provided them the chances to join. For example, Cindy joined SÉSAMES because of Sera, her teacher in her ESPE study, and the SÉSAMES later introduced her and Anna to represent their school to join AeP at FIE, and since then Anna started her half-time researcher work. The resources she developed in SÉSAMES algebra group turned into MET, and since then she and Cindy started to develop MET for more mathematics contents, which later worked as the basic materials for her work in writing papers for IREM and APMEP. A circulation forms, and her resource systems turns into a lived system.

5.6.3 Enlightening the research questions and the DE model

This section reflects on the first two research questions and the DE model based on the case study analysis presented above:

- (1) What DE could be found in mathematics teachers' documentation work? What are the components of DE and the corresponding performances of experienced teachers?
- (2) How DE could get developed through teachers' collective work? What are the factors that could be supportive for DE development?

Related to the first question

The DE development of Anna is closely linked to the collectives that she joined in since the beginning of her career (1989), such as IREM and APMEP. During the 30 years (from 1989-2019), she turned her roles from a brochure user into the core member, from a teacher into a teacher educator and researcher. Different from the Chinese case, she spent her time half in school teaching and half time in doing research jobs. Up to school year of 2018-2019, she kept only two classes in grade 6 for implementing the resources designed in her research projects. This means from a teacher to researcher, she is approaching to the latter more and more by changing her work focus.

In terms of the six views of resource system, Anna's resources showed a strong link between the design view and the rest views, especially between design view and collective view. Since Anna needs to change her working place (half time in school without fixed working space and half time working in FIE and other places where the projects meetings hold), she used digital resources more with her laptop. So Anna has a very rich and inter-connected technological means (cloud drives and different collective working platforms). The collective view plays a very important role in her resource work and professional development by offering her the resources, and also the ideas from a research point of view.

Her five schemes were also bridged with each other, and the ideas she obtained from her resources in collective view (such as the IREM and APMEP brochures) make her be able to have a critical attitude in selecting, adapting and reflecting resources. To summarize, Anna's

research experiences (or at least working with researchers) provide her a meta view on what is mathematics, which suggestions in curriculum programs should be taken, which textbook is more practical and reasonable in the structure design etc., allowing her to be critical towards the rich resources around her.

Related to the second research question

First of all, as presented in the collective view of Anna's resource system, for both of them, they have several professional collectives (APMEP for teachers only; IREM for teachers and researchers; SÉSAMES for doing researches), and each collective provides mature resources with relatively good quality of resource for them. These conditions make their professional development in these collectives possible, and they turned out to grow up in these collectives from users and participants into core members.

Then, their collective work is more voluntary than compulsory. Through their interactions shown in the collective lesson preparation, they exchanged a lot in a equal exchange way (different from the Chinese mentor-apprentice way). In this process, three kinds of interactions could be considered as how they develop DE through collective interactions:

- Conflicts in understanding or ideas are the entry points to see the influences on each other. For example, they changed the ideas of using Scratch through the one hour collective work: at the beginning, Cindy preferred to follow suggestions from program to teach Scratch, then with the arguments of Anna, Cindy changed her attitude and considered the textbooks who suggested to teach Scratch are boring, but in the end, after they finished reading all the textbooks, they both decided to teach Scratch again.
- Agreements and complements could reinforce their common ideas or enrich the current solutions. It seems like to search the hyperlinks with two search energies, which could find the complement information efficiently.
- Questions and answers is a quite direct way to benefit from each other, especially for something unknown to the other. For example, the idea of “danser” proposed by Cindy, it is the first time heard by Anna, but she learned this after it is explained.

Conclusion

This section spent the first two sections in reflecting the three issues of DE (naming system, resource system and schemes) from two levels: an individual level by linking her DE characters and performances within her personal profile and her roles development in collectives (with CHAT framework); an institutional level by linking her DE characters and performances to the French mathematics education professional collectives and the project-based cooperation between schools and research institutes. The third section reflects on the enlightenments from this case study to the first two research questions, DE model and its development in collective work. The third research question on contrasting the two cases will be addressed in Chapter 6.

Chapter 6 Contrasting the case studies, discussion and perspectives

This chapter, drawing from Chapters 4 and 5, presents the discussions on the three research question in four parts: section 6.1 refers to the third research question by contrasting the two cases from naming systems, resource system and schemes; section 6.2 refers to the first two research questions on what is DE and how DE gets developed in collective work; section 6.3 refers to the reflections on issues of theoretical frameworks and methodologies; section 6.4 proposed some perspectives of and development for going further.

6.1 Related to research question 3: Contrasting the two cases

The two contrasting cases were very different. As case study, it is hard to say they represent the Chinese teachers or French teachers, but it is clear that coming from two very different cultures (East Asian and Western), the two cases have some cultural identities.

There had been a large body of comparisons between the East Asian and the West. The East Asian regions were referred as “Confucian-heritage cultures” (Ho, 1991), including the Mainland China, Hong-Kong, Singapore, Mongolia, Korea, Japan and the northern part of Vietnam. About twenty years ago, Leung (2001) reviewed the literature about East Asian teaching culture, and discussed the six dichotomies between the East Asian societies and the Western countries: East Asian looks emphasize content, rote learning, studying hard, extrinsic, while class teaching and taking subject matter as teachers’ competences, while the western values process, meaningful learning, intrinsic motivation, individualized learning and emphasizing teachers’ pedagogy competences.

“Teachers in these countries (East Asian) seem to be ignorant about the latest methods of teaching, and think that mere competence in mathematics is sufficient for effective teaching of the subject. Classroom teaching is conducted in a whole class setting, and given the large class size involved, there is virtually no group work or activities. Instruction is teacher dominated, and student involvement is minimal. Memorization of mathematical facts is stressed and students learn mainly by rote. There is ample amount of practice of mathematical skills, mostly without thorough understanding. Students and teachers are subjected to excessive pressure from the highly competitive examinations, and the students don’t seem to enjoy their study.” (p. 35)

This section refers to the third research question: Through two contrasting cases, is there any similarity of DE in both cases? What could be borrowed and adapted for a mutual benefit? It will be done following the three perspectives: naming systems (6.1.1), resource systems (6.1.2) and schemes 6.1.3).

6.1.1 Seeing from the naming system

This section contrasts the two cases from the perspective of naming system. With the transcriptions of the interview with teachers, one most frequently mentioned term of resources was selected from each case, and studied as the *core element* in teachers’ resources system.

In the Chinese case, 题 (tí) (exercise) was categorized by Gao into three indicators (type, quantity and difficulty level). With these indicators, she formulated the lesson plan structures by selecting the typical exercises as examples, she assigned different types of homework to students for pre-study, for consolidating knowledge as seatwork, and for improving understanding as homework, she prepared particular lesson and sessions for fixing exercises

problems, and she used these three indicators to category, select and evaluate different learning-aid materials.

While in the French case, *activité* (activity) was taken by Anna as the elements for formulating the lesson sequence structure, the school year teaching schedule in her school working (as the role of teacher), the activities were also her main materials and productions in the projects of research collectives (as the role of researcher), the activities designed and feedbacks from students were adapted by her as examples in the teacher training sessions (as teacher trainer).

There are some similarities in the function of these core elements. Both of the two teachers hold a personal repertoire for storing and managing the resources that containing these core elements: the personal exercises bank (both in digital and on her notebooks) for Gao, and the MET resource for Anna. Both of these core elements work as the content circulated among other resources: for Gao, exercise links her personal resources to the learning aid material market, students' work and TRG activities; for Anna, activity links her MET resources to the school shared lesson plans, to her personal online resources collection and sharing, and to her resources obtained and developed through the projects in collective.

This section reflects on the two teachers' resource work and resource system seen from what they emphasized when presenting resources in their resource naming systems. The method of looking for teachers' terms by seeing from their naming system provides a complementary method to find the crucial and basic elements constituting specific resources, which is often not mentioned by teachers in the interviews and in their drawings of resources system representations. For an analogy, the relationship between exercise and Gao's other resources, between activity and Anna's other resources, is like the relationship between atom and molecule, or between cell and cell tissue, between amino acid and protein.

6.1.2 Seeing from the resource system

To understand the resource system, the general information about the resources working conditions for the two teachers were presented in several sections: the general resource work conditions from curricular, technological and institutional aspects (in section 1.2), the collectives in each contexts with potential supports for teachers' resource work (in section 1.3); the teachers' resource working habits in the case studies were also taken into consideration when developing the tools for data collection, such as Dropbox and WeChat as RI-Box (in section 3.3). In both case studies, especially the French case, a large space was spent to explain the resources from the sources, benefits, and the teachers' usages.

This section tries to cross the two cases for similarities and differences from the resource systems perspective: its structure and its components seen through the six views.

A lived resource system with input and output

Both the two teachers' resource systems showed a resource flow with input and output to keep their resource system "lived".

From this aspect, the French origin term "*répertoire et vivier*" (Gueudet & Trouche, 2008, p. 20) in DAD is quite proper to describe the state of the lived resource system. "*Répertoire*" (in English: 'repertoire') refers to a collection containing the data (references or information) classified in a given order⁵⁰. This definition reveals at least two aspects of a living resource system: (1) the logic structure (classified in order); (2) a personal preference in resources

⁵⁰ Répertoire, n.m., "Recueil, livre comportant des données classées selon un certain ordre", from <https://www.larousse.fr/encyclopedie/rechercher?q=Répertoire&t=>

classification (*in a given*) which means there could be another classification orders. “Vivier (in English fishpond)” origins from Latin word “vivarium”, with the meaning of “life in nature”, referring to the container/space/place for farming the fish and keep them alive⁵¹. The definition reveals the rest two features of a living resource system: (3) the resources should be “lived”; (4) all the resources formed into an environment that is friendly for the development of the resources and resource system.

In the case of Gao, she organized her resource system centered on her personal resources, her notebook of “exercises bank” with close link to the exams. For the input of the resources, there are the different learning-aid materials (books and exam papers) she bought by herself and equipped by her middle school; there are the feedbacks from her students in the classroom teaching and homework; there are the articles and information from WeChat official accounts with the explanation about how to organize the teaching about some notions or knowledge; For the output, she shared and exchanged the exercises or valuable resources to her colleagues, she sent the selected exercises to her students; she developed her resources accumulated for years into school-based exercise booklets and shared it with all the mathematics teachers; she also try to diffuse her experience (especially how to accumulate resources) to her apprentice and other members in the same LPG or TRG. The interactions with students and her apprentices work worked as both the input and output, and her personal resources work as the hub linking the rest components of her resource system.

While in the case of Anna, it is not very proper to say her resource system is centered with activity, but the activities in MET worked as the backbone of her resource system. As for the input of her resource system, she has the brochures of IREM and APMEP, the resources related to classroom teaching like lesson plans from other colleagues, resources from the projects (teachers and researchers outside her school) about the teaching resources for different mathematics contents; meanwhile, by participating the projects, she learnt new things and reflected on her own practice, then she diffused what she obtained and developed to other teachers. The roles of Anna and Cindy in the brochures of IREM and APMEP changed from the user (since 1990) to the author (since 2010); the roles of Cindy in ESPE changed from student (in 2000) to teacher trainer (since 2014). These collectives worked as both the input and output for enriching and developing their resource systems.

In both cases, the resource system maintenance is not only a way of “making add up”, but also making subtraction of the resource system. For example, Gao also emphasized the importance of tossing stuffs: each new school year, Gao needs to change her office when she started to teach the following new grade, and that moment is considered for her to “clean” the invaluable resources she accumulated. While for Anna and Cindy, in their collective lesson preparation work, their discussion on reorganizing the common Dropbox folder revealed that their collective shared folder is more than a collection of resources, the teachers often reorganize it regularly.

The design view bridges the rest views in the resource system

In both the case, the design view on resource system is closely crossed with other views.

Mathematics view: In both the two cases, the mathematics view is not obviously emphasized in the resource system with particular resources to obtain mathematics knowledge, but it is hidden in other views of design, didactics and collective etc., and evidenced in schemes

⁵¹ Vivier, n.m. “Enclos où sont introduits les poissons, les crustacés après leur capture ou leur récolte en attendant leur destination définitive; Récipient dans lequel on conserve les poissons vivants ; Bateau muni d’un réservoir dans lequel on conserve le poisson vivant”, from <https://www.larousse.fr/dictionnaires/francais/vivier/82315?q=vivier#81345>

related to selecting, adapting (Gao proposed some exercises related to “property of equality” for students to allow them distinguish the differences of the property between equality and inequality) and reflecting (Anna referred to the articles from IREM brochure to distinguish the notion of algorithmic in mathematics and in information).

Curriculum view: For both Gao and Yao, the curriculum program is national, and to implement the curriculum, they both have the accompany materials (teaching guidance book for Gao, accompany program for Anna), they both use extra resources for better understanding the curriculum but in different way due to the textbook publication system differences. Gao considered the curriculum program and the given textbooks as the basic teaching materials and she used many learning-aid books to make complementation for preparing students in exams. Anna referred to many textbooks and resources from professional collectives (e.g. IREM) to better interpret the curriculum program, and she had no extra pressure to prepare students in their exams.

Didactics view: Both Gao and Anna/Cindy have their stable resources for obtaining information related to pedagogy, Gao has the WeChat official accounts and the teacher training sessions provided by the TROs and TRG activities, while Anna and Cindy have the brochures of APMEP and IREM, and they also learn new ideas by participating the meetings and conferences held by the collectives they worked in, such as the meetings in APMEP, teachers from different schools will share their experiences and ideas about teaching.

Collective view: Both of Gao and Anna/Cindy pay attention on the interactions with the collectives, Gao attends more in the school-based collective activities (LPG and TRG) and as a complementary way for face to face interactions, she uses WeChat group chatting with her colleagues for sharing her resources; while Anna and Cindy had their well organized cloud drive folders and different online work platforms to exchange with other teachers and projects members. The difference is, due to the nature of the technological tools, the resources shared in the WeChat group chatting is not as well organized as the French case, they do not have a common, fixed and regularly updated space for resources.

Student view: Both of Gao and Anna/Cindy emphasize the students’ position in organizing their lessons, they are all good at managing students, Anna gained the schemes through the experiences with tricky students in her first job in Paris, while Gao was majored in education management, and also pay attention in her teaching and working as head teachers. The selected exercises in Gao’s personal notebooks are for students’ exam preparations, while the carefully designed activities in Anna and Cindy’s MET resources are for students’ classroom learning. The difference could be the way they dealing with the feedbacks of students, Gao spend more time in marking students’ homework, and helping them to correct, she also collected the homework mistakes of students and take it as the resources for her second class; while Anna and Cindy performed more lenient.

Design view: Both Gao and Anna have their own personal resources that work as the hub linking other resources: Gao has her exercises bank with the selected resources through years of accumulation, Anna and Cindy have their MET resources that they developed, enriched and improved over years in different projects and research teams. They have also the technological tools for managing this: it is not necessary to be the technologies, but in their own preferred habits, such as the traditional paper notes for Gao. They also have some interpretive resources for following up the trends of either the exams for Gao (with learning aid materials), and the curricular ideas in Anna’s case (with diverse online forums and brochures), to help them to interpret the ideas of curriculum, mathematics and didactics in their daily teaching and resources integrations. These personal resources have very strong personal features closely linked to their working habits and value orientation on what should

be taught and what is the main job as teachers. For example, Gao likes making pencil paper notes and she emphasizes doing exercises to understand mathematics notions and get good marks in exams; while Anna prefers digital online resource and works on her laptop, she pays more attention on activity design.

Lastly, although it is not counted as a specific view, both Gao and Anna/Cindy have the experiences in working with researchers, contributing their experiences to the research projects. The differences could be their attitudes towards the research projects: In the reflective interview with Gao for her IMRS (see more in appendix 1.3), she proposed to delete the “research project” from her IMRS, and she felt that she did not get any resources or benefits through the researches because the cooperation with researchers in the projects is more like giving out data, and she rarely got the feedbacks from the researchers; while for Anna and Cindy, they developed the resources (activities) with the instructions from the researchers (or teacher educators) and they improved and accumulated these resources step by step and formed their personal resources.

This section contrasts the two cases from the structure and components of their resource systems: for the experienced teachers of Gao and Anna, both of their resource systems contain the input and output to exchange resources; to keep the resource system “lived”, they also reorganize through enriching and simplifying the resources regularly; among the six views, the design view locates as the core view, and is closely bridged with other views. To summarize, the structured bridges among different resource and the resource exchanges among the different views could be considered as the common feature of their resource system

6.1.3 Seeing from the schemes

This section tries to cross the two cases from the perspective of schemes. Teachers’ schemes of documentation work locate not only in the phase of lesson preparation, but also in lesson implementation and the reflection after it. It also can be evidenced in terms of resource system management. In each case study, the schemes were explored in the resource system management and development, and in the specific lesson preparation work within five different schemes. In this section, schemes will be reflected on these two situations.

Schemes related to searching for resources

For both Gao and Anna, they show a kind of confidence on their personal resources (or the resources they know well) when searching for resources. None of them mentioned searching engines. To compare, both Yao and Liu started their researching by open the searching engines and typing the teaching topics, even Liu was not a novice teacher anymore (10 years service year). The experienced teachers keep their reservations on the online resources.

Gao proposed her negative comments on online resources directly when comparing the resources from learning aid materials and from online. Anna did not comment, but she showed her way in searching for resources: she opened her platform Padlet where she collected and accumulated many “favorite RSSs”. They search for from their own resources automatically and confidently. The resources they accumulated and processed finally formed their personal resources, and some of them became the meta resource, which was often used as the original materials for starting any task.

Actually for some famous musicians, in their masterpieces, they sometimes took and adapted part of their previous melodies and situated them with new emotions. It is the same for Gao and Anna. In the case of Gao, when she was instructing Yao’s lesson design, she considered the exercises that Yao selected (from the textbooks) were too simple and not representative, so she gave Yao one of her favorite learning-aid book, and asked her to choose some from it.

In the first collective lesson preparation work of Anna and Cindy, they thought on the MET resources almost the first time when considering the available activities, even their MET resources were never used for algorithmic teaching.

Schemes related to selecting resources

The schemes in selecting resources could be evidenced as the pre work with the potential considerations in adapting resources. Teachers have to find the balance point between the requirements from the curriculum program or the teaching objects (what should be achieved), and the available supports (what could be used). The criteria of selecting resources require the teachers' knowledge on curriculum (the teaching object), on mathematics (the learning difficulty and knowledge connections). Sometimes these requirements are not stated clearly especially when it is new teaching topics for teachers.

In the case of Gao, when she was instructing Yao in designing the exercises, the unknown factor for her is not the teaching, but students. She did not know the precise level of Yao's students, which makes it difficult to decide the difficulty and quantity of exercises. Her way of dealing this is "preparing more exercises with rich types and hierarchical difficulties, then making variations by changing the exercises order based on the students' reaction." While in the case of Anna and Cindy, in front of a new teaching topic without any previous experiences to refer, the unknown factor to them is the precise requirement of the curriculum. Their way in fixing this is "taking the curriculum program as the basic principle, then learn the requirements by combining the interpretation of textbooks with the curriculum program and accompany program, in the end taking the students' level and learning difficulties into consideration".

The schemes in selecting resources are closely linked to both searching for and adapting. In specific documentation work, these schemes could be done at the same time, and by leaps.

Schemes related to adapting resources

The schemes related to adapting resources are to find a proper way to implement what they found as available resources in the previous phase, how to organize the resources into a plan with feasibility. When adapting resources, teachers proposed the factors concerned by them to achieve the aim of the documentation work. This requires their knowledge on the situation firstly, including a clear teaching object by making a balance between what is expected in the curriculum and what could be achieved according to the students' level. It requires also the knowledge on the technological means to deal with the resources and to carry out what have been planned, the ability to making variations based on students' reactions.

In the Chinese case, Gao proposed three indicators to consider when adapting the exercises: type (e.g. filling-in-blanks or examples), difficulty (e.g. basic level or for improving) and quantity. She also had the category on lessons (e.g. lessons for new notions or for methods), on learning stage (for daily teaching or for final review). She also emphasized to consider the quantity and richness of exercise types with the limited classroom teaching time.

It should be noticed that there is a vigilance attitude of adapting resources: for Anna and Cindy it is the critical attitude on curriculum program, while for Gao is the critical usage in teaching with supports of GeoGebra.

Knowing the technology is not necessary using it. As Lengel (2008) noted, despite the fact that we live in the information-rich and Digital Society, information technology is not always integrated effectively in schools, and that traditional teaching techniques and styles are employed. Technology, for Butt et al (2008), refers to "both the practice that must be mastered and the pedagogical techniques for passing on that mastery." (p. 13). The case

studies show that teachers with DE do not must to use technology, but they have the knowledge of using technology. Gao considered that using GeoGebra software in geometry teaching could cause an omit of figure drawing process, which might in return damage students' geometry imagination. However, seeing from her previous working experiences, she used technologies quite well. She used to train other teachers in her school on using GeoGebra and Interactive Whiteboard. She received much professional training on using technologies, such as the usage of Interactive Whiteboard given by the professional staffs sent by the Interactive Whiteboard Company. She also built a "digital exercise bank" on computer since 2005. However, up to my follow up started in 2015, she start to quit the technological tools, and back to the paper pencil habits. In 2017, she explained that she used her computer only when she needed to print documents (her computer was linked to the printer). As she explained, "I just do not use it, but I know how to use it. Technology is just a tool, an option to serve teaching. I use it only when it is necessary."

While in the French case, Anna and Cindy showed a critical way in adapting the suggestions from curriculum program and the textbooks according to their own understandings on mathematics notions, didactics regulations. Such a critical way when adapting the resources is based on their rich experiences in working as teachers with students, trainers with teachers and researchers within research teams.

Schemes related to accumulating (and sharing) resources

In both two cases, accumulating (and sharing) resources is done the same time with resource creation. Sharing resources is more like a working habit rather than an extra work for them. In Anna's case, when she was designing the teaching plan with Cindy, she directly created the document in the common Dropbox folder, and collected all the available resources (including her personal favorite resources she collected and accumulated) to the collective working platform. While for Gao, she considered doing exercises in exam papers or learning aid materials as a way of leisure after her daily work. She took photos (with her phone) and kept notes when she found something interesting and shared it immediately to others through the WeChat group chatting on her phone.

They also had a conscious to collect the feedbacks. Such as the mistakes from students' homework, which are used by Gao as the references to adjust her following teaching, and accumulated as her common "wrong topics" notes, then next time when she teach the same topics with other students, she could give more exercises to train students in avoiding making the same mistakes. Anna did not spend as much time as Gao, but she accumulated the students' work as cases in her teacher training sessions.

They used different technologies in accumulating resources according to their personal habits. Anna preferred to take her laptop here and there when traveling between her different working roles, so she developed a well organized online technological tools to support her online work (both individual and collectively with others). She also accumulated the online resources with the online platform. While for Gao, she preferred to keep notes in traditional pencil paper notes, and she used less computer but more cellphone.

Schemes related to reflecting on resources

The two cases both emphasized a verb of trace (in French *veille*, in Chinese 趋势(*qū shì*) which means trends). This shows also how do they reflect on their resources, and how can they criticize the resources.

In Gao' case, she followed the trends through the changes shown in the yearly exam papers and the learning aid materials. She knew the difference between textbooks and exams, and teaching only with the requirements in curriculum program and textbooks is far less enough to

get better scores in exams. She criticized the diverse learning aid materials and also the exercises design of Yao, based on her “sense” cultivated through years following up of exercises and years’ category and management. While for Anna, besides the websites and forums specially for mathematics and didactics she marked as “for tracing”, she also had the IREM and APMEP brochures that she started to use since the beginning of her carrier. This is an opposite view of Gao: Anna reflects directly on what are the mathematics notions, how to design lessons to teach and why should design it in such a way; while Gao reflects from the results, or to say she organizes her teaching quality and consistency according to what is needed in the exam.

Seeing from their lesson design work, the lesson of Anna could be considered as “activity-based design” and Gao’s as “exercise-based design”. The underlying cause should be situated to the exam system and enrollment system.

Their schemes in resources reflecting also can be seen from their global view on the whole teaching (not for an individual specific lesson). Both of them paid a particular attention on “what the students learned” and “what should we do in the following”, especially in reflecting the learning difficulties for students. This could also be part of schemes in adapting resources.

In the second and third MOKE discussions for “property of inequality”, there were some doubts from other teachers on the exercises about “property of equality”: they considered it should be removed because it was not related to the teaching topic. But Gao insisted to keep it, because students had learned the property of equality, so it was a chance to recall their memory, and meanwhile build links between the news things and their prior knowledge. As what she said, “lessons should be connected from the students’ perspectives, but not for the complementation of only a lesson, even it is an open lesson.”

For Anna and Cindy, they also criticized the proposal of the curriculum program about “introducing the notion of variable”. They reflected on how they teach the notion of variable in mathematics, and found that they never proposed the term of variable to students, and if they follow the suggestions of the curriculum program and introduce the term to students in grade 7, it will cause a vocabulary problem, and confuse the students about the variable in algorithmic and in algebra.

These critical details are not easy to be caught from the interviews and their self-presentations on their resource work and resource system. Meanwhile, reflection is not an individual phase of documentation work, as discussed in the previous schemes and also in the resource system views, the reflections can be evidenced through all of them. This inspires me that the connections is not only between the six views, or between the five schemes, but also between the views and schemes.

6.1.4 Conclusion

This section draws conclusion on contrasting the two cases. In section 3.1.2, with the framework of ATD, this study was designed as case studies to analyze each case from a level of mathematics issues, and a level of education noosphere. Finally, the two cases are analyzed from the education noosphere (in section 4.6.1 and 5.6.1) by situating the individual teachers’ profiles to the contexts of school working condition, the teacher education system and curriculum requirements, the institutional collectives for teachers’ work.

6.2 Related to research question 1 and 2

This section draws reflections on the first two research questions: seeing from the two contrasting cases, what are the components of DE (6.2.1), what is the role of teachers’

collective work for developing DE (6.3.2), towards a refined model of DE (6.2.3).

6.2.1 Research question 1: components of DE

What DE could be found in mathematics teachers' documentation work? What are the components of DE and the corresponding performances of experienced teachers?

The two cases all evidenced the core feature of DE: bridging the resources for/from the different views. As concluded in the end of each case study, the two experienced teachers' DE view contains a meta resource (MET for Anna and personal exercises bank for Gao), which works as the original materials to refer in teachers' work; it also contains the technological means allow the teachers bridge links with other resources such as students and other colleagues; it also contains some resources for following up the trends and ideas of curriculum. The emphasis on these views were deeply influenced by both the personal teachers' education experiences, and the value orientation from the culture and the institutions. As experienced teachers, and the leader among most of other teachers, both Gao and Anna hold a strong critical attitude towards the "main stream voice", for Gao she kept a conservative attitude towards mathematics learning/teaching software; while for Anna, she even criticized the curriculum program based on her own understanding about mathematics, didactics and students..

6.2.2 Research question 2: the role of collective work in DE development

How DE could get developed through teachers' collective work? What are the factors that could be supportive for DE development?

Collective work supports and meanwhile gets influenced by teachers' resource work and DE. The psyche operates within a socio-cultural-historical milieu with its undoubtedly important influences, most especially the atmosphere or ethos developed in the classroom or other setting and the social pressures from peers and from institutional norms (Brousseau, 1997). The Chinese TRG is adapting a form of practice-based professional development, including the designing and implementation of teaching practices. For a better efficiency, the multi-level of TRO system combines such a school-based mode with the general traditional teacher trainings, such as regular lectures or workshops, with the guidance of experts. This is summarized as a kind of *practice-based* and *research-oriented work* (Miyakawa & Xu to appear).

The two case studies showed that the collective work supports the DE development from two aspects: (1) the resources provided by the collectives, such as the brochures of IREM and APMEP and the shared lesson plans in the French case, or the exercises and information shared in the WeChat group chatting in the Chinese case; (2) the opportunities to exchange the experiences (including the resource usage and what need to be avoid during the usage), which could be considered a kind of social resources or personal resources. The collective exchanges on the problems, especially the Chinese MOKE activity, are crucial for the novice teachers to experience the whole process from lesson preparation to implementation and reflection.

Experiences do not lead to DE development if there is no reflection and deliberate withdraw. According to Gattegno (1970), where Mason (2014) reemphasized, only awareness is educable, and only behavior is trainable. In the Chinese case, there are ten years' difference on working experience between Liu (since 2002) and Gao (since 1993). In the French case, there are also ten years between Anna (since 1990) and Cindy (since 2000). However, according to Gao's comments, the expertise level of Liu was higher but quite close to Yao, a novice who started to teach since 2015. I observed Liu's lesson preparation work in her office

(generally she prepared the lesson for the following week during the weekend before), and the procedure was: searching online (via search engine) the teaching topic, downloaded the courseware (in ppt or word document), then combined them and modified the details. All her resources for lesson preparation were: textbooks, exercises books along with textbooks, teaching guidance for teachers, school-based exercises booklets and a learning-aid exercises books. The first three were considered by Gao as “very basic things and not deep enough for students”, while the last two resources were the resources also used by students. That is to say, Liu had no personal accumulated resources. Her 15 years’ working experiences (2002-2017) did not bring her the proportional expertise. This evidenced that “one thing we don’t seem to learn from experience, is that we don’t often learn from experience alone” (Mason, 1994), and “a reflective stance, a withdrawing from the action in order to become aware of the action can make learning much more efficient than without it. “ (Mason 2014, p. 23).

The school based mentor-apprentice mode in the Chinese case turned out to be an efficient way for school-based teacher training, especially for novice like Yao, especially MOKE activity, where the mentor instructs the apprentice from lesson design to implementation step by step and hand by hand.

As Berliner (1988) said, beginning teachers could gain their experiences while under the control of a script designed by someone who knows better how to teach a particular lesson... Holding an experienced teacher to a scripted lesson, as recommended by some behavioral program concerned about the fidelity of implementation, is a terrible idea.

This is a policy for the development of expertise because such systems require the teacher to always use context-free rules. But such system actually does manage to have teachers deliver the curriculum that was designed. And for teachers who are in their first year, it could be a crutch of considerable importance and a way for the public to be assured that beginning teachers provide the required curriculum. The influence from the mentor to the apprentice is not only on the action, but also on the value and standards for a lesson.

In the Chinese case, as a novice teacher, Yao is influenced by the whole teaching research group. In this group, she shows some assumptions: Should finish all what she prepared in the lesson plan, that is the complementation of a lesson. In her first MOKE activity with Gao and Zhao, among the questions she proposed, one of them is what she can do when the time for the exercises was not enough. Her first thought is how to adapt a new way to finish the exercises which were from Gao, but not reflecting back why she want to teach so much content in one lesson, why not reduce the teaching object of the lesson, teaching one property of in-equality, but not three. This echoes what Mason (2014) inferred: “People can be trained and cultured into certain types of behaviors and this can be partly conscious and partly unwitting on their part. “(p. 17)

The mentor apprentice mode is not a temporary administrative relationship, but could be lasted in the rest of carrier of the teachers. A feeling from the interview with Gao, is “formal”, like attending a lesson, she used a lot of “right?” with a little bit pause in the end of one sentence she felt important. This was evidenced later in her MOKE discussion with Yao, in her classroom teaching, and in her individual instructions with students in her office. This also happened that, she asked each of her apprentices, even including me during my three-month close observation in her office, to do the exam paper exercises. For collecting the latest practice exam papers from other districts or schools, Gao has also some personal sources, some of her friends who work in other schools, and exchange the papers. This is what she did not mention in the formal interviews, but in private discussions. Zhongkao is a city-level exam for all students, and the result is a crucial indicator to decide if they can enter the top high schools. Thus the schools in Shanghai have some competition, and also among the

teachers, but the natural relationship between them is coexist in a balance of competition and mutual help.

This section reflects on the second research question about how DE could get developed through collective work. One lesson from the Chinese case is the mento-apprentice mode between experienced teachers and novices, and the collective MOKE activity in different hierarchical collectives: from LPG to TRG then to the whole school. While in the French case, the lesson could be the well organized online resources by the professional collectives, and the positions prepared by the research insitutes for the teachers, for example the teacher-researcher position offer by FIE and IREM, which allows teachers do their second work with education researchers, meanwhile invite them to give teacher training by diffussing the ideas from the research projects.

6.2.3 Refining the DE model

This section aims at proposing a refined DE model using the case studies for developing the conceptual DE model proposed in section 3.1.5.

As what Ruthven announced in his study (2013), expertise is different from knowledge, it underpins successful integration of digital technologies into everyday teaching practice, and there is a deliberate choice in the expertise researches: much of the knowledge used by teachers is tacit and resides in schemes of perception and action, and hard to articulate or be aware of. This is the reason why this research explored the DE model in analyzing in experienced teachers' declarations, documentation work, their reflections as well as how they saw themselves (Rollet 1992).

Figure 6.1 shows the refined DE model with a new structure crossing the six views. First of all, the six views are categorized in three types with different shapes, since they are actually not the same type in terms of the nature. The three views of mathematics, curriculum and didactics are often discussed as different types of teacher knowledge (in light green rectangles). While the students and collective are more from an aspect of human resource or social resource (in orange rectangles with circle beads). The design view, as the core part to evidence DE, needs to be explained precisely (in violet circles).

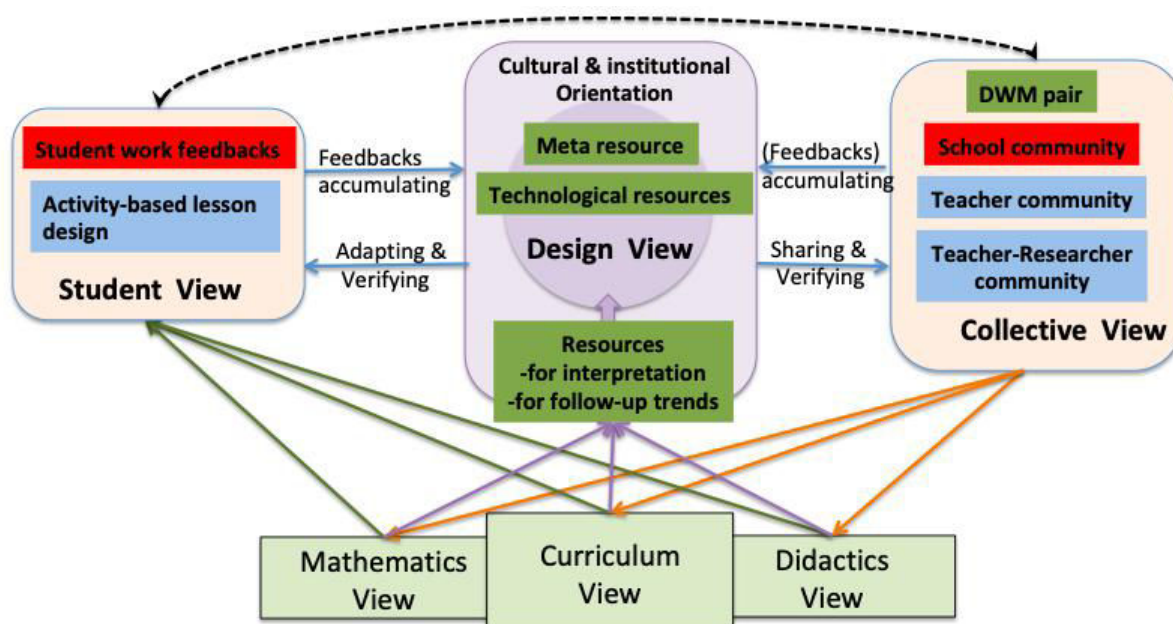


Figure 6.1. A refined DE model crossing views and schemes

In the views of student, collective and design, the different colors represent the components.

- The students view includes the feedbacks from students (in red rectangle, more emphasized in the Chinese case) and the activity-based lesson design (in blue rectangle, more emphasized in the French case).
- The collective view is consisted by DWM pair (in dark green, emphasized in both cases), the school-based community (in red rectangle, more emphasized in the Chinese case such as TRG), teacher community collective (in blue rectangle, more emphasized in the French case such as APMEP), teacher-researcher community collective (in blue rectangle, more emphasized in the French case such as IREM and SÉSAMES).
- The design view contains three components emphasized by both cases (in dark green), meta resource that used as the original materials by the teachers in different tasks, technological resources that support teachers' resource work including the modern technologies and traditional means, and the resources for interpreting and following up the trends of education orientation, such as the curriculum. The design view of teachers is situated in the cultural and institutional contexts with orientations.

The whole DE model shows the complex links between the views and also the resource components inside the views.

- The design view locates in the center of DE model. It links to student view and collective view for verifying the validity and effectiveness of the resources by adapting and sharing off the resources, meanwhile obtaining and accumulating the feedbacks (if there are).
- There could be the exchanges between the student view and collective view when the teacher exchanges the students' feedbacks with the collectives, or she/he adapts the resources from collectives for teaching students. In the Chinese case, the links between the two could be very strong: the teachers in a same LPG could exchange their students' information through daily office discussion, or "borrow/lend" classes for MOKE activity.
- The views of student, collective and design, each of them has links with curriculum, mathematics and didactics.

In the study of Yang, Kaiser, König, & Blömeke (2018), they applied one model constructed in one context (German) to another one (China). This thesis is not aiming at this, but just try to propose a model from a cross analysis of two cases from contrasting contexts (Chinese vs. French): with the same model structure, in each case, the components are emphasized differently:

Figure 6.2 shows the Chinese case applied in the refined DE model.

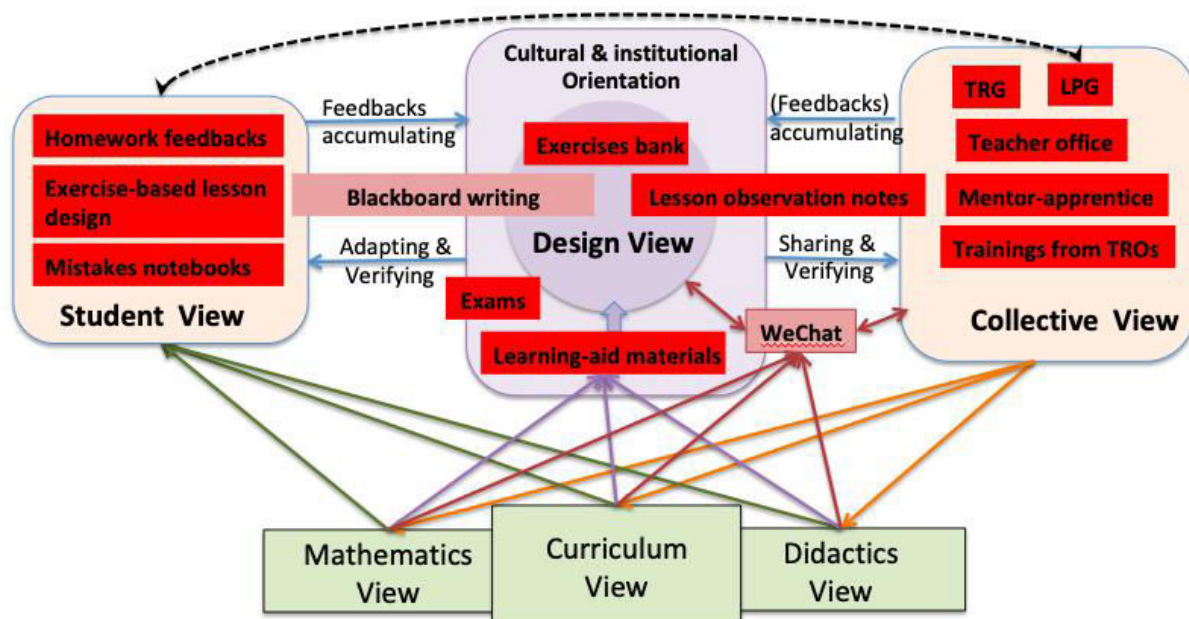


Figure 6.2. The Chinese case of Gao applied in the refined DE model

For the student view, the Chinese case Gao has the students' homework feedbacks, the notes for students' mistakes, and the lesson designed based on exercises.

For the design view, the Chinese case Gao has the personal exercise bank (meta resource), the learning-aid materials for tracing the exams changes, and for interpreting the knowledge of mathematics, curriculum and didactics. Between the design view and student view, the Chinese case Gao emphasizes the usage of blackboard design and writing for students (as the technological resources).

For the collective view, the Chinese case Gao has the hierarchical collectives from DWMs (mentor-apprentice), to colleagues in a same LPG, to colleagues in a same TRG, and the TRO training sessions out of their school. Between the collective view and design view, the Chinese case Gao uses the WeChat for exchanging resources within collectives (as the technological resources).

Keeping the same structure, Figure 6.3 below show the French case applied in the refined DE model.

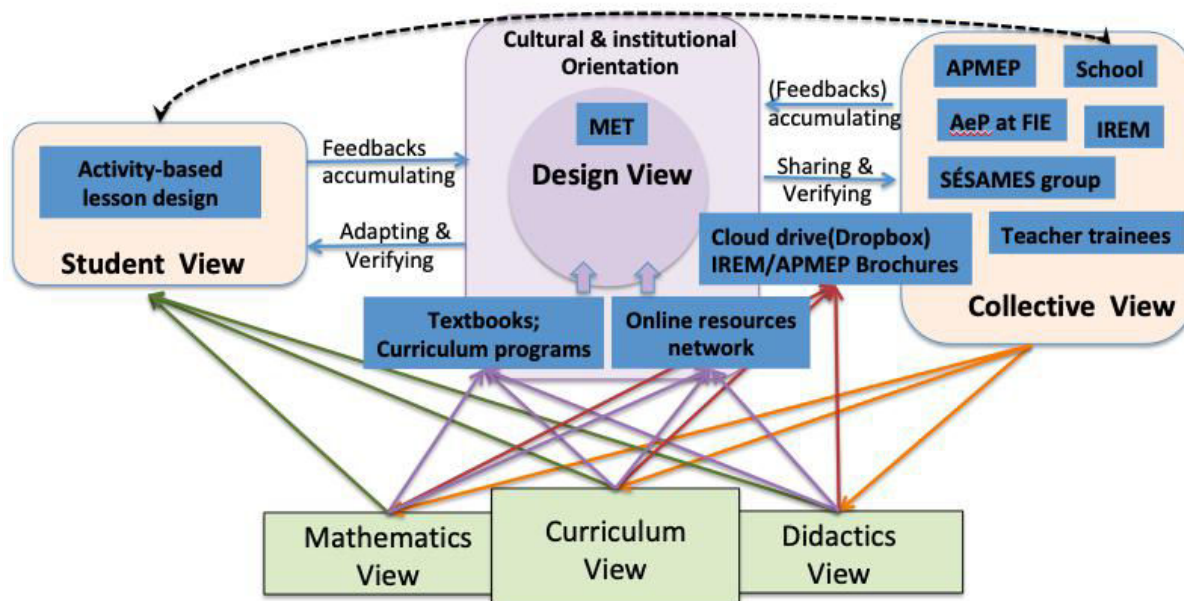


Figure 6.3. The French case of Anna applied in the refined DE model

For the student view, the French case Anna designed the lessons based on activities.

For the design view, the French case Anna has the MET activities (meta resource), the textbooks and curriculum programs for interpreting the knowledge of mathematics, curriculum and didactics, the online resources network (with different websites and forums) for tracing the education ideas.

For the collective view, the French case Anna has different collectives from DWMs (like she and Cindy who shared several collectives), APMEP (teacher community), IREM and SÉSAMES (teacher-researcher collective), and collective interactions through teacher trainings or meetings with the primary school teachers. Between the collective view and design view, the French case Anna uses the cloud drives (as the technological resource) for working with collectives, and obtains ideas from IREM and APMEP brochures (as the technological resource), meanwhile she wrote papers to the brochures and shared her ideas with other brochures users.

6.3 The relevance of theoretical and methodological choices

This section aims at reflecting on the choices of theoretical frameworks (6.3.1) and methodology (6.3.2).

6.3.1 Reflecting from the PhD process, theoretical issues

Three parts are developed in this section: what we could analyze as the weakness of your theoretical construct, our questioning, and the interest of fully exploiting the theoretical networking.

The awareness of some weak points

About schemes, only rules of action and operational invariants have been considered; there are four components in scheme: goals, rules of action, operational invariants and possibilities of inferences (see in section 2.2.2). In this research, DE is considered as schemes in different phases of resources interaction, and is analyzed with two of the four components: rules of action and the operational invariants.

Schemes have to be considered with respect to class of situations. These classes have not been really taken into consideration here (for example “searching for resources”, is it the same class of situations in the case of Algebra and Geometry? In the case of a new lesson, or in the case of an old one)

Some issues to be considered in further research

Documentational genesis is an ongoing process involved in teacher professional development:

Documentational genesis must not be considered as a transformation with a set of resources as input, and a document as output. It is an ongoing process. ... A document developed from a set of resources provides new resources, which can be involved in a new set of resources, which will lead to a new document etc. (Gueudet & Trouche 2009, p. 206).

The case studies showed that not all the resources work in a similar active level. In the experienced teacher’s resource system, compare with some given resources (such as curriculum program and printed textbooks), there are some specific active resources working as the core and hub: the teachers interact with them more frequently by taking them as the origin to refer, refining and enriching them continuously. These resources and the corresponding schemes are developed synchronously with teachers’ professional development in a documentational genesis. Analyzing DE should come with the analysis of the structure of the different roles and positions of resources (extending the reflection lead in the case of MET (section 5.3 and 5.4)

About the theoretical networking

Bikner-Ahsbahr and Prediger (2008) distinguished the strategies in connecting different theories from a total absence of connection to a global unification with a linear order (Figure 6.4).

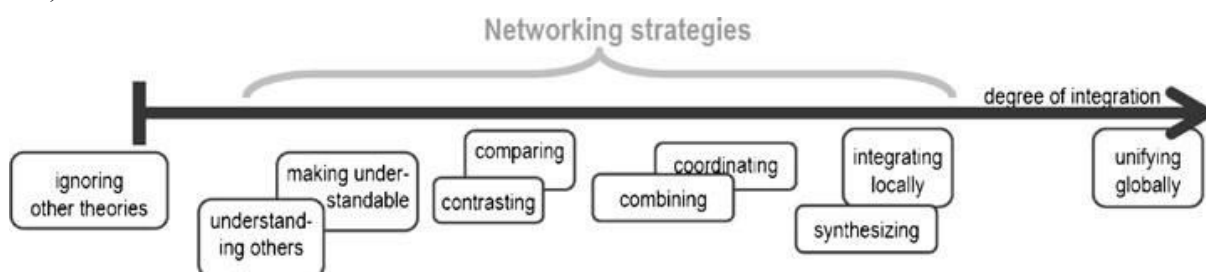


Figure 6.4. Different theoretical networking strategies (Bikner-Ahsbahr and Prediger 2008, p. 492)

Artigue (to be published) evidences the fact that, from its beginning, DAD, developed integrating locally diverse strategies. In a recent paper (Trouche et al. 2019), we combined actually different strategies:

“When writing this paper we went through various stages of: developing understandings of each other’s viewpoint; coordinating the work (e.g. agreeing on common elements of methodology for analyzing the data separately); bringing together the different findings/elements, and comparing insights. Moreover, we developed another aspect of networking: we profited from this cross analysis in terms of deepening our understanding of each approach”.

It appeared particularly fruitful for analyzing teachers’ documentation work, precisely about our case study, evidencing different results according to three theoretical lenses (cf. Figure 6.5, Figure 6.6, and Figure 6.7)

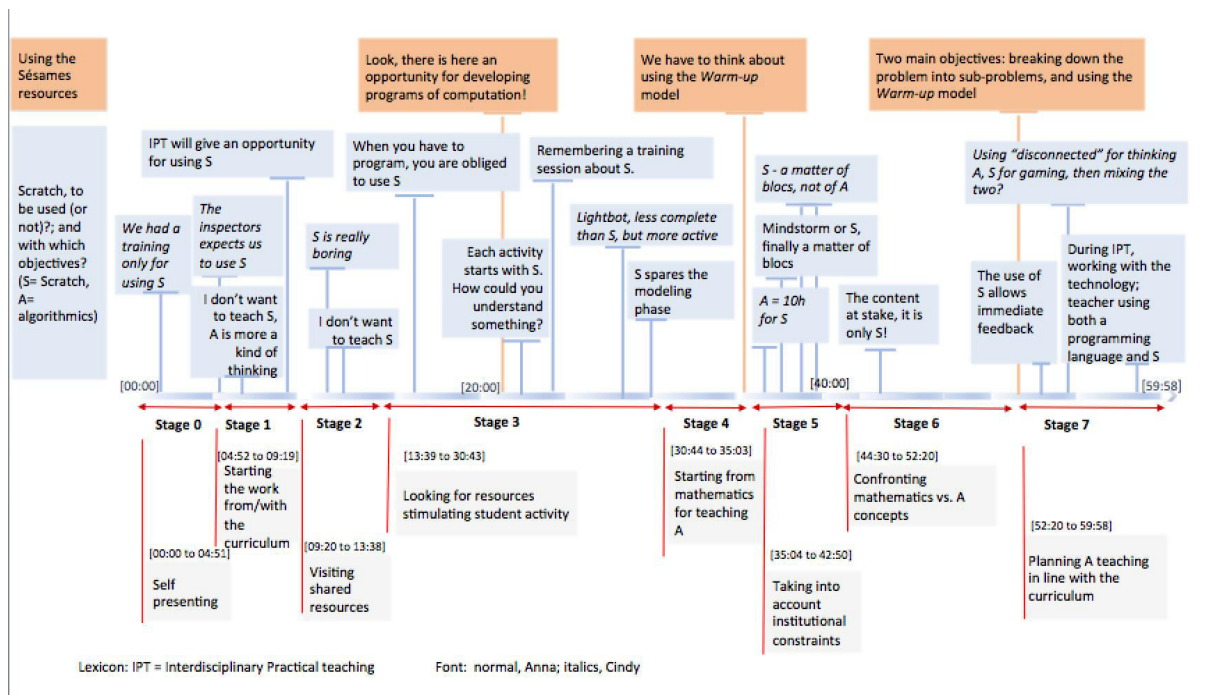


Figure 6.5. Stages, issues and moments, through the lens of DAD (already presented as figure 5.14)

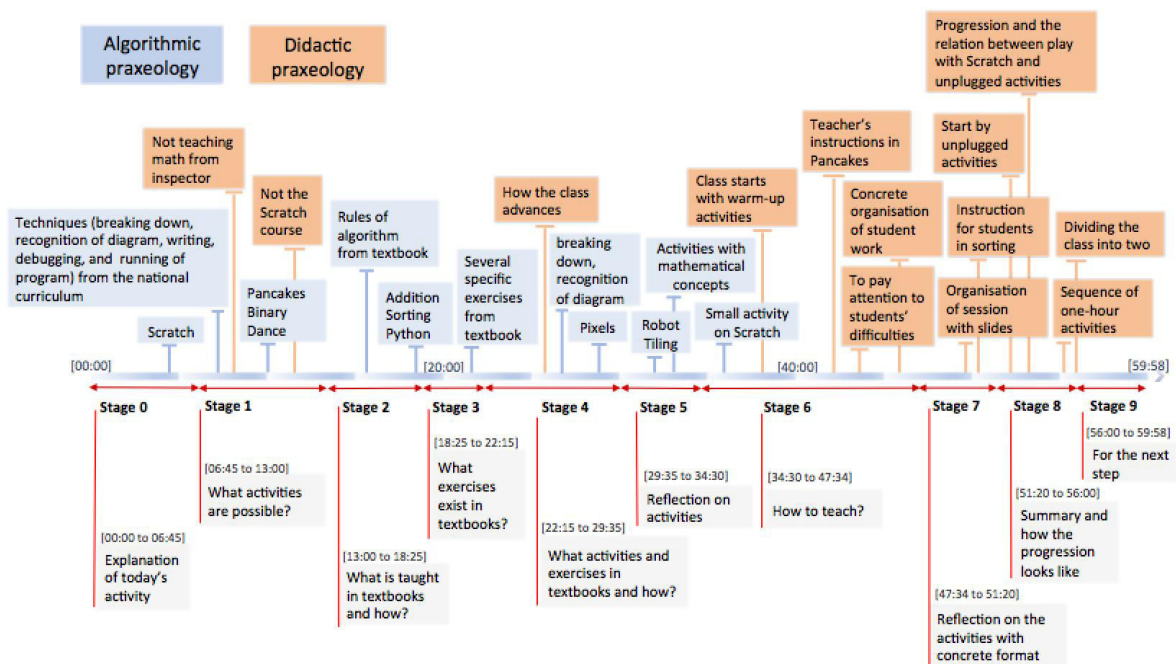


Figure 6.6. Stages, issues and moments, through the lens of ATD (Trouche et al. 2019)

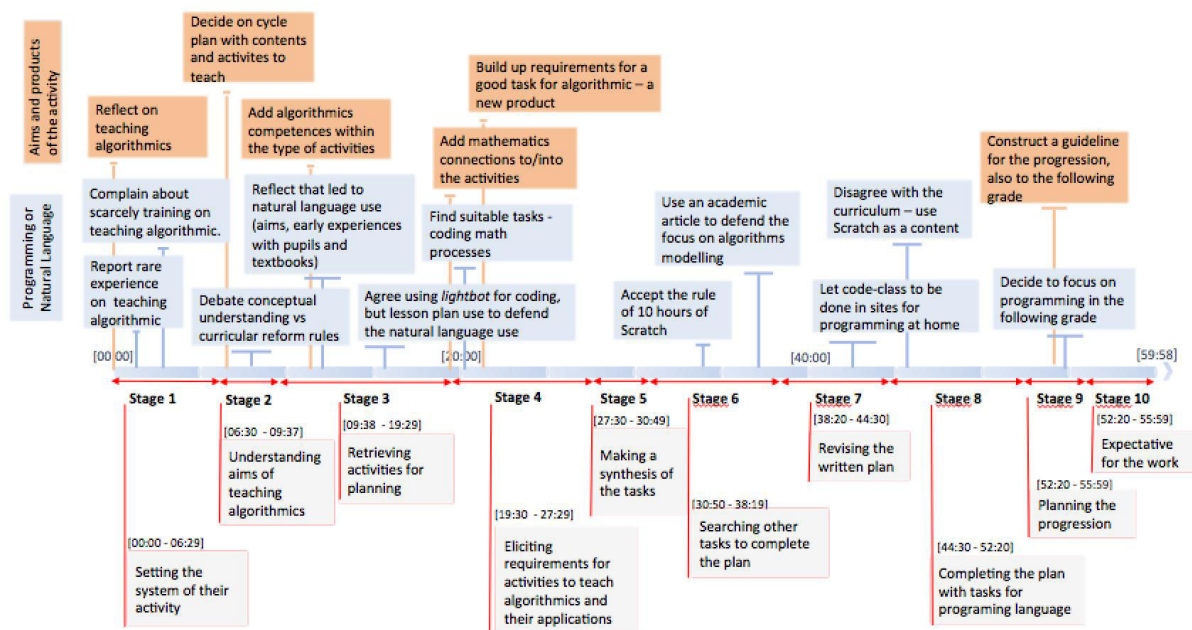


Figure 6.7. Stages, issues and moments, through the lens of CHAT (Trouche et al. 2019)

The three theoretical frameworks provided supports for both data collection and data analysis:

- DAD provides a resource lens to see the resource system (structure and organization schemes), the schemes in interacting with resources for fulfilling the tasks, the links of resource systems, between individuals' (among DWMs) and between individuals' and collectives'.
- CHAT provides a goals lens to situate individual teacher's documentation work into a collective activity system, allowing teachers' schemes in interacting with resources analyzable with the notions of goals, roles, rules and division of labor. It also inspired a consideration on individual teachers' profile and the history development of the activities or collectives where she participated.
- ATD provides a lens of coordination involving the social aspects (collective, institution, community and culture) and how these aspects coordinated with each level, and how teachers take profit and adjust their decisions. It also offers a common descriptive model with clear levels (3.1.2) for describing and analyzing the two contrasting cases with lots of differences.

The crossing of these three theoretical frameworks provides a view on actors' work-praxis-activity, considering the individual (resources, schemes of usage with personal preference), the mediated activity (with resources, media, tools), and the importance of social aspects (collective-institution-community).

We participated to the paper (Trouche et al. 2019) at the end of our PhD, and it convinced us of the interest of using more these three frameworks for diversifying the view on teachers' documentation work: in addition to contrasting different case studies coming from different cultural contexts, contrasting the analysis of a same case from different theoretical perspectives looks really promising, to be exploited more efficiently in further studies.

6.3.2 Reflecting from this PhD process, methodological issues

This section draws reflections on the methodology of reflective investigation, and the methods,

tools developed in this thesis.

First of all, the tools for data collection analysis are not symmetrical in the two cases.

During the four years' PhD study, I spend most of the time in France, and the Chinese data collection were conducted once a year by taking profit of the occasions of attending seminars and short-term job travelling. The different technological working supports and teachers' working habits also influence the data collection tools, for example, when adapting the RI-Box during the observation, I used Dropbox in the French case by combining it with the observation, and WeChat in the Chinese case, the differences (one is cloud drive, the other is social communication software) brought the differences of the data: the French data is more from the teachers with specific document to refer to, while the Chinese data is more from my own field notes and informal interviews with teachers, or even from daily chat in lunch or tea break.

Besides, as a Chinese educated in China, I hold different knowledge on the education contexts, this draws me different attentions when analyzing the data, which maybe ignored if I conducted only single case study. For example, the naming on resources by the teachers and the translations from the original language to English, how they named and used textbook, the blackboard writing in China, and the activity design in France.

Lastly, working within the French research team, I took profits of the projects such ReVEA, where I adapted the recommended interview framework when interviewing my French case; the platform, where I analyzed my French data along with the demanded structure (from situation to web documents, as introduced at the beginning of Chapter 5), and I had the chances to work with other researchers on the same data with different theoretical views (Trouche et al., 2019).

Second, due to the limited time, not all data collected were used sufficiently in the case analysis, and the tools for long-term follow up for each case are not well organized in a continuous and complete way.

There are some very important resources such as the videos of third collective MOKE discussion (in the Chinese case) and second collective lesson preparation work (in the French case) are not fully analyzed. We are aware that we did not fully use the potential of the AnA.doc platform. The textbooks in the Chinese case and its differences with the textbooks used by Anna and Cindy are also valuable to be explored, because in China, the textbooks are given by teachers and they have to implement it without other choices. The lesson plans produced in the collective documentation work in the two cases are also necessary to be contrasted and analyzed.

Besides, the tools for long-term distance follow up need to be improved and completed with extra tools. The Chinese WeChat group chatting (used by Gao with her TRG members) although allows a long-term follow up, but with only this, we can not see a complete layout of their collective resource work; the French Dropbox folder (used by Anna with her school colleagues) follow up provides only the results (lesson plans) of their collective work, we cannot see the process about what they exchange and how they interact during their collective work.

Third, the concept of DWM allows a deeper analysis on teachers' specific interactions within a smallest collective (between two), but to what extent it helps us understanding DE in larger collective?

The choice of DWM takes the considerations of the teachers, this follows the principal of "contrasting teachers' view" of reflective investigation. But it also brings the diversity of the

relationship between DWMs, for example, in the Chinese case, Gao and her two DWMs are more in a relationship of mentor and apprentice, or a resource donor and a resource receptor; while in the French case, Anna and Cindy are working in a more equal with mutual exchange and inspirations. Also, the choice of the objects, if I chose Yao as the main teacher, then for her second DWM, whom will be chosen, it could be different, may be her supervisor in the university? If so, her resource system might involve new elements.

Fourth, there could be also some interactions to be thought between the two cases.

In March 2017, during the follow-up with Gao, for preparing a school activity (open day for parents), I used to try to adapt the French NIM game (part of Anna's activities in algorithmic teaching in grade 7) in one class of grade 8. Twenty selected students who were better at mathematics (from 32) attended this lesson. However, the results turned out very different, the students considered this game too simple, and some of them proposed the final strategies almost immediately. In the end, to finish this lesson, I had to improve the difficulty by adding the number of matches, and added extra activities to ask the students to design similar games.

Gao also attended my lesson. In the discussion after this lesson, she explained the students' secret: Some of her students used to attend the Mathematical Olympiad class in their primary school. NIM game in the Chinese Mathematical Olympiad was well known as "problems of taking the matches".

"The students looked very clever and react very fast, but actually you did not know their background. If you asked the boy (who proposed the strategies) why, I am sure he cannot explain clearly, he only applied the formula he learned, he must had learned this during his primary school study, in the tutorial classes." (Informal comments from Gao)

To making interactions between the two cases, it has been proved that adapting the lesson plan is not a good choice, because students are too different. Maybe we could try to cross the data analysis by inviting the teachers in one case to comment on teachers on the other case. This is a reflection on the fifth principle of Reflective Investigation, contrasting teachers' view, which probably brings us new perspectives.

Lastly, as a conclusion of this section, I would like to redraw the role of "reflection" in the Reflective Investigation. Involving the teachers into both data collection and analysis is the core feature of this methodology. In this way, one question should be paid attention: Are the drawings like RMRS or R-IMRS also part of teachers' resources? I would like to say yes, they are both the resources of teachers, and mine. Without this thesis project, Anna did not need to create a RI-Box for our research, Gao might not notice how she categorized and linked her exercise resources. During the process of being involved in this thesis, for Gao and Anna, they learned the notion of resource system, they reflected when they were being interviewed and followed-up. This could also be considered a step of their professional development.

6.4 Perspectives

This section presents the perspectives of this research with the work worth to be continued after this thesis, both research programs (6.4.1), and development ones (6.4.2), and more personal reflections as provisional ending point(s) (6.4.3).

6.4.1 Programs of research taking advantage of the linguistic diversity

The naming system project was one of the 10 perspectives of DAD research proposed by Trouche (to be published). The complete expression is "contrasting naming systems used by teachers in describing their resources and documentation work, towards a deeper analysis of teachers' resource systems". I would like to propose three directions of research: the first one

developing the reflection from names to verbs, the second one for extending the comparison from Chinese-French to other contrasted cases, the third one for using the contrasted languages for a theoretical deepening.

From naming systems to verbs systems

In this thesis, I made some exploration on teachers' naming on their resources. The method is taking teachers' words and expressions (in interview transcriptions or video transcriptions with dialogues, or teachers' textual documents), and selecting the most frequently mentioned terms. This is a view from the norm of resources.

But besides the naming on the resources by the teachers, actually there are also some verbs along with the norms (naming). The verbs could help us to understand teachers' resources function, and teachers' attitudes. One example in the French case, when Anna was explaining her usage of textbook ("manuel"), two verbs of resource usage, "me servir" (in French; English translation: 'get myself') and "m'appuyer" (in French; English translation 'rely on') were used by her.

*"Then, no doubt that I had the textbook, the textbook of class. I don't remember its name anymore. I think it was Pythagore. But I don't know anymore, yes, I think it was Pythagore. If it exists it should be Pythagore. So, then, it was the textbook that was chose by the school. I got myself (**me servais**) the textbook. I started with the textbook. (Appendix1.6 _ANNA6)*

*"At the beginning I think yes. I **relied** very much **on** (m'appuyais) the textbook at the beginning." (Appendix1.6 _ANNA19)*

The "me server (get myself)" showed that Anna might have conscious of providing herself such resources as reference, but to use it or not, she was not sure. She later explained why she used this verb: "because I also used other resources, it was not the only one and main one". While the verb of "m'appuyer (rely on)" showed a more close relationship between her and the textbook when she was a novice teachers.

Another example in the Chinese case of Gao, when she was describing how she worked on students' homework and the mistakes in their homework, she used the verb of "抓 (zhuā)"(grasp) with the meaning of pushing, catching, keeping working at:

"...the students prepared well enough before the lesson, I 抓(zhuā) (push) them, right?" (Appendix1.1 _GAO6)

This verb reveals an image of Gao's daily work as she described: she arrived at school at 7 in the morning; entered the classroom to check the students' homework; waited for students in her office to solve their questions before the morning session which starts 7h40; spent 45minutes to 1 hour to marking students' homework (70 students of two classes); attending one class for answering students' questions in the noon session (from 12h10 to 12h40); attending another class for answering students' questions in the evening session (from 16h to 16h45); gave some personal instructions to the students with difficulties. During the day, she even tried not to go to the toilet during the lesson breaks, so that the students could find her in her office if they had any questions. She marked each student's homework, and explained their common mistakes at the beginning of her lesson, and asked each student to correct their mistakes and showed her face to face that they had corrected it.

There are also some other verbs, such as the verb of "磨(mó)" in MOKE activity (introduced in section 1.3.1), in Chinese "磨(mó)" translated in English is "sharpen (the knife)", which could be extended in meaning of "refine" or "carve" the lesson. With this, we can imagine the

spirit of MOKE and how teachers deal with the resources. Besides, the verb of “借(jiè)” in MOKE activity used to describe the phenomena that teachers within the same LPG often “借(jiè) (borrow)” lessons from each other to try out their lesson design. Such verbs provide the vivid imagination on what happened in the Chinese TRG situations.

The naming system project takes teachers’ expressions, which exactly echoes the fifth principle of “contrasting teachers’ view” in Reflective Investigation of DAD. The expressions include both norms (how teachers name the resources), and verbs (how they match with the resources in usage description). The information revealed behind could help us better understanding the schemes of the resource usage, as well as the DE attached.

Extending the contrasting pairs for comparative studies

The naming system also provides interesting enter points to make contrasting analysis within different contexts. This is not a new idea to make comparative studies through language. The Lexicon project (Clarke et al. 2017) has made some efforts, where researchers from different language contexts documented the naming systems (lexicons) employed by different communities speaking different languages, to describe the phenomena of the mathematics classroom. The uniqueness of naming system is contrasting teachers’ words. In our paper for contrasting teachers’ resource system between China and Mexico for CERME11 (Wang, Salinas & Trouche 2009), with the interview transcriptions in Chinese and in Spanish, we still found the Chinese teacher’s resource system is more exercise-centered, while the Mexican teacher’s resource system is more structured with students’ learning resources, with which we could infer that her resource system is more learner-centered.

Also in what is in preparation between China and Ukraine for ICMT3 (will be conducted in 2019) (Rafalska, Wang & Trouche), with the similar historical influences remained (e.g. the educational system from the ex Soviet Union), we found some common aspects inferred from the resource naming, such as the role of national curriculum program, the function of teachers’ teaching guidance books, and the social cultural expectations on teachers’ roles etc.

From this perspective, for ICME 14 (2020) in Shanghai, it is also anticipated to see the discussions on the differences of teachers’ resource work and expertise, by crossing contexts from diverse cultures, education systems, institutional contexts and various teacher profiles.

Finally taking advantage of the linguistic gap for deepening concepts

Since the beginning of my PhD in 2015, I started to consider the Chinese translation of DAD and the related conceptions (Wang in progress). However, till this moment, even I had decided the Chinese translation of the thesis title, I am still not quite sure on the current words pick up. The language gaps in my thesis are not only located in the data transcription and translation, but also in the key terms translation. In French, the word document is a larger concept than resource, and it contains even a verb meaning that a document can be anything with the potentials to evidence or support something. In the Chinese language, document is more often used in computer science, while documentation is a term more discussed in field of library science or archival science (Gao 2008), thus resource is a broader concept than document. This reminds me that in different language context, the research terms could be different in terms of the concept extension, and it should be interesting and necessary to build a multi-language glossary (Trouche to be published), for conducting further comparative studies crossing language contexts.

6.4.2 Programs of development taking advantage of the collective potential

Teachers’ DE develops particularly throughout teachers’ collective documentation work, under different forms. This result could lead to projects oriented towards teacher education, first of

all in the French and Chinese cases, second at a more general level.

Reflecting on what we learnt in our PhD study, from the diversity of French and Chinese case, we assume that the teachers themselves could learn from this diversity. This idea could lead to associate some French and Chinese school as "School-Documentation Mates", or to associate some French school in the network of school associated to ECNU, and vice-versa to associate Chinese schools to the AeP at FIE network in France.

At a more general level, as evidenced in this PhD, beyond a common point - the critical role of schools as potential professional learning communities (Roberts & Pruitts 2003) - the difference of collective support, for teacher documentation work, in France and China, is linked to institutional, cultural, historical contexts. It appears clearly through twin projects developed during the last part of our PhD: the PREMaTT project in France ("Penser les ressources de l'enseignement des mathématiques dans un temps de transition", <http://ife.ens-lyon.fr/ife/recherche/groupe-de-travail/prematt>) and the MaTRiTT project in China ("Mathematics Teachers Resources in a Time of Transition", <http://ife.ens-lyon.fr/ife/recherche/groupe-de-travail/matritt-joriss>).

Drawing from this diversity of experiences, leading to very different settings for teachers collective documentation work, we could think about developing of a repertoire of models of collective settings for developing teachers DE, to be appropriated, adapted according to different contexts and to different teachers' needs.

The next international study, launched by the International Commission on Mathematical Instruction (ICMI), is dedicated to *Teachers of Mathematics Working and Learning in Collaborative Groups* (<https://www.mathunion.org/icmi/activities/icmi-studies/ongoing-icmi-studies>), an occasion for developing more the first results of this PhD, and crossing them for other ones, coming from other contexts.

6.4.3 A final reflection

Four years' effort is possible to write a thesis, but is not quite enough for following up teacher expertise, even what I focus is only the resource work aspect of teacher expertise.

Finding the evidences for expertise needs long term follow up in multi occasions (in and out of classroom...), in teachers' different roles (teach students, and teach other teachers to teach...), through different resources of the teachers (more than lesson plan design, but also their notes, their folders management in computer, and the articles or papers they write...).

The methods for follow up teachers' work should also be considered as more than interview and observation, because teachers' expressions perhaps are not the overall description, or they hold different understandings on the research notions (such as what is resource), and lose some crucial details. Especially when I was trying to study their resource system with their RMRS or R-IMRS, the results turned out that the drawings are only a small part of the evidences and references.

Then to see the development of DE, the changes that could be considered as development, it could takes more time. Even till this moment, I still feel a lot of details in my follow up (either face to face or long distance) were not used sufficiently to evidence the DE behaviors. Thus further studies are absolutely necessary to continue.

The collective working contexts for teachers are interesting because they are closely linked to a larger social cultural context. Or we could say, even with only two cases, a picture of the French context and Chinese context has been described with details.

The study on teachers' collective work also encourages me in doing research collectively, especially with Katiane. During four years, we exchanged our information on Anna and Cindy. In many occasions, we presented our work for same conferences, and even the same case of Anna from different aspect. Her research interest on teachers' past experiences also reminds me to pay attention on the influences from teachers' education background on their resource work. And from the two experienced teachers, the study on finding their DE is also a learning process for me, doing educational research is also similar like conducting teaching practice, we all need the view of design, the view of collective, and a critical attitudes towards the basic notions such as mathematics.

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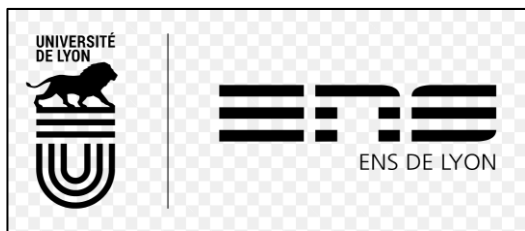
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THÈSE

En vue de l'obtention du grade de Docteur de l'Université de Lyon, délivré par l'École Normale Supérieure de Lyon, et de Docteur de l'ECNU (East China Normal University, Shanghai)

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An investigation of mathematics teachers' documentation expertise and its development in collectives: two contrasting cases in China and France

Une étude de l'expertise documentaire des professeurs de mathématiques et de son développement dans des collectifs : deux études de cas contrastées en Chine et en France

APPENDICES – ANNEXES

Thèse en cotutelle

Directeurs : M. Luc TROUCHE et Mme Binyan XU

Après l'avis de :

M. Jiansheng BAO

Mme Ghislaine GUEUDET

Devant le jury composé de :

M. Jiansheng BAO, Professeur à l'ECNU

M. Lianghuo FAN, Professeure à l'ECNU

Mme Ghislaine GUEUDET, Professeur à l'Université de Bretagne Occidentale

Mme Birgit PEPIN, Professeur à Eindhoven University of Technology

Mme ANNA SOURY-LAVERGNE, Maîtresse de conférences HDR à l'ENS de Lyon

M. Luc TROUCHE, Professeur à l'École Normale Supérieure de Lyon

Mme Binyan XU, Professeure à l'ECNU

Table of contents

Appendix 1	3
Transcription of interviews for teachers’ resource work and resource systems.....	3
1.1 First interview with Gao on November 2015	3
1.2 Second interview with Gao in April 2017	27
1.2.1 Selected transcriptions, translation and marks	28
1.2.2 Inferred Mapping Resource System (IMRS) of GAO (April 2017)	38
1.2.3 Reflective IMRS (R-IMRS) of GAO (April 2017)	39
1.3 Third interview with Gao on October 2017	40
1.3.1 Selected transcriptions, translation and marks	40
1.3.2 Reflective Mapping Resource System (RMRS) of GAO (October 2017)	43
1.4 First interview with Liu on April 2017.....	44
1.4.1 Selected transcriptions, translation and marks	44
1.4.2 Inferred Mapping Resource System (IMRS) of LIU (April 2017)	51
1.4.3 Reflective IMRS (R-IMRS) of LIU (April 2017)	51
1.5 First interview with Yao on March 2017	52
1.5.1 Selected transcriptions, translation and marks	52
1.5.2 Inferred Mapping Resource System (IMRS) of YAO (March 2017)	55
1.5.3 Reflective IMRS (R-IMRS) of YAO (March 2017).....	55
1.6 Interview with Anna on June 2017.....	57
1.6.1 Selected transcriptions, translation and marks	57
1.6.2 Reflective Mapping Resource System (RMRS) of ANNA (May 2015)	65
1.6.2 Reflective Mapping Resource System (RMRS) of ANNA (June 2017)	66
1.7 Interview with Cindy on May 2015	67
1.7.1 Transcriptions	67
1.7.2 Reflective Mapping Resource System (RMRS) of Cindy (May 2015)	82
1.8 Lexicon of the teachers’ naming systems.....	83
1.9 Logbook of teaching resources usage	90
Appendix 2	93
Transcription of teachers’ collective lesson preparation videos.....	93
2.1 Transcriptions of first MOKE activity	93
2.2 Transcriptions of second MOKE activity	113
2.3 Transcriptions of third MOKE activity	140
2.4 Transcriptions of first French collective lesson preparation	144

Appendix 1

Transcription of interviews for teachers’ resource work and resource systems

This appendix includes the transcriptions of the interviews with the teachers for their resources work and resource systems. It includes Chinese and French data. In the following eight sections, five of them are about Chinese case: three interviews with GAO in different periods, November 2015 (1.1), March 2017 (1.2) and October 2017 (1.3); two transcriptions of interviews with Gao’s two colleagues, Liu (1.4) and Yao (1.5); the last two sections are the interview transcriptions of the French cases, Anna (1.6) and Cindy (1.7). An overview of lexicon (1.8) for the terms related to resources will be presented in two sections: Chinese part (Chinese-English) and French part (French-English), then section 1.9 is about the logbook of resource usage used in Chinese context.

1.1 First interview with Gao on November 2015

The first interview with Gao (accompanied by Zhai, who was in charge of our school visiting) was made in the afternoon of 17th November 2015, in the teacher office of grade 7 (Picture 1.1), after the observation of an open lesson given by Gao. The topic she taught for the open lesson was about “the factorization method” (content of grade 7). The interview was conducted in Gao’s office, when she was teaching two classes in grade 7. The interview was recorded in audio format, and then transcribed in Chinese (on the left column), and translated into English (on the middle column). The important answers from Gao to be cited in the thesis writing are highlighted in yellow, and a third column of marks is prepared for explaining the important answers. Important Chinese resource namings were translated into the format of “Chinese naming + Chinese Pinyin pronunciation + English explaining”. A final summarization on these terms is generated into appendix 1.8.



Picture 1.1. Gao’s personal working desk in teacher office of grade 7 (2015)

This interview lasts for 46 minutes, with 56 questions from the researcher, concerning four topics:

- (1) Resources used in the lesson preparation (taking the open class as example)
- (2) Resources used for daily math teaching (e.g. resources for students, for teachers, and how to share)
- (3) Collective working (e.g. teacher collective work in and outside the school, collaborative projects with universities or institutions)
- (4) Gao's personal school daily work information (e.g. working hours each week)

Chinese Transcriptions	English translation	Marks
<p>R1: 我想针对刚刚您上的公开课问一些问题, 您在被这堂课的过程中, 参考了哪些材料和资源?</p> <p>GAO1: 这个, 我们有一些 课外书籍, 一般就是每年出的 课外书籍, 每年都会更新的, 我都会借鉴来看一看。</p>	<p>R1: I would like to ask some questions about your open lesson just now, when you were preparing the lesson, what materials and resources did you refer?</p> <p>GAO1: Ehm, we have some 课外书籍(kè wài shū jí)(extracurricular books), generally each year there will be some newly updated 课外书籍(kè wài shū jí)(extracurricular books), I always take to see what I can use.</p>	<p>The first time Gao mentions her resource of extracurricular books</p>
<p>R2: 课外书籍是指哪些?</p> <p>GAO2: 有学校, 就是正规的 教学参考书, 也有那种, 比如这个 教材全解啊, 有那个 辅导与训练啊, 因为它的 题目, 因为每年都有不断的更新, 它结合中考的 题型在不断的改变的, 你看我们现在的 题是越来越灵活。那老墨守成规在一个 课本上, 我因为跟学生说, 墨守成规的话, 这个分数不会很高, 因为 课本上的东西是最基本的东西, 最基本的, 对吧, 关键是让学生呢, 去灵活的去应用, 那学生自己挖掘的能力不强的话呢, 那只有老师们帮忙他们去提升了, 对吧, 不断的去教对吧, 所以说我们的作用就是在于这里 (笑)。所</p>	<p>R2: What are the extracurricular books?</p> <p>GAO2: There are (from schools), like the formal 教学参考书(jiào xué cān kǎo shū)(teaching guidance book), and there are also, such as this 教材全解(jiào cái quán jiě)(the full explanation of the textbooks), this 辅导与训练(fǔ dǎo yǔ xùn liàn)(instructions and training), because the 题目(tí mù)(exercises) will be updated each year, it changes continuously according to the 题型(tí xíng)(question types) of 中考(zōng kǎo)(high school entrance exam), our 题(tí)(exam questions) are become more and more flexible now. So only using the 课本(kè běn)(textbooks), I often tell my students, only using the 课本(kè běn)(textbooks) cannot get a good mark, because the things in the 课本(kè běn)(textbooks) are only the very basic things. The key points remains on letting the students to learn in depth. If the students cannot dig the</p>	<p>Gao presents three two extracurricular books she used, and explains why she uses them: requirements from exam and the shortage of textbooks. This evidences her knowledge of exam, of textbooks, of learning-aid materials. Besides, she has a strong sense of responsibility towards students:</p>

以要去翻阅很多的书籍，去比较一下哪些题目比较适合我们学生，然后进行一些变化。	knowledge deeper, then the teachers need to offer help, right? Teach them and that is our function (laughing). So we need to browse a lot of 书籍(shū jí) (books), to compare which 题目(tí mù) (exercises) are more suitable for our students, and then make some changes.	selecting and verifying exercises are the function of teachers
<p>R3: 那这些书籍是您个人选择的吗？还是说整个年级组都用？</p> <p>GAO3: 因为被这节课备课时间比较紧，本来我以前就上过这节公开课，所以我就拿了以前的课件，进行了筛选，因为每一年的学生都不一样的，当时我写的时候，写教案的时候，不是针对现在的学生的吗，对吧，所以进行了筛选，我是昨天在4班上了一节课以后，感觉还是不错，但是5班上课，5班学生的层次总体比我们班好一些，学生就提出来了，为什么要用“十字相乘法”，所以我这节课呢，就不是单纯的去用，告诉他们用十字相乘，同时告诉他们十字相乘是来源于多项式乘以多项式的一个法则，所以我今天引用的是多项式乘法，是过渡到十字相乘的图，而不是单纯的把图拿出来。5班上课的时候，我拿出来图，学生就问“为什么一定要用这个十字相乘图呢？”对吧，其实它是，本身就是整式乘法运算转换过来的，所以在我们班级在这一点上，我就又做了一个改进的。</p>	<p>R3: You choose these books on your own or they are used by the whole grade?</p> <p>GAO3: For this open class just now, because it is a bit hurry and I do not have so much time to prepare, so I used some old 课件(kè jiàn) (courseware), and made some selections and modifications, because the students are different. When I was preparing then, writing the 教案(jiào àn) (lesson plans), it was not for these students now, right? So I made some modification. Yesterday I conducted this in Class 4, I feel it was fine. But the students in Class 5 are better than my students, they asked me why we must use « cross multiplication method», So in this lesson, I did not only tell them directly the method of cross multiplication, but explained that it comes from a regulation of polynomial multiply polynomial. So that is why I introduced the « cross multiplication », and not proposing directly the method. In Class 5, when I propose the method, some students asked, “why we must use this?” Right? Actually it is, itself is from the integral expression multiplication. So I used it in my class, I made some improvement.</p>	<p>Gao describes how she prepares the open lesson: based on her previous lesson plan, making modifications according to students' performances in different classes, implementing it in different classes.</p> <p>Here she mentions one oral concept, 借班(jiè bān) (borrow class), which means a teacher can borrow another class from other teachers to try out her lesson design, which is quite often happened within LPG when they are preparing some important open lessons.</p>
R4: 今天是几班？	R4: So today, the class is?	Gao explains

<p>GAO4: 今天是1班, 是我自己的班, 昨天我借了刘老师的4班试着上了一下, 因为本来是随堂课的话, 那么第一个班级和第二个班级在教学过程中其实还是有不一样的, 那么第一个班级中, 如果学生是感觉到有困惑的话, 我肯定会在第二个班进行一个修整, 对吧, 所以就是说, 即便是一个人教两个班, 其实两个班级学生程度不一样, 前后课程的顺序不一样, 课时也是会不一样的。对吧, 因为学生是千变万化的, 可能这个学生遇到的问题, 我在原来备课的过程中是没有想到的, 那么, 哎, 但是在学生身上却发现了这些问题, 那么我肯定要及时去纠正他, 那么已经上过的班级呢, 我就用后续的课程去再去进行一个弥补, 因为我们不是有练习课么, 有面批作业, 作业基本都是面批的, 你看到刚才进来的学生就是, 今天上午上课完了之后, 在学校里完成的東西, 我要进行面批, 去修整他今天上课没有听懂的东西, 那么回家再做一个巩固练习的话, 就能达到一个训练的目的。</p>	<p>GAO4: Today is Class 1, my own class. Yesterday I 借班(jiè bān) (borrow class) 4 from Liu and tried it. Since it is actually the 随堂课(suí táng kè) (regular lesson), first class and the second class are different in the teaching process. So in the first class, if the students have any confusing parts, I will absolutely make some modification in the second class, right? So that is to say, even one teacher teaches two classes, actually the students are different in their performance level, and the teaching order is different, so the lesson is also different, right? Because the students vary a lot. The problems met by this students that I ignored or I did not noticed in my lesson preparation, may appeared on those students, then I surely go to correct him/her. Then for the class I have given the lesson, I make up later in the following lessons. Because we have also 练习课(liàn xí kè) (exercise lesson), we have 面批作业(miàn pī zuò yè) (face to face homework correcting), basically I correct students' 作业(zuò yè) (homework) face to face with the students. The student you saw who came here just now is like this. Today, after the lesson in the morning, they have something to finish at school; I have to correct these face to face, to fix things they did not understand about today's lesson. Then they can do some 巩固练习(gǒng gù liàn xí) (exercises for consolidation) as homework, in this way we achieve an aim of training.</p>	<p>how she makes adjustments in her two classes: she often makes changes based on students' reactions in her first lesson that day, then she uses homework as an essential way to make up those parts she feels she does not explain quite well: she marks all the students' homework, and asks them to correct the mistakes in front of her during the break.</p>
<p>R5: 您刚刚课堂上留给他们的作业是?</p> <p>GAO5: 这是学校作业, 啊, 我们预习作业是昨天晚上就布置的, 你没看见, 刚上课的时候, 学生都已经做好了, 做过了的在家里。(课本上的) 课后</p>	<p>R5: what did you give to them as homework?</p> <p>GAO5: That was 学校作业(xué xiào zuò yè) (school work). Ah, our 预习作业(yù xí zuò yè) (pre-study homework) was assigned last night, you did not notice it. At the beginning of the lesson, the students had already done it, they did it at</p>	<p>Gao explains the pre-study homework, school work and general homework; she insists this since grade 6 students.</p>

<p>习题都是提前做完的。我们这种模式其实从预备年级(6年级)就已经开始了。一开始的时候, 学生觉得比较困难, 因为他们不知道什么是预习。小学没有这种预习的吗, 对吧。我对他们的预习要求就是, 一要把整个课本小节通读一遍, 第二个就是找到知识点, 这堂课主要的知识结构是什么, 概念是什么, 要点是什么, 然后看例题, 把课后练习按照自己的理解, 把它们都做一遍, 不会的时候, 他们就会把这些问题带到课堂里, 那么利用课堂时间去解决掉它们, 我就不用刻意花时间在课堂上组织他们做课后练习了。我的课后练习速度就会比较快, 就可以很快的过掉它。一呢, 我上课讲完了, 我让他们回过头看一下昨天自己的预习作业做的怎样, 他们会发现问题的, 像我们学生就发现, 哟, 我这道题没有分解到底, 对吧, 或者说, 只拆了常数项, 没有去考虑一次项的系数之和的问题, 对吧, 所以它这里就有一个融合的过程, 对吧, 有一个迁移的过程, 那相对来说, 学生在学习上, 就有一个慢慢循环的过程。</p>	<p>home. The 课后习题(kè hòu xí tí) (after-lesson exercises)¹ should be done before the lesson. Such mode has started since the preparation grade (grade 6). At the beginning, the students may feel very difficult, because they do not know what is preview. There is no preview in primary school, right? I asked them, firstly read the section in the textbook, secondly find the knowledge points, what is the main knowledge structure, what are the concepts, what are the key knowledge points, then read the 例题(lì tí) (examples), do the 课后习题(kè hòu xí tí) (after-lesson exercises) based on their own understanding. They can bring their 问题(wèn tí) (questions) making them confused to the classroom, then (I will) solve them during the classroom teaching, so I do not need to spend time to organize them do the 课后习题(kè hòu xí tí) (after-lesson exercises). My 课后习题(kè hòu xí tí) (after-lesson exercises) then can be passed quite soon. On one hand, after I finish my lesson, I ask them to reflect on their 预习作业(yù xí zuò yè) (preview work), they will find some 问题(wèn tí) (problems). For example our students can find, oh, I did not totally resolute (the factors) in this 题(tí)(exercise), right? Or to say, only resolute the constant term, without considering the 问题(wèn tí) (matter) of sum of the fist degree coefficients, right? So there is a process of fusion, right? A process of transfer, that is relatively to say, the students, on learning, have a process of slow circle.</p>	
<p>R6: 我也觉得您这堂课进展比较顺。</p> <p>GAO6: 对, 因为学生前期工作做的也足, 我会抓</p>	<p>R6: I feel the lesson works fluently</p> <p>GAO6: Yes, because the students prepared well enough before the lesson, I 抓(zhuā) (push) them, right?</p>	<p>Gao pushes students in their homework, with a verb “抓”</p>

¹ After-lesson exercise: on the textbooks, after the presentation of each section, there will be some exercises corresponding to the knowledge of the section (generally 3-10) for students,

他们的吗，对吧。		(zhuā) grab
<p>R7: 全校都是这种模式吗？还是说这是您自己班级推行的？</p> <p>GAO7: 我们是要求预习的，我们年级组，因为我是备课组长，数学，我们这里的备课组长。我们是从预备年级要求他们必须每天预习的，每个班级都要的，要预习的。预习的方法大家都是一样的。</p>	<p>R7: Such mode works throughout the school? Or only your classes?</p> <p>GAO7: We asked them to preview, in our grade, because I am the leader of LPG, math, the leader of LPG here. We asked since the preparation grade (grade 6) to preview everyday, every class. The method is the same for us.</p>	<p>预习作业(yù xí zuò yè) (preview work) is a routine work for students since grade 6, in Gao's class</p>
<p>R8: 那么其他年级呢？</p> <p>GAO8: 其他年级，（预习）作业布置的方式方法可能不一样，但是布置肯定也是布置的。有的可能呢就是看一看，看一看，我觉得流于形式，有些同学慢慢呢慢慢呢就不看了，因为看的东西你很难去检查，对吧，你至少呢，写下来的东西，至少他去做。他去抄了，他去找他才能抄到它读吧，对吧。他课后练习做了，是因为他要学会他肯定要去例题他才能会做，所以就逼着他去看书，去阅读。</p>	<p>R8: what about other grades?</p> <p>GAO 8: other grades, the method for assigning 预习作业(yù xí zuò yè) (preview work) maybe different, but there must be some. Some may be only (ask them to) read, read, I feel it is too formalistic, some students will not read later, because it is hard to evaluate whether they read or not, right? You at least, write something down, at least he/she did it. If he copies, he needs to search for and read then he can make a copy, right? He did the 课后习题(kè hòu xí tí) (after-lesson exercises), because he had to read the 例题(lì tí) (examples) then he learnt, so (I) 逼(bī) (compel) them to read the 书(shū)(textbook), to read.</p>	<p>The reason Gao insisted to assign the preview homework: she knows students' psychology; they will be lazy if she does not push.</p> <p>Gao used a verb 逼(bī) (compel) to describe how to make students really read</p>
<p>R9: 您刚刚说您现在教初一（7年级），也就是说现在您的学生在6年级的时候就开始这种学习模式了？</p> <p>GAO9: 对的，我们一般是4年一循环，我是先教完一届初三（9年级）之后，再从6年级开始，这样4年一个大循环，整个体系也会比较清晰。我是为了培养他们的学习习惯，对吧，从小学结束后，我就开始</p>	<p>R9: You mentioned you are teaching grade7 this year, so you started it in your classes since grade 6?</p> <p>GAO: Yes, we generally teach in 4 years as one circle, I taught one year in grade 9, then I restarted from grade 6, so such 4 years can be called as a big circle, and the whole (teaching) system is quite clear for me. I just want to train their learning habits. I feel it is good, I feel they have gotten some results.</p>	<p>Gao emphasizes the importance of students' learning habit: preview each day</p>

培养他们养成这样的习惯。我感觉挺好的，我觉得还是比较有效果的。		
<p>R10: 回到刚才参考书的话题,我还有问题没问完,您那些书怎么找的,您自己找的吗?</p> <p>GAO10: 我自己,我喜欢,书店里每年,我都都会到书店里去翻一些资料,去看看有没有新的东西,有没有改变,因为有的书是一版两版三版的嘛,不断的在改,那么版本在改变的时候,其实就是题目在改。</p>	<p>R10: Let's back to the topic of the learning-aid books, I have some other questions, how did you search these books? On your own?</p> <p>G10: My own. I like it. Each year in the bookstore, I go to the bookstore to check some 资料(zī liào) (documents) each year, because some 书(shū) (extracurricular books) have the 1st edition, the 2nd edition, and the 3rd edition, they are always changing. The change of editions means the 题目(tí mù) (exercises) inside are changing.</p>	Gao explains how she traced the trends of the extracurricular books (learning-aid books)
<p>R11: 您有特殊的系列关注吗?</p> <p>GAO11: 其实我们发现的问题还是很多的,有些书是上一届延续下来的,有些书是上一年级用过的,然后延续下来给我们用,因为毕竟,数学这个,四年以后,有的时候格局会不一样的,所以通常就是,上一个年级留给我们,我们也把资料留给下一个年级,那有些书是我自己固定买的,那像这本(金典)和那本辅导与训练,它们的难易程度还是比较好的,因为这三本书(辅导与训练),我是从预备到初三,整个系统里面,我是自己都备的,自备的,就是我自己去买全套的书籍。</p>	<p>R11: Will you concern some special features of the books?</p> <p>Gao11: Actually we found that there are lots of problems. Some 书(shū) (books) are remained by the former grade, some 书(shū) (books) are from the 上一届(shàng yī jiè)(former graduating classes²); they left the books to us. Because after 4 years, the math will change, so generally the 上一年级(shàng yī nián jí)(former grade) left to us, then we also leave our 资料(zī liào) (documents) to the next grade. Then I purchase some of the 书(shū) (extracurricular books). Such as this (金典 jīn diǎn), and that 辅导与训练(fǔ dǎo yǔ xùn liàn) (instructions and training), their difficulty degree is good. These 书(shū) (extracurricular books), from grade 6 to grade 9, the whole system, I buy them by myself, prepare for myself, I went to buy the whole set of these 书籍(shū jí) (books).</p>	<p>The way of transferring and sharing resources inside the school.</p> <p>Gao has some personal resources as a complement of the resources.</p>
<p>R12: 这些学生有吗?</p> <p>GAO12: 这些只是我备课</p>	<p>R12: Do the students have these?</p> <p>GAO12: These are only for my lesson</p>	Gao emphasizes one of math

² The grade 9 is called graduating classes, namely the terminal classes in middle school.

<p>用的，我买这么多的书不可能要求学生们也去买的，对吧，我只是去翻阅去了解，因为像这本书里面，它有一些知识点的一些分析，对吧，比如说十字相乘，还有一些方式和方法，其实学生阅读一下也蛮好，但是学生没有这个能力和时间，他们做不到坐下来静下心来分析它。</p>	<p>preparation, I buy so many 书(shū) (extracurricular books) and I cannot ask the students to buy all of them, right? I just try to read and learn, because in these 书(shū) (books), there are analyses on the knowledge points, right? Such as the 十字相乘(shí zì xiāng chéng), and some other methods, actually it is good if the students can read them, but they do not have so much ability and time, they can not sit down quietly and analysis.</p>	<p>teachers' roles: selecting valuable exercises for students</p>
<p>R13: 您觉得它跟教材比怎么样?</p> <p>GAO13: 它比教材的量要大，它的知识难点要高，它还有专门，后面的专门的一些扩展，知识的扩展和提高，那我么在学生能力所及的情况下也会补充一些，对吧。它的一些练习题因为也是一直在更新的嘛，有的时候（我）就会节选一些有意思的习题，或者一些比较典型的例题.....题目作为例题，上课时候去讲解。</p>	<p>R13: How do you think them comparing with the textbook?</p> <p>Gao13: It contains more than the 教材(jiào cái) (textbook). The difficulty is higher. There are also some specific expensive blocks, about expanding and improving. Then I will make some supplementary within the ability of the students, right? The 练习题(liàn xí tí) (exercises) will be updated regularly, sometimes I will selected some interesting 习题(xí tí) (exercises), or some typical... 题目(tí mù)(exercises) as 例题(lì tí) (examples) for my classroom teaching.</p>	<p>The differences between textbooks and the extracurricular books, and how does Gao use the selected exercise in class: a critical attitude towards textbooks.</p>
<p>R14: 您最初怎么知道这个书的?</p> <p>GAO14: 我是自己去找，去书城里去翻的，然后就是觉得这一系列的书还是比较好的，所以我是把这一系列的书，从预备到初三的书都买到了，这就是8个学期嘛，8本书，我自己是自备的。我每年都会去（书城）稍微去看看，他们出（新）书嘛，总归是有他们的道理，我不能要求学生去买，但是我可以买来去看看有什么可以借</p>	<p>R14: How do you know this book?</p> <p>Gao14: I find it by myself, looking for them in the bookstore, and then I think this set of 书(shū) (extracurricular books) is good. So I bought the whole sets of the 书(shū) (extracurricular books), the 书(shū) (extracurricular books) from grade 6 to grade 9, 8 书(shū) (extracurricular books) for 4 years in the middle school study, I prepare for my own. I go to the bookstore every year, they will have some new 书(shū) (extracurricular books), and they have the reasons (to put forward new versions), I can not ask my students to buy, but I can buy them back to see what I</p>	<p>How does Gao trace the extracurricular books (explained in detail)</p>

鉴的。	can borrow for my teaching.	
<p>R15: 这本也是吗?</p> <p>GAO15: 对的, 这是这两年新出的, 辅导与训练。它因为有层次, 有基础题, 有提高题, 有拓展题, 所以, 这些都是作为教师用书去根据学生的不同层次去给学生去选题目, 因为练习册也好, 教材也好, 他们的题目量还是有局限的, 对吧, 教材呢还是比较基础的。</p>	<p>R15: (instructions and training) How about this book?</p> <p>Gao15: Yes. This book appears recently 2 years. 辅导与训练(fǔ dǎo yǔ xùn liàn) (instructions and training). It contains the 基础题(jī chǔ tí) (elementary exercises), the 提高题(tí gāo tí) (exercises for improvement), 拓展题(tuò zhǎn tí) (exercises for expansion), so these 3 books are all for teachers to choose 题目(tí mù) (exercises) for students. Because no matter the 练习册(liàn xí cè) (exercises book along with the textbook), or the 教材(jiào cái) (textbook), the 题目量(tí mù liàng) (exercise quantity) is limited, right? The 教材(jiào cái) (textbook) is more basic.</p>	<p>Features of 辅导与训练(fǔ dǎo yǔ xùn liàn) (instructions and training).</p> <p>The lack of textbook, and how to do differentiated instruction</p>
<p>R16: 那么这本呢?</p> <p>GAO16: 这本是拓展题比较多, 提高题比较多, 难度比较大, 我们就是等复习, 现在我们是讲新课, 然后有练习课, 到最后期末复习课的时候我就可以相对的增加一些灵活运用, 我们学生就是说灵活运用这方面比较差, 就是分析语言的能力比较差, 因为接触到的题目比较少, 那么数学不管怎么说, 还是要多做多练, 对吧, 但是呢现在没有时间, 所以我们要精讲, 精练, 那其实还是要练, 因为练了才有感觉, 比如我们今天讲尝试, 他们不做, 怎么叫尝试呢? 对吧, 就要有一个过程, 对吧, 通过失败, 通过成功去积累经验, 你只给他做一道题, 他就达不到尝试的一个效果, 对吧, 做的多了么, 我们又没有时间, 所以很多东</p>	<p>R16: How about this book?</p> <p>Gao16: There are more 拓展题(tuò zhǎn tí) (exercises for expansion) and提高题(tí gāo tí) (exercises for improvement). Now we have 新课(xīn kè) (new lessons), then 练习课 (liàn xí kè) (exercise lesson), and in the end we have the 复习课(fù xí kè) (review lessons), then I will add some to train the flexibility of the students, our students are weak in flexibal application, that is to say their ability in analyzing the (math) language is weak, because they do not do enough 题目(tí mù)(exercises). Any way, Mathematics needs to do more practice, right? But we do not have time, so have to teach and practice the selected things; actually practice is still needed, because you have the feelings only after you practice. For example, we talk about try, if they do not do it, how to try, right? There should be a process, right? Through failures, accumulate the experiences via success. You give them one 题(tí)(exercises), they can not achieve that effect, right? To do more, we do not have time, so, lots of things, in teaching, there</p>	<p>How to use the different extra-curricular books in different lesson types: for new lesson and for review lesson. The importance of reading ability and doing exercises in mathematics learning</p>

西呢,教学上也是两难的,对吧。	is a dilemma, right?	
<p>R17: 那学生都有些什么资源?</p> <p>GAO17: 练习册,还有书,还有校本。对的,我们标配的是练习册,校本还有课本。</p>	<p>R17: What resources will the students have?</p> <p>GAO17: 练习册(liàn xí cè) (exercises book along with the textbook), 书(shū) (textbook), and 校本(xiào běn) (school based exercises book). Right, they are standard equipped with the练习册(liàn xí cè) (exercises book along with the textbook), 校本(xiào běn) (school based exercises book) and 课本(kè běn) (textbooks)</p>	Students' resources
<p>R18: 校本和练习册有什么区别吗?</p> <p>GAO18: 校本是我们自主研发的,学校里面自己编辑的,就是老师们自己编写的,练习册是上面给的,国家统一标配的,跟课本一套的,这个练习册很薄的,你看。我一般给学生留作业就是这俩。</p>	<p>R18: What are the difference between the exercise book and the school-based exercise book?</p> <p>GAO18: The校本(xiào běn) (school based exercises book) is developed by our school, our teachers write it. The练习册(liàn xí cè) (exercises book along with the textbook) is sent by the nation along with the 课本(kè běn) (textbooks), it is too thin, look. I generally use these two for students' 作业(zuò yè) (homework).</p>	School-based developed resources
<p>R19: 您会给他们发别的题吗?</p> <p>GAO19: 会的,但是基本上要到后面,后期的复习阶段的时候发一些别的习题,否则现在,每天一个新课,每天一个新课,对吧,他们能把这些新东西消化就很不容易了,所以知识点的延伸必须要放在复习课,新课过程中是根本就没时间的。</p>	<p>R19: When will you send the other exercises?</p> <p>GAO19: Yes. Basically later, in the review phrase, I will send them some other习题(xí tí) (exercises). Otherwise it will be too heavy for the students, because they learned 新课(xīn kè) (new lessons), everyday they have one 新课(xīn kè) (new lessons), right? It is not easy for them to digest the new things, so the knowledge expansion must be put in the复习课(fù xí kè) (review lessons), there is no time during the process of 新课(xīn kè) (new lessons)</p>	Extra resources for students according to different stage and lesson types.
<p>R20: 那这些材料别的老师也有吗?</p> <p>GAO20: 他们都有,我们都是互相推荐和借鉴</p>	<p>R20: Will other teachers use the same books like you?</p> <p>GAO20: Yes, they all have. We can also borrow from each other and exchange.</p>	LPG and lesson preparation work

的，我们有时候，因为是一个 备课组 吗，我们也会针对某一节或者一章的内容怎么来上，进行一个 集体备课 。	Sometimes, within one 备课组(bèi kè zǔ) (Lesson Preparation Group, LPG) , we will have some 集体备课(jí tǐ bèi kè) (collective lesson preparation) .	
R21: 整个备课组会共享教案吗? GAO21: 不完全一样，虽然一块备课，但是每个班的情况不一样，层次差异蛮大的。	R21: Then will the whole LPG share the same lesson plan? GAO21: Not all ways, although we prepare the lessons together, but the situation is different in each class, the students' performance levels are quite different.	Resources share among teachers in one LPG
R22: 您会把关吗? GAO22: 一般不会，教学其实是一个自觉的过程，有一个自我反省的过程，因为我们的老师，我觉得还是比较勤勉的，特别是数学老师，还是比较简单，比较勤勉的，他们会自动根据自己的学生情况进行调整的。我觉得吧，有的时候可以去要求，反而会达不到一个好的效果，关键是要积极主动去改变自己，提升自己，这样才能达到一个良性的循环。	R22: And you will help them to mentor their lesson plan? GAO22: No, I think it depends on the self-regulation of the teachers. They will have reflections. I think our math teachers are all hard-working teachers ... they always adapt themselves to their students' situations. I think by demanding will not gain good effects.	Her way of teacher management as a leader
R23: 那么备课组组长日常的工作是什么? GAO23: 统一教学进度，然后遇到比较复杂的 题 ，我们会一起探讨一些教学方式和方法，对吧，怎样去教学生，比如这次 期中考试 考完以后遇到了 试卷 上哪些 问题 ，怎么去克服它，那么 备课组 要商量一下。大家找一个方式和方法，然后教学过程中进行一个改进。	R23: Then what is the job of the Leader of Lesson Preparation Group? GAO23: Unify the 教学进度(jiào xué jìn dù)(teaching progress), when facing some complex题(tí) (exercises), we will discuss the teaching methods together, how to teach the students. For example, after this 期中考试(qī zhōng kǎo shì) (mid-term exam), we will discuss what问题(wèn tí) (problems) appeared on the 试卷(shì juàn) (exam paper), then our 备课组(bèi kè zǔ) (Lesson Preparation Group) (LPG) will discuss. We together try to find the solution and methods, then improve the teaching.	The job of LPG leader

<p>R24: 这种讨论是有规定时间频率的吗?</p> <p>GAO24: 没有, 我们就是不定时的, 比如平时批改练习的时候, 就发现, 诶, 学生有一通病, 一个共同的问题, 那大家就广而告之, 那么你们班有没有这样的情况啊, 或者你们班有没有别的现象或者别的问题发生? 所以我们, 我们的备课是有固定时间的, 每周二下午都是的, 但是呢我们不是拘于这个固定时间, 平时发现问题就会去解决它, 不会把问题留到周二。留到周二的话, 等解决了, 时间也就过掉了, 其实让一个年级组的同一学科的老师们放在一个办公室工作的目的就在此, 大家能够及时的进行沟通, 对吧。</p>	<p>R24: Is there any regular time for doing such discussion?</p> <p>GAO24: No, we do not have. We do it whenever we need. For example, when marking the 练习(liàn xí) (exercises), we find, ah, a common 问题(wèn tí) (problems) among the students, then we will share it among the teachers, ask them does this happen in your class or is there any similar phenomenon, etc. So we have regular time for lesson preparation, Tuesday afternoon, but not only this, we also do it in our daily teaching, we will fix it right now when we meet the 问题(wèn tí) (problems), but not keeping the 问题(wèn tí) (problems) until Tuesday. So that is also the reason why we keep the teachers in the same Grade in a common office, we can communicate in time.</p>	<p>Collective work in LPG</p>
<p>R25: 那么周二下午的活动是什么?</p> <p>GAO25: 每周二下午, 我们有教研组活动, 一个月一次, 然后我们每两周, 区里有一个教研活动, 就是区里有一节听课, 上个星期他们布置的是网上教研, 区里的活动也有, 函授的, 就是人要到位的。就是组织听课, 对吧, 然后进行评课或者是经验交流, 然后也会进行一个网上教研, 就是今天比如我们今天应该去听课的, 面对面的, 进别的学校别人的课堂, 听完之后, 因为人很多, 不可能每个老师都发表意见, 所以会进行网上教研, 大家就这个问</p>	<p>R25: Then about the Tuesday afternoon?</p> <p>Gao25: Each Tuesday afternoon, we have 教研组活动(jiào yán zǔ huó dòng) (Teching Research Group activities), one time per month. And we have a 教研活动(jiào yán huó dòng) (Teaching Research activities) in district each two weeks. It was a 听课(tīng kè) (lesson observation), last week was the 网上教研(wǎng shàng jiào yán) (online teaching research), which means organizing us do 听课(tīng kè) (lesson observation), right? Then 评课(píng kè) (lesson evaluation) and 经验交流(jīng yàn jiāo liú) (experience exchange), then there will also be a 网上教研(wǎng shàng jiào yán) (online teaching research). For example, actually today we should attend a 听课(tīng kè) (lesson observation), face to face, to other schools and other's classroom, then after</p>	<p>Collective work in TRG</p>

题去进行讨论，说说自己的看法。	we observe it, there are two many people, so it is impossible to let each teacher talk, so we can do 网上教研(wǎng shàng jiào yán) (online teaching research), then we can discuss the 问题(wèn tí) (issue), and talk some of our own ideas.	
R26: 每个人都发言? GAO26: 对的, 我们每个人都有ID号码, 可以发言探讨, 他们要求的, 所以这个是网上教研。	R26: Everyone needs to talk? GAO26: Yes, each teacher has his own ID, it is requested that each one should give some comments, so this is网上教研(wǎng shàng jiào yán) (online teaching research).	
R27: 这个教研活动是所有老师必须要参加的吗? GAO27: 对的, 针对全区每个老师的。像我们上周是网上教研, 这个星期就是直接现场听课, 因为网上教研不占用时间, 但是外出听课要占用时间, 你还要自己利用交通工具去, 所以每个星期二下午, 我们数学课都不会安排的。我们学校每个学科都这样的, 每个学科每周都会有空下来半天处理这些。	R27: Do the TRG activities open for all the teachers? GAO27: Yes, each teacher who works in our district. Like last week it was网上教研(wǎng shàng jiào yán) (online teaching research), then this week we should 现场听课(xiàn chǎng tīng kè) (on spot lesson observation). Because 网上教研(wǎng shàng jiào yán) (online teaching research) does not cost time, but going out 听课(tīng kè) (lesson observation) takes time, you have to take the vehicle to go and back, so every Tuesday afternoon, for the math teachers, we do not have any lesson. Each discipline is like this, each discipline has such half a day each week to arrange these.	Regulations and works for teachers in TRG activities
R28: 那除了刚刚了解到的您在学校用到的这些实体资源, 您有没有用网络资源? GAO28: 也有的。我关注近两年的中考分析, 现在上网比较少了, 我用微信比较多, 微信上现在也有初中数学的微信平台, 我用的是两个, 基本上常用的就是两个微信平台。	R28: Besides these resources you mentioned, do you have any online resources? GAO28: Yes, also some. Like the analysis of 中考(zhōng kǎo) (high school entrance exam). Now I seldom surf the网(wǎng) (Internet), I use more 微信(wēi xìn) (Wechat). Now there is also the 微信平台(wēi xìn píng tái) (Wechat platform) about middle school mathematics. I often use two微信平台(wēi xìn píng tái) (Wechat platform)	Online resources: Wechat, office from laptop to cellphone
R29: 您说的是公众号?	R29: Do you mean by the official	Wechat

<p>GAO29: 对的, 公众号, 他们有推送文章, 还有课程, 比如新区的公开课, 他们也会放在上面。</p>	<p>accounts?</p> <p>GAO: Yes. 公众号(gōng zhòng hào) (official account). They often put forward some 文章(wén zhāng) (articles) and 课程(kè chéng) (courses), such as the 公开课(gōng kāi kè) (open lesson) of our district, they will put them on it.</p>	<p>presentation</p>
<p>R30: 面向上海的还是全国的?</p> <p>GAO30: 额.....我加入的是一个浦东新区的, 是一个区级的。张江集团有一个老师叫王哲, 他其实是, 他跟市教研员是有关联的, 他除了推送一些课程, 也会推送一些教研员研究的比较前沿的课题内容, 对, 我就是看一下, 每天他都会推送, 不定时的推送一些东西。不过这个主要是针对上海教材的。然后, 我也会关心一下, 一些比较好的, 外面的一些教育机构的那些微信平台, 比如学而思啊之类的, 也可以去看一下, 关心一下。</p>	<p>R30: Is only for Shanghai, or throughout the country?</p> <p>GAO30: The one I join is in Pudong district, it is district-level. In our education group, there is a teacher called Wang, he actually, he has some links with the city-level 教研员 (jiào yán yuán) (Teaching Research Officers), so besides the 课程(kè chéng) (courses), he also shares something about the lately 课题(kè tí) (research project) by 教研员(jiào yán yuán) (Teaching Research Officers), , yes, I read and learn it, he sends everyday. But they are more about the Shanghai教材 (jiào cái) (textbook). Then, I also follow some微信平台(wēi xìn píng tái) (Wechat platform) of the good 教育机构(jiào yù jī gòu) (education agencies) outside the school. Like 学而思(xué ér sī)³, it is ok to go to see and learn.</p>	<p>Wechat presentation and other apps on Gao's cellphone</p>
<p>R31: 有没有其他的网站?</p> <p>GAO31: 网站嘛, 有一个上海, 上海有一个上海中考网, 他有中考, 一模二模的试题试卷, 试卷分析, 然后还有一个各个年级期中期末的试卷。所以即便现在教7年级, 我也会关注一下, 对, 因为他们上面也有这个年级的考试试卷, 尤其是别的区的, 外区的一些动态, 因为我</p>	<p>R31: Any websites?</p> <p>GAO31: Websites, there is a Shanghai, 上海中考网(Shanghai Zhōng Kǎo Wǎng) (website for Shang hai high school entrance exam)⁴, they have the 试题(shì tí)(exam questions)试卷(shì juàn)(exam paper) of 模一(mó yī)(first practice exam) and 模二(mó èr)(second practice exam) for 中考(zhōng kǎo) (high school entrance exam), then they also have试卷 (shì juàn) (exam paper) for 期中(qī zhōng)(mid-term exam)期末(qī mò)(final exam) for each grade, especially from</p>	<p>Websites used by Gao</p>

³ TAL Education: <http://brand.speiyou.com>.

⁴ <http://www.zhongkao.com>

们现在有很多都是教研员指导下的，对吧，那问题是每个区的 教研员 还不一样的， 中考 却是全市的呀，所以除了关心本区以外，还要关心一些外区的一些动态信息，因为中考最后出 卷子 的是整个上海市的嘛。	other districts, the 动态(dòng tài)(trends) of other districts. Because most of us are under the instruction of 教研员(jiào yán yuán) (Teaching Research Officers), right? Then the问题(wèn tí) (issue) cared by the教研员(jiào yán yuán) (Teaching Research Officers) are different, but the中考(zhōng kǎo) (high school entrance exam) is for the whole city, so besides caring our own district, (I) care also the 动态(dòng tài)(trends) and 信息(xìn xī)(information) from other districts, because the final 卷子(juàn zi)(exam paper) of is for the whole Shanghai.	
R32: 您有哪些可以和同行交流的机会? GAO32: 外出 听课 , 我们学校还组织过去外校, 外省市去 听课 , 对, 我们去苏州, 组织所有数学老师去 听课 , 我们学校也经常有外省市的老师来我们这里 听课 啊 交流学习 。我们下周就会有一个江西那边的学校要来一批老师 跟岗学习 。	R32: Do you have any other chance to work collectively with other colleagues? GAO32: 听课(tīng kè) (lesson observation) outside our school. Our school often organizes us to visit other provinces and cities and听课(tīng kè) (lesson observation). For example, our schools used to arrange all the math teachers go to Suzhou for听课(tīng kè) (lesson observation). Also, teachers from other provinces and cities will come to our school to听课(tīng kè) (lesson observation), 交流学习(jiāo liú xué xí) (exchange) Next week, there will be a team of teachers come from Jiāngxī Province, they come here for跟岗学习(gēn gǎng xué xí)(full time training) ⁵ .	Other chance to work with other teachers outside school
R33: 这个是常规活动吗还是什么合作? GAO33: 这个要看的, 我们跟华师大有一些合作, 跟他们的基础教育办公室, 有时候有合作的, 需要接待这些老师, 我们就会接下来。比如我这周四	R33: Is that a regular activity or some cooperation? ZHAI33: It depends. We have some cooperation with ECNU, and with their Basic Education Office, sometimes we have cooperation, we need to welcome some these teachers, so we will accept this (task). For example, I have an open lesson	Cooperations with research insitutes

⁵ It is a mode similar like internship, if the training period lasts one week, then the visiting teacher (or the to-be-trained teacher) will be arranged to follow a local teacher (generally an experienced one, as his/her mentor), all the mentor's school work during whole week (from the morning till afternoon), including observing the lessons, attending the meetings, etc.

就有一节公开课，兰州那边的一个老师要过来，也是安排了周四上一节课。这种培训我们有时候还是跟课题结合在一起的，一些教科研的课题，包括有时候老师们会外出培训也是有的。	this Thursday, and a teacher from Lanzhou Province also will come, and also have a lesson to give. Such training sometimes is linked to the projects, and also sometimes our teachers will attend the training outside.	
R34: 这个基础教育办公室是？ ZHAI34: 是浦东新区的教育局的	Q34: The Basic Education Office? ZHAI34: the Basic Education Office in Pudong district.	Disctric level insitutions
R35: 哦，我们学校也有一个基础教育办公室 ZHAI35: 对，我们跟华师大的基础教育办公室联系也挺频繁的，我们有一些项目，找导师也是通过华师大基础教育办公室找到的。你比如说郑，黄中敬等等，这些导师会带我们做课题研究。	R35: In ECNU, there is also a Basic Education Office. ZHAI35: Yes, we also contact very often with that in ECNU. Most of the time, our projects are based on the supervisor arranged by ECNU, such as Prof. Zheng. He leads us to do some projects researches.	Cooperation with univeristies
R36: 那么课题题目谁提出？ ZHAI36: 我们提的，然后我们找到他们带着我们做研究。	R36: Then who proposed the project? ZHAI36: Us, proposed by our school, and then we apply to them to lead us conduct this projects.	The source of the research projects
R37: 那么你们这种课题都是这些导师带的吗？有没有老师们自己做的？ ZHAI37: 就是，高校导师来指导，我们老师们自己来做的，大家一起做的，课题会被分散成子课题，每个人都有的，具体到课题组的。	R37: Do you always cooperate with universities? Is there any projects conducted only by teachers? ZHAI37: Like, with the instructions from the universities, but the teachers in our school will participate. We work together.	The supervisor of the research projects
R38: 有没有专门针对数学的？ ZHAI38: 数学的话，有的，有的，是夏敏他们，原来	R38:Is there any project only for mathematics? ZHAI38: Mathematics, yes, yes, by Teacher Xia, there used to be a group.	Research for mathematics

<p>有一个课题。</p> <p>GAO38: 那是他们下一个备课组的内容, 我们没有参与。</p>	<p>GAO38: that was in another备课组(bèi kè zǔ) Lesson Preparation Group (LPG), we did not attend.</p>	
<p>R39: 几年级? 6年级?</p> <p>GAO39: 当时他们是初三, 不, 是初二, 建立课题的时候那年是初二, 对吧?</p> <p>ZHAI39: 哦你说那个, 对, 就是13年的时候, 跟郑太年他们做的, 基于学习科学的, 是他们一个子课题。一般一个课题到我们学校的时候, 具体到每个老师, 那切入点就可能不一样, 会小一点, 然后根据自己的学科联系起来, 数学有数学学科的, 语文有语文学科的, 那么自己就会有自己的子课题。</p>	<p>R39: Do you mean the Grade 6 (because downstairs there is the Grade 6 office)?</p> <p>GAO39: It was in grade 9, no, in grade 8, they built the 课题 (kè tí)(research project) right?</p> <p>ZHAI39: That one you told, yes, it was 2013, with Prof. Zheng, it was based on Learning Science. Mathematics should be one of the sub-projects of that project. Because the project opens to all the disciplines, so for mathematics, we will find an entry point.</p>	<p>One research project example</p>
<p>R40: 那负责人呢?</p> <p>GAO40: 这个不同的, 有的是备课组长, 像我们有时候探讨的不是学科类的, 那么我们做的就是那个, 基于, 关于学习困难生的一个调查和跟踪。我们这个是全科的, 不单单是数学, 是各个学科的。我们是整个年级组的。我主要负责德育这一块, 从德育的角度来指导学生, 从思想上提高学生的学习认识, 其实很多学习困难并非是智力问题, 对吧, 其实还是一个学习态度问题, 还有一个家庭教育的问题, 因为我们大多数老师, 大多数数学老师, 都是班主任, 所以从别的角度看, 不光光是数学角</p>	<p>R40: Then who will in charge of this?</p> <p>GAO40: It depends. It can be the 备课组长(bèi kè zǔ zhǎng)(leader of LPG). Like what we discuss is not about subject, we do that, based, about, learning difficulties of the students. Ours is crossing subjects, not for mathematics, it is for all the disciplines, open to the students have learning problems in the whole grade. I am in charge of Moral Education, which means to help the students from a point of moral education, improve their recognition. Actually many learning difficulties are not the problem of intelligence, but the learning attitudes and the family education. Most of us mathematics teachers are also work as head teachers, so we cannot only focus on the discipline teaching in classroom, but also other aspects. Learning attitude, family education, parents' self-identity,</p>	<p>Gao's experiences in doing research projects</p>

度，还有学习态度，家庭教育，家长的认同等等，其实各方面都对学生的影响很大。所以课堂上讲的再好，课后家长不配合，课余时间学生不认真学的话，这就是形同虚设了，对吧。	etc. can all influence students. So even you teach very well in class, but the parents never cooperate and the students never learn after class, which will be useless, right?	
R41: 那您怎么想到这个课题的? GAO41: 其实是我自己在做我们年级的工作，然后翟老师觉得这个可以提炼一下申请课题。	R41: Where did you get this project? GAO41: We find it during our teaching. Actually I was doing my job, but Madame Zhai thought what we were doing can be generated into a project. So we have a name of the project, and we continue working on this.	How does Gao generate this project
R42: 那参与人员呢? GAO42: 基本上我们是要求整个年级组的老师都参与，这是一个团队活动。这不是老师的兴趣问题，培养学生是我们每个老师的职责，对吧，这是每个老师都要去面对的一个问题，所以遇到不同的问题，会有最后一个问题的积累。	R42: Then who will participate this project? GAO42: Basically, we asked all the teachers participate in the projects, this is a collective activity. Not by interests, because cultivating the students is not an interest, but our job, right? This is a problem that every teacher needs to face, so (we) will meet different problems, and then in the end (we) will have some accumulation of problems.	The sense of responsibility
R43: 什么时候开始的？还在进行中吗？ GAO43a: 对，从去年，预备年级（6年级）就开始了。 ZHAI43: 我们进行到后来的时候，发现这个还是挺有意义的，所以今年上半年(2015年11月)我们又跟华师大做了一个课题申报，作为华师大附属学校的课题，所以后面我们可能还要申请以为导师来指导我们。所以呢，导师现	R43: So, this project has been in processing? When did it start? GAO43a: Yes, since last year (2014), the grade 6. ZHAI43: Afterward, we found it is quite valuable, so we applied to ECNU in the first half-year (2015) as a project of ECNU affiliated school. So later we will probably invite Prof. Zheng Tainian instruct us. But the issue of the supervisor is not determined, our research does not stop. Our research mainly based on practice. The theoretical things we still need the experts' suggestions.	What Gao thinks she can help in the research project

<p>在还没有到位，但是我们的研究没有停止。</p> <p>GAO43b: 我们的研究主要是基于实践，对吧。理论方面的提升还是要靠专家的（笑）。</p>	<p>GAO43b: Our research is mainly based on our practice, right? The theoretical aspects we need the experts (laugh)</p>	
<p>R44: 那您平时怎么进行研究？</p> <p>GAO44: 啊，我们呢，主要就是通过学生的案例，学生案例的一个具体分析，我们要提升到理论的话，也没有太多时间，关键是我们每天都在接触学生，案例的积累，方式方法的一个运用。这其实是我们经常可以做到的。</p>	<p>R44: How did you do research generally?</p> <p>GAO44: Ah, we, mainly from the students' cases, a specific analysis on students' cases, we do not have time to improve into a theoretical level. The key points are that we contacted the students, everyday, accumulating the cases, applying the methods and solutions. These are what we can do often.</p>	<p>How does Gao carry out the ideas of the research projects?</p>
<p>R45: 老师们会做针对课题的讨论吗？</p> <p>GAO45: 会的，案例吗，每个学生情况不一样，所以大家在群里会交流一些问题的。</p>	<p>R45: Will the teachers discuss about the projects?</p> <p>GAO45: Yes, case right? Every student has different condition, so we will communicate in the group chatting.</p>	<p>Collective discussion for research project</p>
<p>R46: 您的学校怎么申请课题？</p> <p>ZHAI46: 其实我们渠道很多的，有区级的课题，跟区里申报能立项的话就是区级课题，然后还有市级的，比如说我们有一个市级的德育课题，就是跟上海市的某一个德育机构进行合作的，然后华师大这边呢，其实我们这个课题是一个申报一个合作，是一个合作，我们申报上去呢，如果华师大觉得这个课题可行，就会派导师跟我们接头，指导我们开展课题，这样子的。所以是不一样的，除了这个以外，除了区级课题，市级课题</p>	<p>R46: How do you apply the projects?</p> <p>ZHAI46: We have several options, the district-level projects, if the district approved the application, it will become a district-level project, and then we have the city level. For example, in our city there is a project about moral education, calling for some cooperation with a moral education institution, then the side of ECNU, actually our project is a cooperation project, it is a cooperation, we apply it, then if ECNU feels it is ok, they will send a supervisor to instruct us doing the research project, like this. So it is different, except this, except the district-level project, and city-level project, there are also some from the teachers, and they are basically the</p>	<p>The process of applying and doing research projects</p>

以外呢，还有老师自己去申报课题的也是有的，这个基本上就是区级课题。	district-level project.	
R47: 那么现在这个德育项目是？ ZHAI47: 这个是跟华师大合作的课题。	R47: What is the current moral education project? ZHAI47: it is cooperated with ECNU.	The details about the projects
R48: 课题数量是上面的规定吗？每年要进行多少课题？ ZHAI48: 没有，没有规定，但是每年年终考核的时候，课题进行的情况会作为一个考核项目的，所以虽然不是硬性规定，但是你的话，肯定是好的。这是考核学校的一个指标，基本上每个学校都会有课题，有开题结题这些流程。	R48: The number of the project is limited by your upper class? How many projects you need to do? ZHAI48: No, no obligation, but each year, there is a evaluation for the school, and the project will be considered as a factor, so even it is not compulsory, but if you have, it is absolutely good. This is a factor to evaluate the school, so basically each school will have some projects, with the formal procedures like open the project and final reports.	The research projects and the teacher/school evaluation
R49: 能不能介绍一下您的办公室？ GAO49: 我们属于是班级授课制，我们是标准的班级授课制，国外的很多可能是走班制，他们有固定教室，我们没有，我们有固定的班级，我们学生就在这，不用走班。这些书架上，都是书，学生的资料，试卷啊之类的，教具，都是跟教学有关的，这个 橱子 里的东西是我们自己的，我们每个学年都要搬家的，每个年级一个楼层嘛，等学生搬了，我们也搬到那层的办公室去。我自己的 橱子 里方放我的一些 教材 ， 笔记本 ，像是 听课笔记 ， 会议笔记 啊之类的，学生的 作业 资料啊，工作手册，学生的 成绩 资	R49: Could you present your office? GAO49: We use the Class-based teaching system; we are using the standard class-based teaching system. In the foreign schools, they may use optional-class system, they have fixed discipline classroom, and we do not. We have fixed class, for our students, they do not need to move. On these 书架(shū jià)(bookshelves), they are all 书(shū)(books), 学生资料(xué shēng zī liào)(documents of the students), 试卷(shì juàn)(exam paper), and 教具(jiào jù)(teaching instruments), all related to teaching. The things in this 橱子(chú zi)(cabinet) are ours; we need to move our office each year. Each grade will use one floor, so when the students move, we move also to the office in their floor. My own 橱子(chú zi)(cabinet), I put some 教材(jiào cái)(textbook), my 笔记本(bǐ jì běn)(notebooks), like 听课(tīng kè bǐ	Gao's resources inside her office: her books, her laptop etc.

<p>料之类的，还有以前的试卷，还有一些自己的私人物品。我的这些东西都比较齐全，学校配的笔记本，原则上不让带回家，我很多东西需要用的时候都是放网盘上，不需要带回家的。还有一些这个名著，因为班主任工作需要关心学生其他的学科学习，所以我也有一些名著，专门让学生来读的，学生家长都会捐一些，放在我这里。</p>	<p>jì)(notebook for lesson observation), 会议笔记(tīng kè bǐ jì)(notebook for meetings) students' 作业 (zuò yè) (homework)资料 (zī liào) (documents), my 工作手册(gōng zuò shǒu cè)(work book), 学生成绩(xué shēng chéng jì) (student's exam results), and some previous 试卷(shì juàn) (exam paper), and some of my personal stuffs. My things are quite ready. The 笔记本电脑(bǐ jì běn diàn nǎo)(laptop) sent by the school, I couldn't take it back home with me, So I put things on the 网盘(wǎng pán)(cloud disk), no need to take it back home. And some other 名著 (míng zhù)(masterworks), as a head teacher, I have to care students' learning in other disciplines, so I have some books prepared for students, sometimes the parents will donate some and they will put them in my place.</p>	
<p>R50: 这些教具（三角尺）会用吗？我看落灰了。</p> <p>GAO50: 教具上几何课一定会用的。</p>	<p>R50: Will you use these teaching instruments (set square)? I can see the dust.</p> <p>GAO50: Surely I will use 教具(jiào jù)(teaching instruments) when teaching geometry.</p>	<p>Gao's teaching instruments</p>
<p>R51: 上代数和几何课资源选择上会区别对待吗？</p> <p>GAO51: 其实我们以前的课程，很多年以前是把这两个合在一起的，那现在为了让学生思路清晰，就把代数和几何分开了，这是一个过程，再以前还有代数老师和几何老师的，现在又合在一起了，所以分久必合，合久必分，这其实就是教学的过程。我们是按照教科书的安排顺序来进行的，这学期在讲代数，因式分解，然后讲分式，后面就开始要涉及几何了，我们课本上有几</p>	<p>R51: Will you use different resources when teaching algebra and geometry?</p> <p>GAO51: Actually long time ago, we put them together. Now for students' better understanding, we separated the algebra and geometry, this is a process, long time ago, there were teacher for algebra, and teacher for geometry, now we put them together, so it is "long period of division, together for a long time to divide", this is a process of teaching. We teach along with the textbook, this semester we teach algebra, then the factorization, then fraction, then the geometry, we have some content about geometry on the textbook.</p>	<p>Gao's different treatment in teaching algebra and geometry</p>

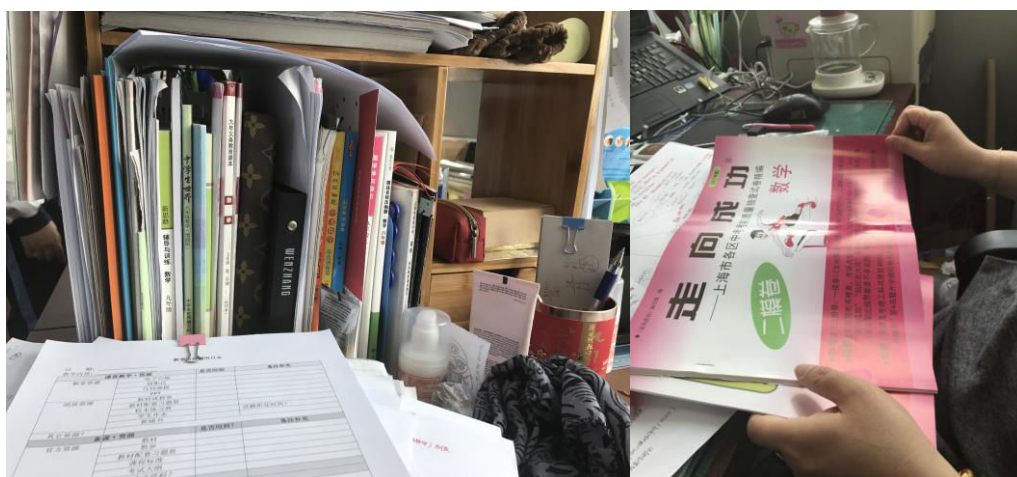
何内容,后面就开始讲了。		
<p>R52: 您教学进度是根据教材的顺序来的?</p> <p>GAO52: 对的,按照教材来的,因为教材是一个体系,对吧,编教材嘛肯定要有体系的,先讲什么,后讲什么,他是,她不是说单讲一个方程的知识系统,而是说方程讲到一定程度之后,和它相关的东西都呈现出来,所以我们现在的教材是螺旋式上升的,不是直线的,对吧。</p>	<p>R52: So you teach along with the textbook?</p> <p>GAO52: Yes, along with the requirements on the 教材(jiào cái) (textbook), because it is a system, right? Writing the 教材(jiào cái) (textbook), there should be a system, teach what firstly and secondly, it is, it is not like teaching function only as a system, but, after teaching it to some extent, you need to present the related knowledge, so our 教材 (jiào cái) (textbook) now is teaching in a upper circle, not a straight, right?</p>	Gao's teaching schedule and the textbooks
<p>R53: 您能描述一下您的日常工作吗?</p> <p>GAO53: 7点左右进学校,然后进班级,看看学生情况,看看他们的作业,如果他们愿意,可以来我办公室面批,问问题。7点四十学生早自修,他们学语文或者英语,没有数学,所以这个时间我就开始批作业,中午要看着学生吃饭的,因为在学校食堂吃,要带他们组织他们去。然后进教室12点10分左右到12点40,我们有午自修,老师们可以自己,都可以协商的,就是解决当天作业问题,改作业,比如今天语文作业有个问题需要跟全班同学讲一下,那么语文老师就去。12点40到下午4点,课表上的课程就结束了,4点到4点3刻,我们就是晚自修,晚自修之后,如果学生有特殊困难,我们会单独辅导,这样的话,有的老师就要5</p>	<p>R53: Could you describe your day?</p> <p>GAO53: I arrive at school around 7, then I go into the class, to see how are the students going, see their 作业(zuò yè) (homework), if they want, they can come to my office to ask 问题(wèn tí) (questions). At 7h40, they have a section of 早自修(zǎo zì xīu)(morning self-learning), for Chinese or English, not math, so I start 批作业(pī zuò yè) (marking homework) since then. I have to organize them to have lunch, because they eat at school, Then about 12h10 till 12h40, they have a section of 午自修(wǔ zì xīu)(noon self-learning session), the teachers will go in turn, mainly for solving the in the 作业问题(zuò yè wèn tí) homework problems, correcting homework. For example, today the Chinese teacher has some homework problems to explain to all the class, and then the Chinese teacher will go. From 12h40 to 4pm, the 课程(kè chéng) (courses) on the 课表(kè biǎo) (course schedule). From 4pm to 4h45, we have a 晚自修(wǎn zì xīu)(evening self-learning session) after this, if the students have</p>	Gao's daily work

点半才会离开学校。	some problems, we will give some 单独辅导 (dān dú fǔ dǎo)(individual instruction), so, some teacher needs to leave school at 17h30.	
<p>R54: 您一周上多少课?</p> <p>GAO54: 我们一周12节课,一天2节,星期三叠课。一般老师是7点40到16点15,这是正常老师的上班时间。我基本上会保证自己在我两个班至少有一个午自修或者晚自修的时间,帮解决一些作业问题,否则没有时间去解决的呀。</p>	<p>R54: How many lessons do you have?</p> <p>GAO54: We have 12 lessons each week, 2 lesson for each day, and 叠课(dié kè)(two continuous lessons given together) on Wednesday. So from 7h40 to 16h15, it is the normal working hours for the teacher. I will try to use at least one午自修(wǔzì xīu)(noon self-learning session) or one 晚自修(wǎn zì xīu)(evening self-learning session) for each of my two classes, to help them in solving the 作业问题(zuò yè wèn tí) homework problem, otherwise I have no time.</p>	Gao's usage of time spent with students: all for their homework, introduce 叠课 (dié kè)(two continuous lessons given together)
<p>R55: 您作业批改花多少时间?</p> <p>GAO55: 我会比较快,1节课到1小时吧,我的速度比较快,1节课我基本可以把两个班的作业批改完,就是第一轮批改,但是纠正和订正的时间会比较长,对的,面批,那就是是一整天的时间,我教60几个学生,全部过关的话,需要一整天的时间的。</p>	<p>R55: How much time do you spend in marking students' homework?</p> <p>GAO55: I do it fast, one lesson (45 minutes) to one hour, I do it fast, one lesson I can basically marking the two classes' homework, this is the first round. But for the modification it costs more time, that is a whole day, I have more than 60 students, it will cost me a whole day to let everyone pass.</p>	
<p>R56: 您今天上完公开课,后面还有什么工作要做吗?</p> <p>GAO56: 这个,正常流程,我上完课之后会有一个讨论的,但是今天因为时间关系,讨论应该会放到下周二的教研组活动里了,但是我们私下里也经常沟通的,听完课聊一聊。然后我需要记录一下别的老师提的有意思的建议,然后写一份总结,书面的,</p>	<p>R56: What will you do after the open lesson?</p> <p>GAO56: This, according to the normal procedure, there should be a discussion after my lesson. But since the time today is quite limited, the discussion should be done during the教研组活动(jiào yán zǔ huó dòng) (Teching Research Group activities) next Tuesday. But we often communicate in private, talk after the lesson. Then I have to write down the suggestions from other teachers, and quite a 总结(zǒng jié)(summary report), in</p>	The regulation after open lesson: writing reflective reports

要交给学校的。每堂公开课老师都要写 反思 的。	paper, and submit it to the school. Each teacher who gave the open lesson needs to do this 反思(fǎn sī)(reflection report)	
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1.2 Second interview with Gao in April 2017

The second interview was conducted in Gao's office (Picture 1.2), in 28th April 2017, when she was teaching grade 8. This interview was a more in-depth interview for the questions in the first interview. The interview was conducted in Gao's office, when she was teaching two classes in grade 8. The interview was recorded in audio format, and then transcribed in Chinese (on the left column), and translated into English (on the middle column). The important answers from Gao to be cited in the thesis writing are highlighted in yellow, and a third column of marks is prepared for explaining the important answers.



Picture 1.2. Second interview with Gao for her resource system

The interview was recorded in audio format with some photos when the teacher was pointing to some specific resources during the interview. The whole interview lasts for 30minutes. 70 questions were asked with interests on:

- (1) Her personal information (education background, working experiences and training experience);
- (2) Her comments on “expert” and “how to be an expert”, as well as the ideas on the institutional regulations, such as “title promotion” for evaluate teachers, collaborative projects;
- (3) Explanations on the specific resources for teaching including her personal ones and the shared ones, students’ resources and how she made complementation, how does she mentor other teachers (Liu and Yao) and her comments on them;
- (4) Explanation on online resources.

Among the 90 questions (70 for the IMRS and 20 for the R-IMRS), 25 answers were selected and kept in the following table. The following table contains three columns: selected transcriptions of the audio that to be used in the thesis (on the left, in Chinese), the English translation on the middle column, the important answers to be cited in the thesis are high highlighted in yellow, and a third column of marks is for explaining the selected answers. Important Chinese resource namings were translated into the format of “Chinese naming +

Chinese Pinyin pronunciation + English explaining”. A final summarization on these terms is generated into appendix 1.8.

1.2.1 Selected transcriptions, translation and marks

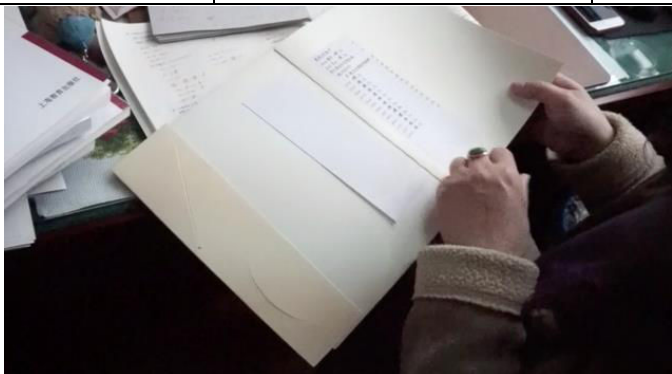
Selected transcriptions in Chinese	English translation	Marks
<p>R1: 您怎样看当前技术的发展对您教学的影响?</p> <p>GAO1: 技术嘛永远是辅助条件, 要看它在教学中是不是用的有效, 而且是能够为教育服务的, 而不是因为这门技术一定要用, 而是因为教学中需要它我才去用。对吧, 就像我们现在的白板技术, 理论上讲是方便, 但是更多实际过程中, 其实对学生的影响, 我就是觉得, 特别是作图方面就有点脱离学生的实际, 我们可以用图片, 可以用电脑上面的这些工具去简化作图的过程, 学生是一个模仿的过程对吧, 你不可能脱离这个实际, 所以我们学了白板, 也推广了白板, 我曾经上过一节专门的白板的课, 但是我真正上课, 用到这个技术的, 不多, 很少。</p>	<p>R12: What do you think about the influences from technology development on your teaching ?</p> <p>GAO12: Technology is always an assistant condition, it depends on whether it works in teaching or not, and it is not must to use it, I use it only when it is necessary in my teaching. Right ? Like the Electronic White Board, literally it is convinient, but in reality, especially for students, I think, especially in figure drawing, it is out of reality...</p>	<p>白板 (bái bǎn) (Electronic White Board)</p>
<p>R2: 这个白板的课程, 是谁来上的?</p> <p>GAO2: 一个是市级共享课里有, 然后教室里面不都是白板吗, 对吧, 所以, 而且公司也来教过我们, 因为装了嘛, 最好就是让老师也来用嘛, 但白板, 在运用上我觉得, 有点脱离实际, 因为它只能在教室里做, 在电脑上, 我们的版本和那个版本不太一样, 做出来的效果不一样, 所以仅仅是, 我觉得是为了用而用。</p>	<p>R2: who gave this lesson ?</p> <p>GAO2: In a city-level shared lesson project. In our school we also have, right ? Someone from the Whiteboard company also came to teach us how to use it....</p>	<p>市级共享课(shì jí gòng xiǎng kè)(city-level shared lesson)</p>
<p>R3: 那如果教几何的话, 您还是会觉得传统的黑板演示画图好</p>	<p>R3: About teaching geogebra, do you prefer</p>	<p>压轴题(yā zhóu tí)(final question in the exam⁶)</p>

⁶ The final question in the exam paper, often appears in mathematics and physics exams, with characteristics of high score, high difficulty and requires more comprehensive ability.

<p>吗？</p> <p>GAO3: 那要看，平时画图的话，我觉得还是自己手工画图，你能画出来，学生肯定能画出来，连你都画不出来，怎么要求学生去画呢？对吧，然后在初三讲压轴题的时候，因为学生已经具备了画图能力，为了提高上课的信息量，有的时候还有一个动态，让学生能够先了解，对吧，所以运用几何画板啊，相对来说可以提高课堂效率，但是最终，临考试之前的那种压轴题的讲解，我一般也不会用几何画板，因为学生过于依赖动画，那考试的时候哪来的动画啊，对吧，所有的动应该都在学生的手上，所以一定要让学生一进去懂这个，在做题的过程中感悟这些内容，而不是靠眼睛看到的这些东西。</p>	<p>the traditional blackboard or ?</p> <p>GAO : it depends, generally I draw it with hand, if you can draw it, then your students can, if you cannot, how could students be able to draw it ? Right ? In grade 9, when explaining the压轴题 (yā zhóu tí)(final question in the exam...for the classroom efficiency...I will use GeoGebra...but finally before the exam, I also do not use the GeoGebra, because that will make the students rely on it, then what they can rely in the exams, right ? The students have to do it by their hands...</p>	<p>几何画板(jǐ hé huà bǎn) (GeoGebra)</p> <p>课堂效率(kè táng xiào lǜ) (classroom efficiency)</p> <p>动手(dòng shǒu) (do it yourself)</p>
<p>R4: 那在代数上呢？</p> <p>GAO4: 代数上用的.....更少吧，只能是呈现了。就是一个电子黑板，我觉得就是一个电子黑板，快速呈现。但是我们现在要求学生记笔记的啊，你太快了学生的笔记跟不上，对吧，笔记是学习的根本啊，不仅仅是初中，到大学其实也要靠笔记。</p>	<p>R4 : What about algebra ?</p> <p>GAO4 : On algebra...less, only for presentation. It is just an e-blackboard, for fast presentation. But we ask the students to take notes, too fast the students can not catch up, right ? Notes are the basic of their learning, not only for middle school, but also in university studies.</p>	<p>电子黑板(diàn zǐ hēi bǎn) (e-blackboard)</p> <p>学生笔记</p>
<p>R5: 嗯</p> <p>GAO5: 你从小不养成的话，就靠拍照肯定不行的，拍照有依赖性的，很浅，一定要自己动手记，好记性不如赖笔头嘛，万一你在做题中出现问题，你好歹能在笔记上找到痕迹，记了你至少在脑子里有一遍印象，不管深还是浅，</p>	<p>R5 : Em</p> <p>GAO5 :You have to have this habit...Taking notes by your self.</p>	<p>学生笔记(xué shēng bǐ jì) (notes made by students)</p>

<p>对吧，至少有印象。所以我们从预备年级开始的时候就让学生记笔记了。</p>		
<p>R6: 他们会有错题本吗?</p> <p>GAO6: 嗯.....错题本, 我没有专门.....但是到期中期末的时候会有试题订正, 会有专门的本子让他们记一记, 平时错题就直接订正在原题上了。所以我们工作量非常大, 我们所有的本子都要订正的。因为我们学校的学生比较差, 所以有时候会要求他们一遍一遍的订正。</p>	<p>R6: Do they have the notes for mistakes ?</p> <p>GAO 6 : Em.. the notes for mistakes, I do not ask... but they have to make the notes for correcting the exam questions in the final or mid-term exams...</p>	<p>试题订正本 (shì tí dīng zhèng běn) (notebook for exam questions)</p> <p>错题 (cuò tí) (mistakes)</p>
<p>R7: 您用课程标准吗?</p> <p>GAO7: 我有, 有一个6年级到初三的一个课程标准, 但是我现在不知道放在哪去了。</p>	<p>R7: Do you use the curriculum standard ?</p> <p>GAO 7 : I have, I have one from grade 6 to grade 9, but I do not know where I put it.</p>	<p>课程标准 (kè chéng biāo zhǔn) (curriculum standard)</p>
<p>R8: 您平时会看吗?</p> <p>GAO8: 应该不会吧, 现在就不会看了, 因为从预备到初三已经滚过好几遍了。</p>	<p>R8 : Do you use it ?</p> <p>GAO8 : I suppose no, not now, because from grade 6 to grade8, I have taught for many times.</p>	
<p>R9: 那您比较喜欢的教辅资源有哪些?</p> <p>GAO9: 书的名字吗?</p> <p>R10: 对, 您可以指一下</p> <p>GAO10: 一个是这本辅导与训练。现在还用到这一本同步学典。因为它这上面有例题, 题目难度要稍微高一点。然后同步学典它还是比较基础。这种书的题目类型比较多, 然后现在还有一本, 这一本呢, 全册我也有, 就是六年级, 哦这是它。还有一本蓝色的, 蓝色的是每课一练, 这个是以单元为单位的分析。还有一本绿颜色的, 就是红蓝绿, 三本。(红色) 这个是每天的测试卷, 这个用的</p>	<p>R9: Which learning materials do you like?</p> <p>GAO9: Books' names you mean?</p> <p>R10: you can point them.</p> <p>GAO10: ...This contains examples, the difficulty is higher....This is more basic, there more exercise types...This blue one is for each lesson, this is for the whole chapter. This (red one) is for test papers I do not use it quite often. This (green one) is for improving...</p>	<p>辅导与训练 辅导与训练 (fǔ dǎo yǔ xùn liàn) (instructions and training)</p> <p>同步学典 (tóng bù xué diǎn) (synchronize learning)</p> <p>测试卷 (cè shì juàn) (test paper)</p>

不多。这个（绿色）是属于提高型的，这（蓝色）是属于每课一练型的，这（红色的）属于单元分析的。		
<p>R11: 您备课的时候会用到哪些东西？</p> <p>GAO11: 主要就是自己的经验咯（笑）。即便有再多的教辅材料也要有所选择，还要有自己的对这节课的一个理解。然后选择的，课堂上选择的题目基本上和例题相仿，因为我们是预习的，预习之后上课再讲同一个一模一样的题目，对学生来讲他就有枯燥乏味的感觉，所以在例题选择上只要符合书上的要求，要对学生那个预习有一点点的提升。就是不会用书上一模一样的例题。</p>	<p>R15: what do you use when preparing your lesson ?</p> <p>GAO15: mainly my own experiences (laughing). Even there are more learning aid materials, we have to have our own understanding... About the choice of examples, it needs to meet the requirements of the textbook, and improve what they students have learned in their pre-study.</p>	<p>Resources :</p> <p>经验 (jīng yàn) (experience)</p> <p>Related to schemes :</p> <p>Variation on the examples of the textbooks to avoid making the exmaples dull.</p>
<p>R12: 您现在网络资源用的多吗？</p> <p>GAO12: 现在用手机多啊。喏，现在微信上有很多与数学有关的一些公众号，里面有一些题目的要求，比如这个，它经常有一些个二模啊，同步课堂的一些信息，进行一些概括整理，我觉得也都是比较好。它介绍的一些数学的知识点，所以这些东西可以看一下，了解一下。这其实就是一个信息量的一个补充啊，对吧。平时有的时候自己不一定去看，即便看了书他有的时候也，书也毕竟有一定的局限性，比如书上很多讲什么就集中的讲什么，对不，这个内容就比较宽泛一点。</p>	<p>R16: Do you use online resources ?</p> <p>Gao16: Now more with cellphone. See, now there are many official accounts on WeChat about mathematics....it introduced some mathematics knowledge ...It is actually some complementary information...The books have limites, for exmaple, the books often explain only what they focus...</p>	<p>Related to resources :</p> <p>公众号</p> <p>手机(shǒu jī)(cellphone)</p> <p>微信(wēi xìn) (Wechat)</p> <p>Related to schemes :</p>
<p>R13: 您比较喜欢的是哪个公众号？</p> <p>GAO13: 这几个都是我比较关注的公众号，都是关于数学的，有一些好的文章信息之类的几个公众号之间都会分享的，比如你看这个，中考二模分析的，它正在</p>	<p>R17: which account do you like?</p> <p>GAO: ...This (is from) a teacher, I think he is teaching grade 6, you see what he shared are all for grade 6.</p>	<p>老师(lǎo shī)(teacher)</p>

<p>几个公众号里都发了。这个号发的中考一模二模比较多。然后这个老师我估计他在教 6 年级，你看他发的内容大多都是 6 年级的。</p>		
<p>R14: 还有视频的，是他自己的视频吗？</p> <p>GAO14: 有的时候是吧，他的视频是不出现人的，都是对着屏幕讲题目分析题目。</p>	<p>R18: Videos, are they from her own?</p> <p>GAO18: Sometimes, there is no people in his video, only cameras towards the screen and he is explaining and analyzing the exercises.</p>	<p>视频(shì pín)(video)</p>
<p>R15: 您在用这些 app 或者公众号的时候回跟网络上的人交流分享吗？</p> <p>GAO15: 不会。我就是看。其理论上讲，对我直观的收获并不多，我现在教 8 年级，那我关注的更多的是 8 年级的东西，再就是初三（9 年级）现在每年出来的一模二模试题我会关注一下，我想关注一下变化，所以没事我会拿来做一个。你看看，这个是二模卷，有些么，我会做一些适当的整理（找书本）。这里都是几何证明了，就是相思形比较多。然后二模的 23 题就是四边形为主，对，一般一模和二模卷子是不一样的，所以我就做了一些归纳，还有目录，你看。</p>	<p>R19: will you exchange with people online with these apps?</p> <p>GAO: No, I just read....</p> <p>Some of them, I will make some management (she took out her notbook)...</p> <p>Then the二十三题(èr shí sān tí) (final question in the exam is about similar figure....</p> <p>So you see, I make some category and conclusion, and the table, you see.</p>	<p>二十三题(èr shí sān tí) (final question in the exam⁷)</p> <p>目录(mù lù)(table)</p>
		

⁷ The final question in the exam paper, often appears in mathematics and physics exams, with characteristics of high score, high difficulty and requires more comprehensive ability

Picture GAO15 The table list of Gao's notebook

<p>R16: 您从哪里收集的?</p> <p>GAO16: 有的是做试卷, 有的是从手机上看到的, 有一些我觉得有价值的, 可借鉴的, 我就记下来, 你看这个就是, 宝山区的二模卷, 关于多种解法, 虽然吧有些解法有点绕, 但是觉得可以借鉴, 上课的时候可以适当的叙述一下给学生。然后这里, 这个假期我后面有一些整理, 是 14-16 年的一模卷, 这个假期就是, 有一模, 有二模, 18 题, 16 年的, 15 年, 14 年, 我整理了 3 年, 都是 18 题, 然后后面的整理我还没有结束, 我还在整理过程中, 那么有时间我就做一做, 其实同一道题, 经过几遍之后, 会发现, 有一些新的理解, 我第二次看的时候, 有时候会找到更简单的方法, 那我就会拿红笔做一个记录和补充。其实你看, 这样整理笔记也是很麻烦的, 这样一本本的试卷, 对吧, 有很多题目做完了觉得没什么意思, 没有保存的必要性, 但是按照自己的需要来, 把有价值的东西挑出来保存就比较好。像我这本试卷要是丢了就丢了, 但是我这个笔记不能丢的, 尤其初三的时候, 我到时候要翻一翻的, 特别是 18 题, 不管一模还是二模, 都是以图形的运动为主, 只不过涉及的当下内容不一样而已。我们是应试教育嘛, 要面对现实。我们总结一下, 会让学生学得轻松一点</p>	<p>R16: where do you get them?</p> <p>GAO16: some are from exam papers, some are from cellphone, I will keep down when I saw things valuable... I do it since 3 years, all about the 18th exercises (one exercise type in exam papers), it is not finished, I am still doing it, I do it whenever I have time, actually for one exercise, after I do it several times, I will find some new understanding, my second time when reading it, I will find an easier solution, then I marked my notes with red pen. So you see, it is very complex for managing the notes</p>	<p>Schemes related to accumulating resources and managing resources</p>
<p>R17: 您怎么理解资源或者说教学资源?</p> <p>GAO17: 资源就是一种信息吧, 哪怕是数学教材, 十几年几十年也没有什么大变, 变得只不过是一个程序, 对吧, 以前是一块为主, 讲方程一口气讲到底, 对吧,</p>	<p>R17: How do you understand resources?</p> <p>GAO: resource is a kind of information... Our mathematics textbook, during the last decades, did not change too much,</p>	

<p>讲什么，也是从头讲到底，一个内容全部讲完，现在就是讲螺旋式上升，讲一点留一点，讲一点留一点，但是不管怎么变，总的框架是不变的，但是资源的提升是题目本身应该有所发展。我们现在是题目灵活性越来越多，越来越.....靠我们自己去编，有的时候就缺乏严密性，对吧，我们其实自己能力不足的话，缺乏严密性，有的时候还是拿来主义比较好一点，进行借鉴，拿来一道题，现在看来改一个数据，有的题目没有变化，而有的题目，改一个数据的话，本质上改变很多的。</p>	<p>what had been changed is just the order and the blocks...anyway...the general framework did not change, but the improvement in resources locates in the development of exercises. Our exercises (and the exam questions) are more and more flexible, more and more...there is a lack of rigor if we design and develop the exercises by ourselves... our ability is not enough...so sometimes it is better to ‘take’, to borrow, take one exercise, change and adapt it.</p>	
<p>R18: 这个“拿”是指到哪里去拿？</p> <p>GAO18: 网络上，或者是这几年书店里出的课外书籍啊。我们是可以自己作为一个借鉴，不一定是推荐给学生，对吧。各个出版社，不同的人编的内容他对当下同样一个教材的内容，他会有不同的感悟，不同的那个视觉角度去处理，也是不一样的，对吧。</p>	<p>R18 : where to take ?</p> <p>GAO18 : online, or the extra-curricular books from the bookstore... Different publishing houses, different editors will have different understanding, and perspectives to process (the exercises)...</p>	<p>The verb “拿” (ná)(take)</p>
<p>R19: 您觉得这个教材编写的怎么样？</p> <p>GAO19: 书.....作为应试角度来说的话，65%到 70%，只能.....就是整本书全部会的话，全部撸一遍的话，就是最多是 70%，65%啦。更多的还是练习册上，各方面在这一块的提升。因为书上的知识点，它只是题目类型是一部分对吧，比如应用题，他就是呈现的是应用题的形式，那我们在试卷上，应用题还会，有选择题啊，填空题啊，从不同的形式去表达，或者和其他题相结合的这</p>	<p>R19: How do you think about the textbooks?</p> <p>GAO19: The textbook...seeing from the exam aspect, it only covers 65% to 70%, only...actually if the students learn and finish all the exercises in it, all of them, the maximum (of their score) is 70%, or 65%. More efforts should be on the exercises books. The exercise in textbooks</p>	

<p>种复合型的题目。学生看到的题目量少的话，他还是缺乏一个训练和理解，所以在题目选择上要，各个方面都要顾及到，涉及到。</p>	<p>covers only part of the exercise types, right? But in the exam papers, there are choice questions and filling-up topics and problem solving, in different formats, or even some composites of questions mixed several question types. The students need to practice more through more exercises, so in daily exercises selection, each types (of exercises) need to be considered</p>	
<p>R20: 介绍一下您这些书?</p> <p>GAO20: 你看到我桌子上的这些都是一部分，其他的我都带回家了，家里我有一套完整的，预备到初三的，8 本教材和教参，还有相应的参考书，一些教学资料，我是专门放好的，因为每年都要用的吗，每年都有更新，那么更新了，新的留下，旧的嘛我就扔掉了，但是其实数学的很多东西，旧的还是在的，因为数学，体系上大致没有什么大变化，以前的东西可以借鉴一下，就是以前的东西，稍微来讲，难度上要简单一些。</p>	<p>R20 : Could you introduce your books ?</p> <p>GAO20 : ...the rest are in my home, I have a complete set at home, from grade 6 to grade 9, eight textbooks with the teaching guidance books...Each year I have to update them, then new things will be kept, and old things I will throw them away...</p>	<p>Scheme in managing resource system (adding up and reducing things)</p>
<p>R21: 都是您自己的吗?</p> <p>GAO29: 这些是我自己买的，其实我所有的书都是我自己买的，哪怕是重复的，我也得自己买，我不喜欢图书馆借书，图书馆借的书就不能往上写，对吧，有的时候还是可以记一记，划一划，等下次想用的时候，可以拿出来翻一翻，你图书馆的要还的呀。</p>	<p>R21 : Are they yours ?</p> <p>GAO29 : ...I bought all the books by myself actually...I do not like to borrow books from library, because (I) cannot write on it....</p>	<p>Why she does not use the books in library.</p> <p>图书馆 (tú shū guǎn) (library)</p>

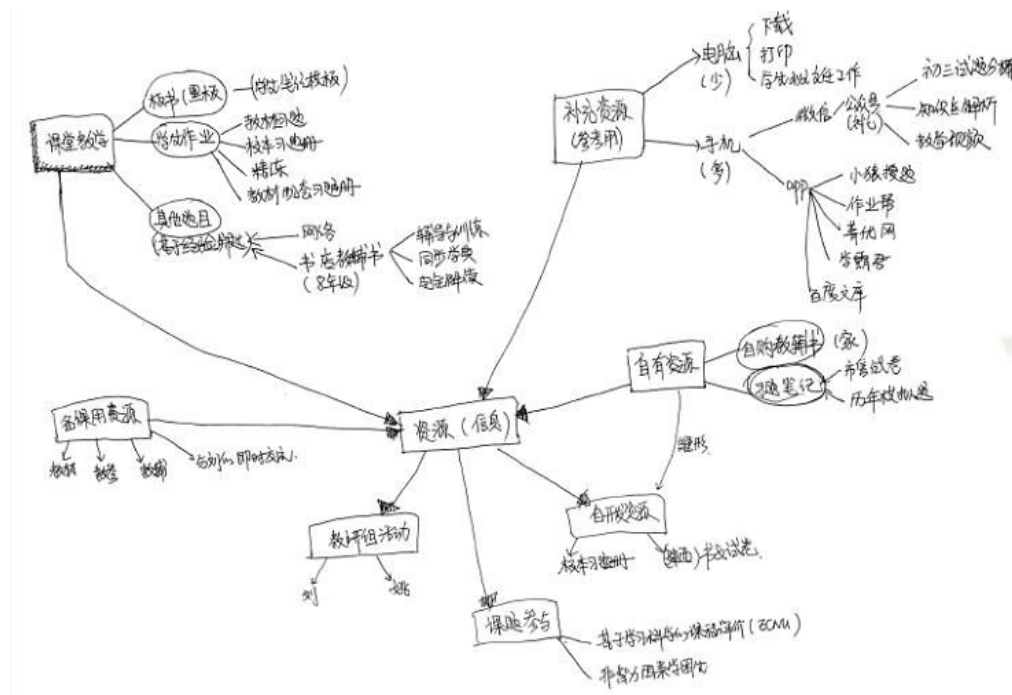
The following three questions were selected from the interview for Reflecting on her IMRS, which was conducted the second day, questions were only for her complementation. The interview lasts for 10 minutes, five explanations were selected from Gao's answer.

Chinese Transcriptions	English translation	Marks
<p>R22: 您觉得哪里需要改吗?</p> <p>GAO22: 公众号里面其实, 其实关注的是一个整体, 它因为不是课时内容, 它关注的其实是, 公众号的话, 你要根据别人发送的信息去吸收一些内容, 比如它讲的这种二模题的解题啊, 解题的这种规律, 这只能作为日常的一种积累。不一定能够直接用到我明天的课堂中, 但是肯定是对我的课堂教学是有帮助的, 它是潜移默化的一种作用, 不是直接的。</p>	<p>R22: Do you want to change anything?</p> <p>GAO22: The WeChat official account is actually for a whole, not the content for lessons. It is for, the official account, you have to obtain something from what others sent, such as the explanations on examples, for exams... This can only be taken as a daily accumulation. It is unnecessary to use it in my classroom teaching tomorrow, but it must be helpful for my lesson. It is a tacit help, not directly</p>	How WeChat official account helps Gao
<p>R23: 您以前编的那套题, 现在还能买到吗?</p> <p>GAO23: 没有了, 这种教辅寿命不长, 不是定期更新的话, 不是系列产品的话, 它寿命都不是很长。</p>	<p>R23: Your learning aid book, is it still available in the bookstore?</p> <p>GAO23: No, such learning aid materials, their lifetime is not long, is it is not updated regularly, or not a series product, its lifetime is not long.</p>	Knowledge about learning aid materials
<p>R24: 嗯</p> <p>GAO24: 因为像考试啊题目会有变化, 然后就是教材不是也产生一些变化吗, 对吧, 所以这种书不是非常……像这种教辅(手指)它们是系统型的, 它是不断的更新改善的, 略微有一些变化, 有的时候变化不是很大, 对吧, 所以, 那套书嘛是即时性的, 符合那个时候, 一段时间是可以根据它操作的。</p>	<p>R24: Em.</p> <p>GAO24: Because the exams the exam questions change. The textbooks also change, right? So this type of books is not very...like these learning aid materials, they are systematically updated and refined, with some small changes, sometimes it changes not so big, right? So, my book was just for that period, it can be used in a given period.</p>	Knowledge about learning aid materials
<p>R25: 然后是您的课题参与这块, 您可以详细说说吗?</p>	<p>R25: Could you say something about your project?</p>	Ideas about research project

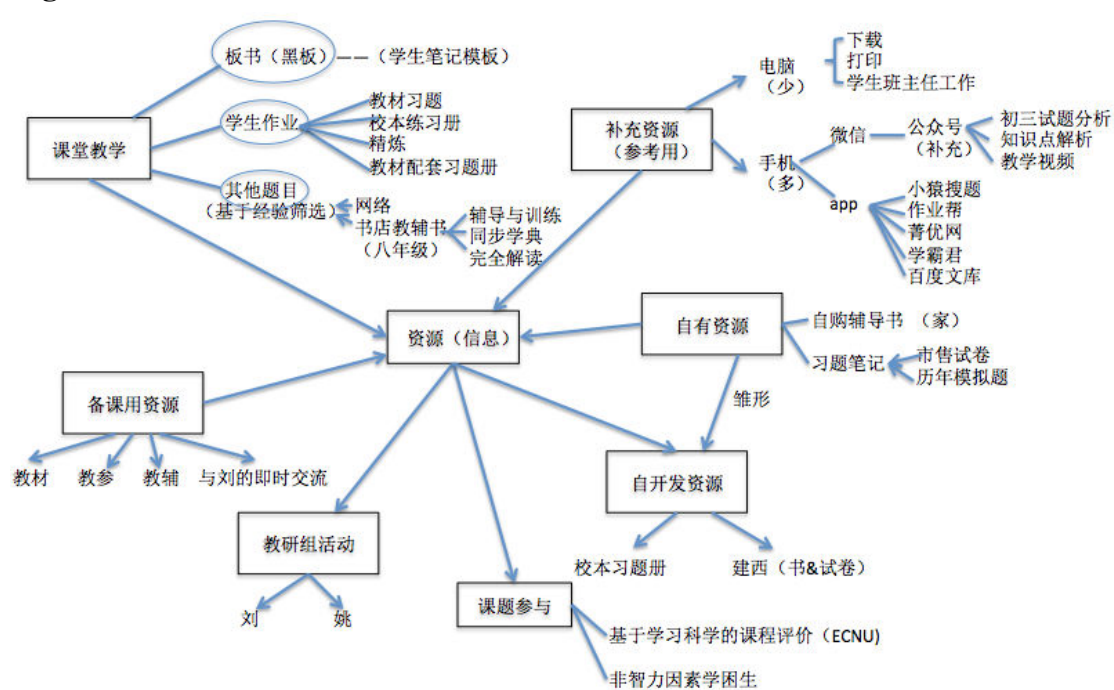
<p>GAO25: 这块，我觉得没什么好补充的了，我觉得现在做课题就是为了做课题，我觉得只是为了做课题而做课题，我觉得他们（研究者）都是在吸收资源，没有在产生结果，很多修复都是在我们自身自己，平时自己在日常教学生活中不断的进行改进。当我们觉得这方法不好，于是想个别的方法方式来看看能不能解决。只是我们不大擅长于书面的积累，但是方式肯定，一定是在不断的进化中的，在改进中的。比如学生的各种变化，学生产生的，比如不爱做作业啊之类的，不断的在修复，最终想要达到的目的就是能够让学生轻松的愿意进行一个学习。最主要的是这个，这个在论文中有没有体现，我不知道，因为我没有参与论文的书写，只是进行了这个项目的一个操作。</p>	<p>GAO25: ...I do the research only for the research, I think they (researchers) only take resources from us, not produce the results (for us), many problems we have to fix on our own, and improve comniously in our daily teaching....</p>	
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1.2.2 Inferred Mapping Resource System (IMRS) of GAO (April 2017)

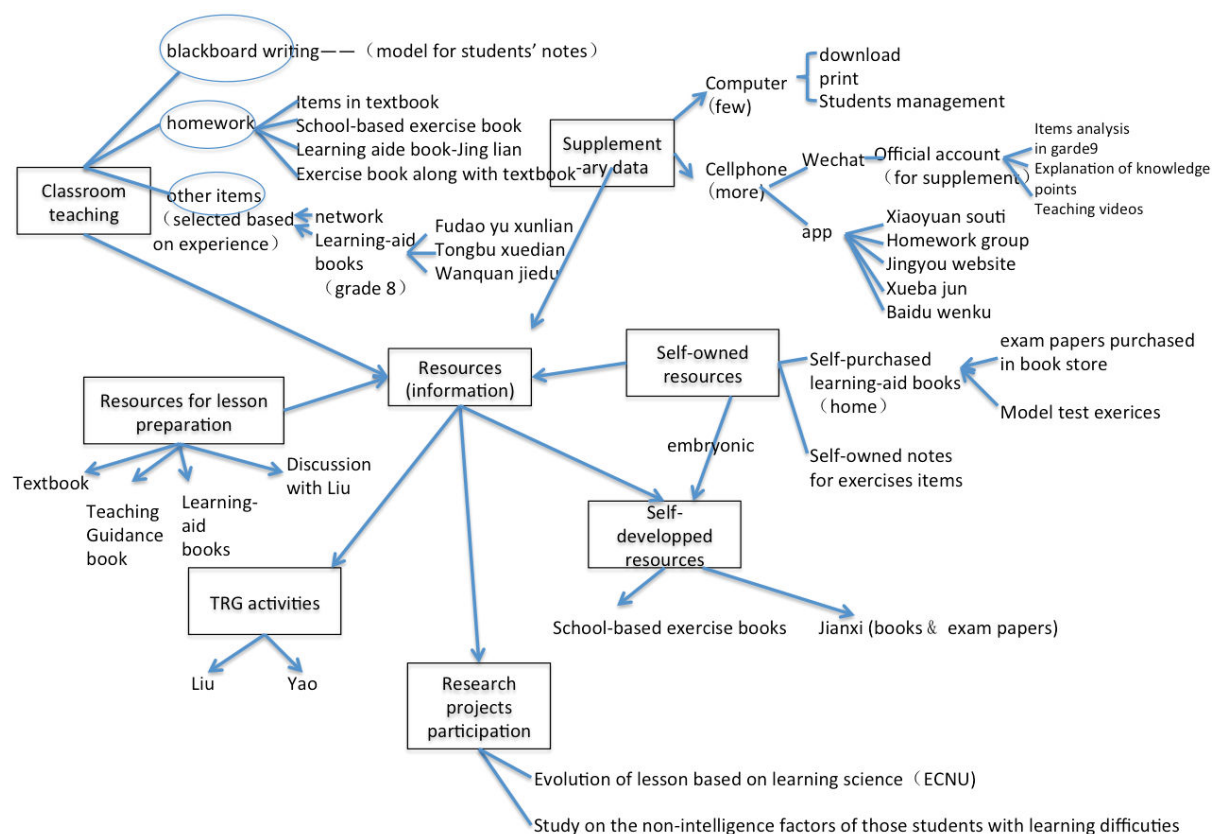
Chinese origin drawing



Digital refined version

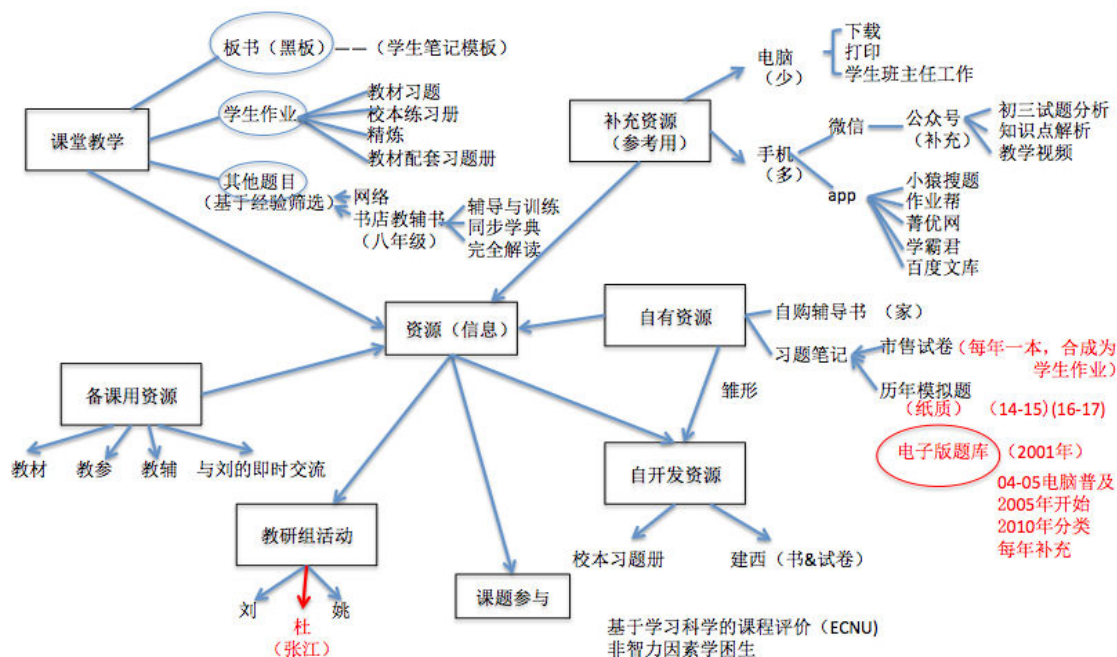


English translation

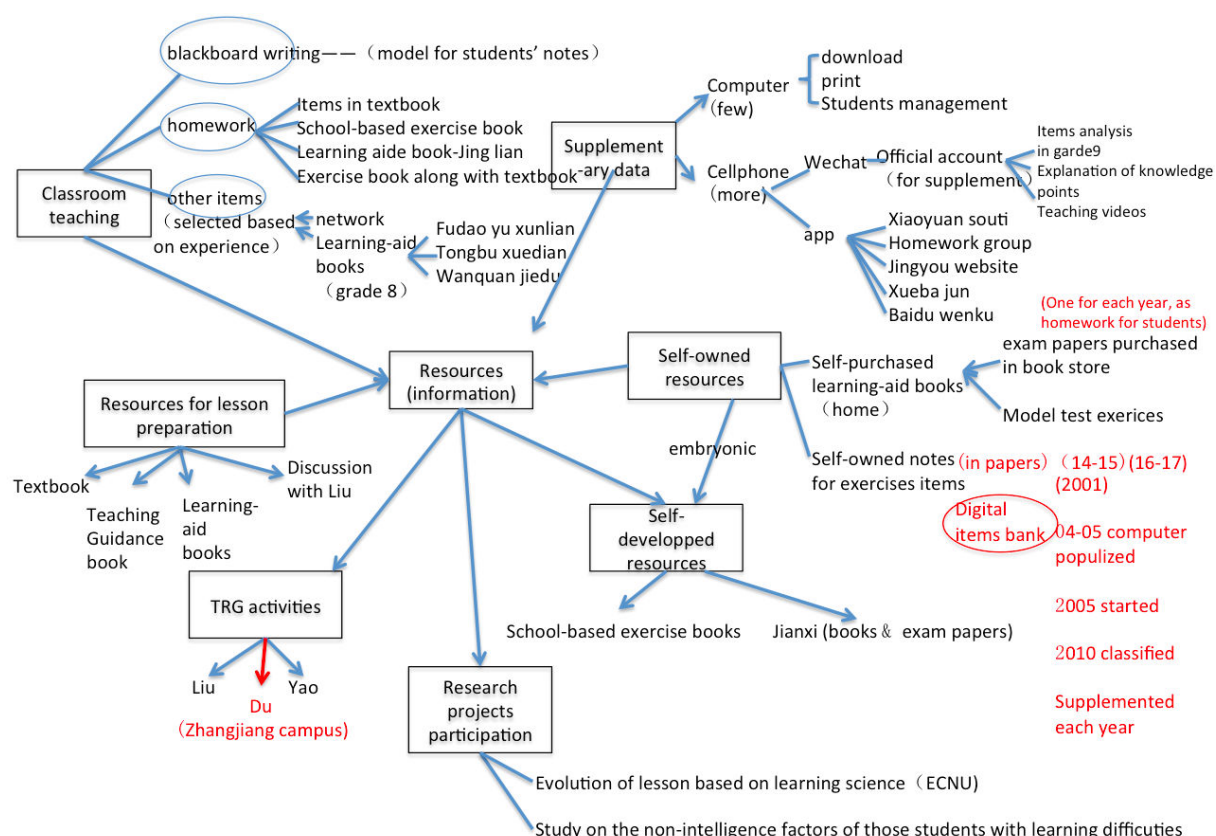


1.2.3 Reflective IMRS (R-IMRS) of GAO (April 2017)

Digital refined version



English translation



1.3 Third interview with Gao on October 2017

This interview was conducted six months after the second interview, November 2017, when Gao and Liu were teaching grade 9. The interview lasts 30 minutes, in their new office.

The interview questions (36 questions) are mainly for learning the changes of Gao's resources use, because she started to teach the graduated classes (the last year for preparing the students in their high school entrance exam). Three main topics were asked: (1) the changes of the resources during the past half year; (2) the new version of resource system and her category of resources; (3) the suggestions for the other teachers (especially for her apprentices) in resource working habits.

Among the 70 questions, 29 answers were selected and kept in the following table with three columns: the selected transcriptions in Chinese (on the left), the English translation (in the middle) and the marks (on the right).

1.3.1 Selected transcriptions, translation and marks

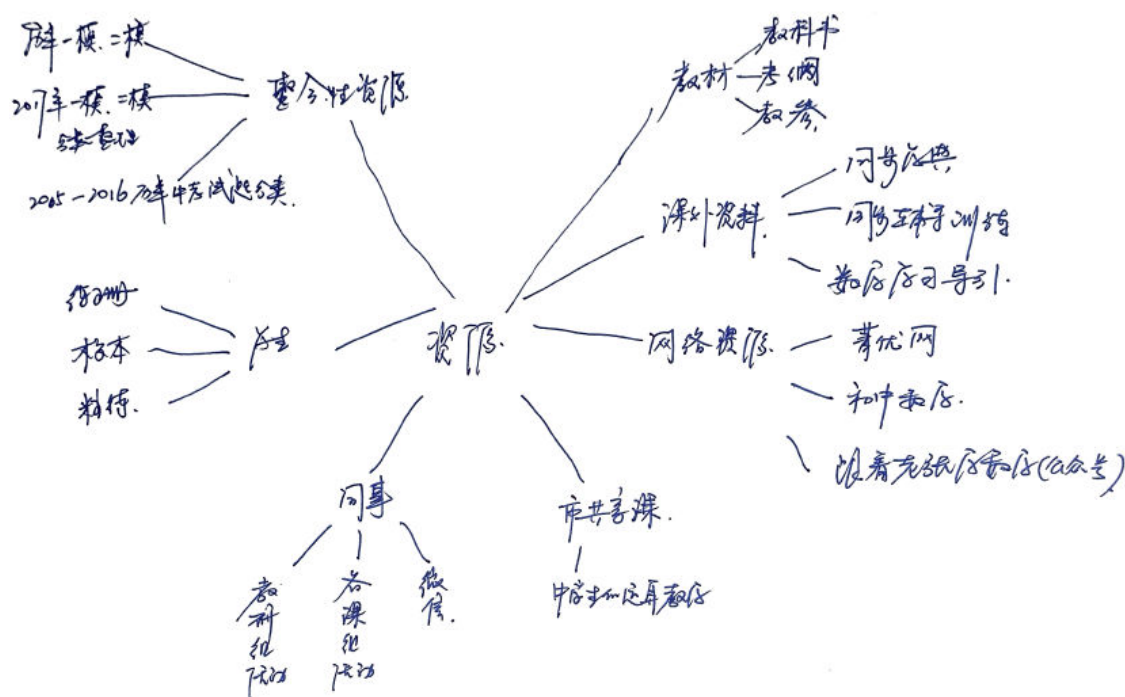
Selected transcriptions in Chinese		
R1:	我这次来想跟您了解一下您现在的资源工作情况。距离上次过了半年了，您现在在开始教9年级毕业班了，会不会在资源上有一些变动呢？	
GAO1:	应该.....基本上.....不会有，不会有太大的变动的。因为本身教育就是持续	

性的，不可能有很大的变化的，更何况（我）教了那么多年，都已经成了一种，基本一种固定的模式了，对吧，所以这种变化.....应该没有，基本上资源啊，利用啊，都是差不多，因为像这种，资料的积累基本上每年都在进行中的。
<p>R2: 今年在参考资料上也没有变动吗？</p> <p>GAO2: 没有，没有，还是那几本。这几本书，我因为，我一直用的。我用了好多年的，还是老办法，你看精炼，因为用上手了，基本上没有什么变化的。</p>
<p>R3: 您现在对上次的资源系统图还有印象吗？</p> <p>GAO3: 哦，哦，没有，其实呢，这个版块结构，我因为我从来没有系统的去反思过我的资源，我的资源的框架，对吧，但是基本结构呢，就是差不多的其实.....</p>
<p>R4: 如果让您对您的资源进行分类，您大概会分几类？</p> <p>GAO5: 应该是，纸质的，网络的，还有就是，自己的那个，电子的资源。</p>
<p>R5: 您觉得有哪些对新手老师快速成长的建议？</p> <p>GAO5: 关键是要积累，要能够举一反三，然后要汇总的，要及时进行分类汇总，所以，对吧，关键是，青年教师现在缺乏的就是一个积累。他们会拿书上的资源来用，对吧，但是对于积累的过程，就比较欠缺了一点。</p>
<p>R6: 那怎么积累呢？</p> <p>GAO6: 网上啊，外面的这些信息啊，都是，还有，就是像这次，这种电子稿（教案），有的时候网上不一定你拿的到对吧，那你就通过你认识的一些人啊，对吧，问他们要一下，那这就是获取资源。</p>
<p>R7: 教学方法上呢？</p> <p>GAO7: 那其实这个主要是靠自己对自己平时的不断的改善啊，去体会，去实践，对吧，比如自己平时上课的内容和方法在这个班级，那在第二个班级是不是要进行改进，这就是自己要去不断的修复反思了，对吧。</p>
<p>R8: 技术方面呢？</p> <p>GAO8: 技术嘛，现在是年纪大了，我用的技术是越来越少了，靠的就是一支粉笔，黑板上画，几何画板用的少了。我觉得新手老师也是，自己要多画多写，反而提高更快。因为几何画板是动态的，考试的时候你总不能去给学生画吧，这个只能靠学生自己的想象力，所以还是用粉笔在黑板上画图比较好，进行图形变化啊，我觉得好一点，体验过程呀</p>
<p>R9: 怎么看待教师之间的合作？</p> <p>GAO9: 这个还是要经常交流沟通的，因为人都有局限性的，我看到的，对吧，可能就刘就看到，那她看到的我可能就没看到，所以互相沟通么，就是取长补短，互相补足么，对吧，这是备课组存在的意义，特别是最后复习的时候，对吧。这个现在的资源整合就特别重要，否则只有自己的想法，没有别人的东西。</p>
<p>R10: 您从教这么多年，觉得自己在哪些方面能力提升的比较多？</p> <p>GAO10: 关键是，对题目的这种把控能力，我感觉是加强了，对吧，别人，以前是拿来做题，现在是自己可以从中去寻找，合适学生的题目，对吧，然后进行一个适</p>

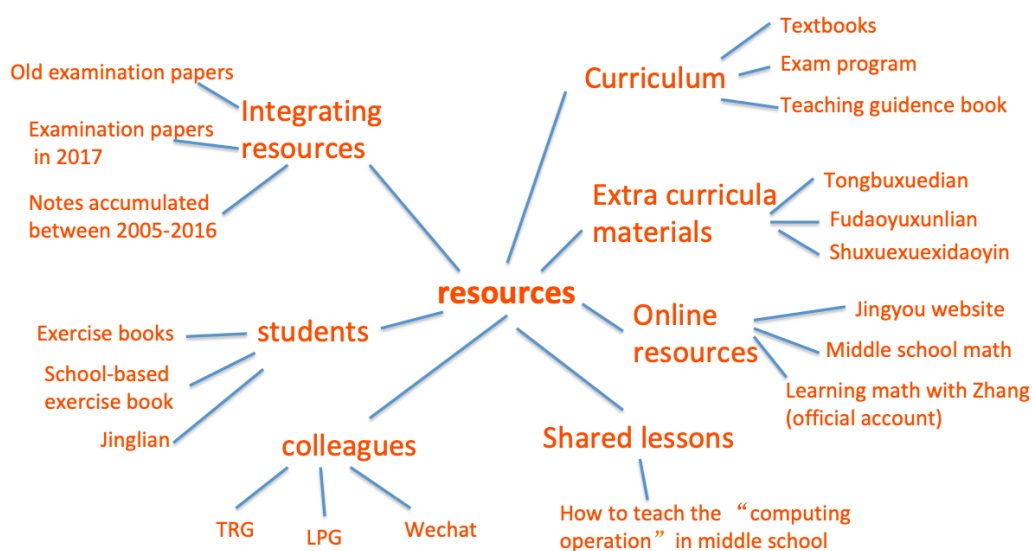
<p>当的变化，就能将看到的東西将他整合到一起，对吧。</p>
<p>R11: 技术方面呢？</p> <p>GAO11: 技术呢，现在技术能用的更多了，几何画板啊之类的，以前都没有的，你看以前啊，没有电脑，资源的获取方法很慢的，只能通过书啊纸质的途径去获取，或者问师傅要，现在就方便多了。但是我现在不太用这些了，我是擅长但是不用（笑），几何画板我还是能够得心应手的，但是呢，我越来越觉得，课堂上，没有用的必要性。</p>
<p>R12: 您觉得刘老师和姚老师在资源处理上，能力水平如何？</p> <p>GAO12: 刘老师在资源积累上还是欠缺的，还是做的不是很好。对吧。其他的还可以。姚么，我现在不知道她写教案的状态，刘一直在办公室，我能每天都看见，小姚比较远，不清楚她，所以，我估计，她比刘要年轻么，所以稍低，但其实差不多</p>
<p>R13: 但其实她俩的工作年限差很多的</p> <p>GAO13: 对的，差很多的，要差很多。应该说，在看到的题目，掌握的题型，见过的东西，不如刘多的其实</p>
<p>R14: 促进新老师快速成长的有哪些动因您觉得？</p> <p>GAO14: 学生的考试成绩啊（笑），考不好老师就要去想办法了，做变动。</p>
<p>R15: 您对现在的大环境，技术啊，网络啊对教师的影响怎么看？</p> <p>GAO15: 这个对老师是正面的，对学生我觉得是负面的。</p>
<p>R16: 为什么？</p> <p>GAO16: 这现在答案到处都是，你看这些公众号，对我们老师来说很便利，拿来借鉴，但是学生也能去搜，那就是拿来主义。这还要看家长怎么管控了，按照我们的要求，其实是可以控制的，但是有的家长就是做不到配合，放纵型的，对吧，所以这个东西就不大好把控。</p>
<p>R17: 资源呢？</p> <p>GAO17: 很多资源都是从这个网站搬到那个网站，有的题目是错的，错都一样的错。所以有些网站，原创性的资源还不是太多。</p>
<p>R18: 教辅市场呢？</p> <p>GAO18: 教辅市场也是一样的。但是教辅材料的话，它的更新呢，其实没有网络快，但是做网络的人呢，其实也不是太过于用心，所以很多东西更新的都不是很快。但是每年中考的试题变换速度还是蛮大的。其实教辅市场上书太多了，学生不可能买来全做，全做那中考肯定没问题里，对吧。</p>
<p>R19: 里面的题目怎么编的？</p> <p>GAO19: 其实是来自于中考，还有教研员他们编的卷子啊什么的，很少有人专门去编新题的，因为编新题要考虑它的严密性啊，对吧，答案的可靠性啊等等，所以，我们一般情况下，也不会自己去编题目。题目拿来的可能性比较大一点。一个是时间，再一个，我们本身的能力就不是很强。</p>

1.3.2 Reflective Mapping Resource System (RMRS) of GAO (October 2017)

Chinese origin drawing



English translation



1.4 First interview with Liu on April 2017

The interview with Liu was conducted in her office, lasting for 46mins. Including 120 questions concerning for:

- (1) her personal information (e.g. education background, the courses she learnt about resource use, the trainings she had obtained during her inservice work, her working experiences before working in this middle school)
- (2) her resources often used for math teaching, and her way of working with resources
- (3) her explanations on “title promotion” (the article publications)
- (4) her potential documentation working mates (GAO, LX and ZHANG)



Picture 1.4. Interview with Liu for her resource work and resouce system

1.4.1 Selected transcriptions, translation and marks

Among the 120 questions, 41 answers were selected and kept in the following table with three columns: the selected transcriptions in Chinese (on the left), the English translation (in the middle) and the marks (on the right).

Selected transcriptions in Chinese	English Mark
<p>R1: 请您说说您这些年跟教学资源使用上有关的培训</p> <p>LIU1: 有各种培训, 专门针对用技术的没有, 基本上都是关于教学技能, 第一种是关于理论上面的, 还有就是作为班主任处理班级问题的。比如说啊, 我们还上过护理课程, 专门处理学生的突发状况。</p>	<p>Trainings related to resources usage</p>
<p>R2: 有专门针数学的吗?</p> <p>LIU3: 崇明区有一个数学工作室, 比如新的老师不知道课堂重</p>	<p>Experiences related to mathematics videos</p>

难点怎么把握，课堂用语，怎么解释知识点等等细节，这个工作室专门研究这些的。	
<p>R3: 它由谁组织的?</p> <p>LIU3: 主要是教研员牵头，还有一些区里的骨干教师，带领这些新老师钻研教材。到各个学校区调研，特别是对年轻人开展一些教材方面的小讲座。年轻老师刚工作的时候对教材的把握不是很全面，比较片面一点。</p>	The organisers for the training
<p>R4: 专门研究教材的?</p> <p>LIU4: 对。</p>	It was for textbooks
<p>R5: 您自己怎么看?</p> <p>LIU5: 教材重要，因为是里面的知识点不好解释。你比如说，分数计算里面的 $\frac{1}{2}+\frac{1}{2}=1$，怎么跟学生解释？再比如说，$\frac{1}{3}+\frac{1}{3}=\frac{2}{3}$，怎么跟学生解释？</p> <p>R6: 您是说单位 1 的概念吗？</p> <p>LIU6: 对，但是很多学生理解不了，怎么样让学生理解这些这是一个教学难点。</p>	Textbooks are important, difficulties in notions
<p>R7:你们大学的时候没有学这个吗？</p> <p>LIU7: 不学的，大学的时候不学任何有关教材的事情。因为教材版本不一样，我们有全国版的，有苏教版的，还有沪教版的，不一样的。而且我们大学的时候不学初中教材，高中教材，我们那个时候也不知道我会到初中来教书，我们那个时候一般毕业了都会去高中，我们实习也是高中。</p>	University study about textbooks (no)
<p>R8: 那跟数学教学有关的课程有哪些？</p> <p>LIU8: 心理学我们学的，比如小孩子的心理特征啊对吧，哪些现象，哪些效应，我现在都忘了，很多。我不学跟教材有关的东西。我们大学四年没摸过什么初中教材高中教材，没有的。就学那个高等代数，微积分啥的。</p>	University courses
<p>R9: 这些东西你现在用的上吗？</p> <p>LIU9: 没有，没有任何帮助，用不到。但是大学里面学习的数学拓展思维还是有帮助的，很训练思维，看问题的时候吧，我说不上来，就是觉得思维灵活些</p>	Useful for now? Not directly
<p>R10: 您怎么理解现在的技术与教育和你自己工作的关系？</p> <p>LIU10: 我觉得影响还是很大的。比如刚开始的时候，我们学的虽然是数学与计算机专业，但是在计算机方面我们学的并不多，在大学里，主要还是课堂上来学习这些最基本的微积分，还是最古老的那种课堂，还是教授在黑板上，四个黑板上不停的拉写啊那种，就是接触技术很少。后来到工作岗位上以后就会发现必须要借助于技术手段，比如说电子白板啊必须要进入课堂。</p>	Relationship between technology and mathematics teaching

刚开始的时候我们就是一根粉笔走天下。就是感觉第一方面与学生是脱节的，学生接触的多，我们接触的少。第二个就是运用一些技术能够让学生更直观的学习，你比如说最开始的时候我们用几何画板，一下子就出来的，比如圆与圆的相交啊相切啊相离啊，一下就出来了，但是用我们传统的纸笔方法，学生没有办法理解。	
<p>R11: 但是我们以前都是这样学过来的。</p> <p>LIU11: 对，我们是这样学了，一开始还这样做了，但是对比一下，发现后来用几何画板会很快就出来了，但是在备课上，要花更多的时间，但是课堂上学生的学习就能更直观，学习效率更高，理解起来也更快。而且有的时候从网上借鉴别人的一些东西啊，你比如说微视频啊，解释一些东西都行，因为有的时候靠老师说真的说不清楚。</p>	Usage of GeoGebra
<p>R12: 你说的微视频是什么？</p> <p>LIU12: 就比如说电脑上面下载的，跟知识点相关的东西。</p> <p>R13: 自己剪视频吗？</p> <p>LIU13: 对。还有就是自己做，自己录好，比如说就是几年前了，在崇明的时候我们当时学习分数的时候，6 年级的时候吧，孩子们没有办法理解几分之几，那种平均。我们就找几个小同学提前讲清楚，我们提前录一个微视频，就是拿个橘子然后平均分，特别强调平均分成几瓣，然后就整个过程中穿插解释分数加法，$1/3+1/3=2/3$，最后这个结果，我们现在知道是分母不变，分子相加减，但是这是法则，学生学过了也知道是 $2/3$，学生不知道原理，其实这个 2 是 3 份中的 2 份，他们解释不清楚，不理解的，所以我们提前录好，把这个视频在课堂上展示出来，如果你靠课堂上讲这个过程，那一节课哪里够的呢，所以得提前去做，准备好这个工作，这个我认为也算是一种技术应用吧。</p>	Use video to teach mathematics, one example
<p>R14: 您有其他数学教学软件吗？</p> <p>LIU14: 软件我接触不多，就是几何画板，其它的没了。但是这个太费时间了。就一个图，你没有一个小时，半个小时，你根本没有办法，只是为了这一个图，就要一个小时的时间，但是一节课下来，有的时候得需要好几个图。这个就太占时间了。所以我经常有的时候网上下载一各视频，自己截取一下视频</p>	Difficuties in making videos
<p>R15: 视频剪辑都是自己？</p> <p>LIU15: 涉及到剪视频都是请别人帮忙的，我自己剪不了。</p> <p>R16: 别人？</p> <p>LIU16: 其它老师。我们学校有个信息老师，专门就是有时候帮我们解决一些问题，人蛮好的。</p>	Who helps her in video making
R17:听高老师说您在准备职称评一级，那您现在是中二？	Related to promotion

LIU17: 刚开始工作的时候是没有级的, 第一年实习, 然后就是中二, 之后必须要工作五年才能评一级。	
R18: 有哪些考核标准? LIU18: 要考试, 有论文, 论文就是体现你对教学实践的思考和认识。就某一个点有自己的认识。还有一个就是计算机, 计算机也要考试, word 啊 excel 啊这些东西, 在工作中需要用到的, 还有一个是英语, 英语也要考试, 但是考什么我还不知道。	Related to promotion: publication
R19: 计算机考试? LIU19: 计算机考试是考过了, 就是最基本的, 比我们日常工作用到的再深一些, 考的东西其实平时也用不到的, 比如 excel 编写, 是我们平时用不到的东西。我们平时用到的就是排列好, 然后大小啊, 平均值啊, 从高到低, 还有就是某个分数的筛选啊之类的。那个里面我记得我考的还有很多其他的東西。也是 excel 里面的东西。	Related to promotion: exams on computer
R20: 考数学吗? LIU20: 数学就是中考高考卷子, 因为初中要为高中做衔接, 得做些准备。	Related to promotion: high school and university entrance exam papers
R21: 论文呢? LIU21: 正式的写这是我第一次。以前写的关于什么什么体会的那种, 这些只是文章。	Related to promotion: writing papers
R22: 文章, 和论文 LIU22: 不一样的。论文就像这种, 还是第一次。以前都是写什么教学随笔。	ibid
R23: 学校要求写得吗? LIU23: 学校要求上交。一个学期交一篇。就是教学中遇到一些问题, 你总结一下, 你觉得对别人有什么帮助啊或者怎样的, 存在哪些问题啊。反思一下, 就是随笔嘛。但是我觉得上升不到论文吧, 我觉得上升不到。论文我的感觉就是你要观察的这个现象怎么说呢更深刻一些	ibid
R24: 高老师对您的专业上的影响有哪些? LIU24: 就是理论性更强一些。比如以前我们讲知识点啊, 比如说怎么用简单明了的方法, 贴近于生活。她就是给我们解释的时候, 贴近于生活, 但是也不能太通俗, 还要用专业语言去说。每次都是这样的。你比如说, 每次上课的时候, 我们为了解释一个知识点对吧, 就用比较通俗的语言去说, 那高老师就会说, 要求就是还是要用专业语言, 书面语言去解释, 还有就是有的时候有些教材内容吃不准, 拿捏不准, 高老师也会跟我们讲。	Work with Gao

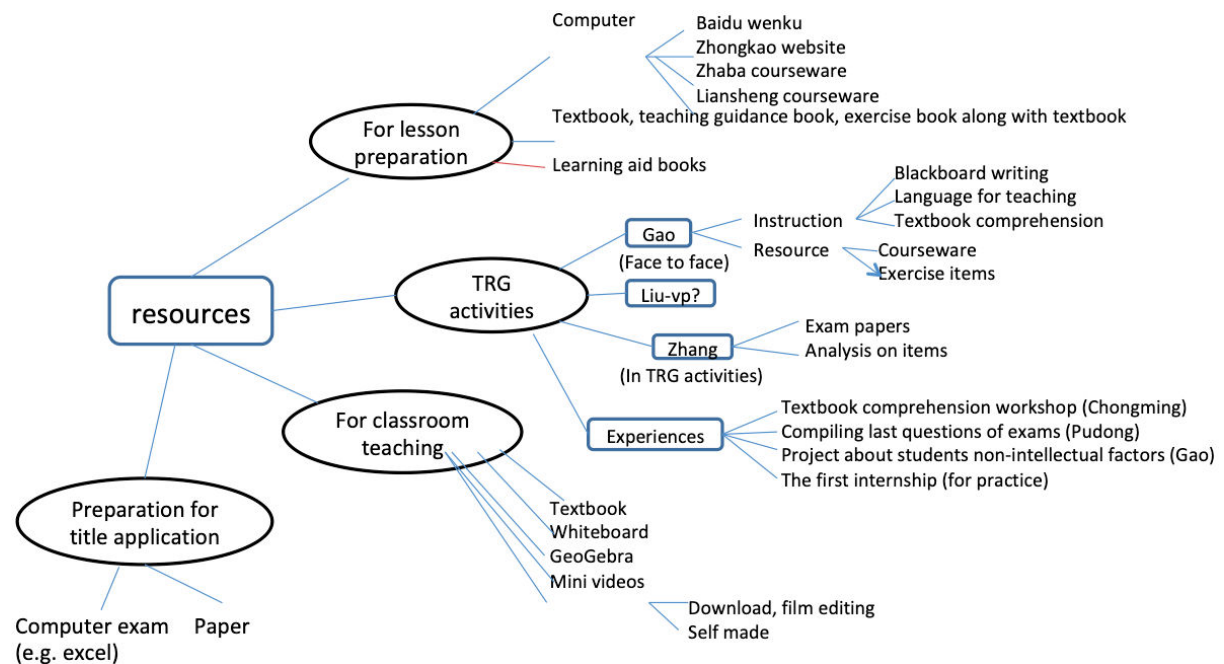
<p>R24: 教材?</p> <p>LIU24: 教材。就是教材我们也有吃不准的地方啊, 因为每一次都是 4 年下来, 一轮是 4 年, 然后 4 年以后书本多多少少会有一些改变, 对知识点的要求是不一样的。比如说, 以前, 两条线垂直, k_1 乘以 k_2 等于 -1, 斜率上面, 以前是有要求的, 现在就没有这个要求了。我们上课的时候还是会用以前的方法来教, 但是这样不行, 因为这种方法在中考的时候不能直接用, 是扣分的, 不能用, 就这样, 取消了很多内容。</p>	Textbooks changes
<p>R25: 还有其它的吗?</p> <p>LIU25: 她也会提供给我们上课所需要的资源啊。以前就是比如说教案, 她做好了以后跟大家共享一下。你比如说几何画板不是很麻烦吗, 她就是做好, 共享给三个数学老师, 一个年级 3 个, 还有张江的, 5 个, 5 个老师, 然后就共享, 她就回提供这些资源。</p>	Work with Gao
<p>R26: 几何画板的?</p> <p>LIU26: 对, 几何画板的, 她自己做好了给我们也用, 这样就不是每个老师都需要去做了。因为做这个太麻烦了</p>	GeoGebra
<p>R27: 通过什么形式共享?</p> <p>LIU27: 就是拷过来啊, 用 u 盘啊或者微信啊邮箱发过去。</p>	Share resources
<p>R28: 除了高老师, 你还有其它老师合作吗?</p> <p>LIU28: 最多的就是高老师了吧。我觉得我在高老师身上学的蛮多的。以前呢板书写的比较龙飞凤舞的, 就是想到哪里写到哪里, 就是黑板上, 没有章法可寻吧, 我看她的板书就是一节课之后, 这一节有哪些知识点, 关键点, 在给学生总结的时候, 圈圈点点就出来了, 我觉得挺好, 后来我也改了一下, 我觉得蛮好 (笑)</p>	Work with other teachers
<p>R29: 教研组其他老师呢?</p> <p>LIU29: 张老师我觉得, 进入初三, 她很注重系统性的东西。因为现在她已经开始给我们灌输一些系统性的东西了。初三不是有总复习吗。然后我就觉得教研会的时候, 数学教研组会议的时候, 她就给我们, 每次都要求我们不管你处在哪个年级, 中考卷一定要去做, 然后每个年级的期中考试卷, 期末考试卷你都要做, 你就算你在初一, 你也要把初二初三的期末期中考试卷都拿过来, 你要了解, 在同一个阶段, 各个年级正在讲什么知识点。你要对这个有了解, 她这样就是在有意识的给我们呢灌输一个总的全局观, 4 年的一种感觉, 要去了解别的年级所学的知识, 这样做到一个心理有数, 我觉得她现在就在灌输, 给底下的任课老师培养和加强这种意识。比如期中考试期末考试之后啦从事教研活动, 都会去做中考卷, 各个年级交叉做, 你做他的, 她做你的。</p>	ibid

<p>R30: 会讨论吗?</p> <p>LIU30: 对, 会讨论, 哪个地方问题多, 陷阱多, 以后在教学的时候或者说你在提前教一些知识的时候, 她肯定会有一个穿插进去的对吧, 你比如说你现在讲实数里面, 有理数无理数, 有理数的时候就可以有意无意的穿插一下, 到时候你解决的时候就好解决了, 像打预防针一样对吧, 哪个地方陷阱比较多。每个阶段安排得主题不一样, 她有时候安排得主题就是分析试卷, 然后去发现问题, 她有时候问的就是将一些关于就是日常生活当中出现的问题, 反正他定的主题不一样。</p>	ibid
<p>R31: 有哪些大考试?</p> <p>LIU31: 有整个区的, 也有片区考试, 比如期中考试, 比如说, 一百多个学校, 然后里面有几所学校, 比如 130 多个学校, 有 100 所参加联校考, 然后区里面一起考试</p>	Exams for students
<p>R32: 也是一起分析吗?</p> <p>LIU32: 对, 区里会发给每个学校的教导处, 教导处再下发给学科的教研组长</p>	TRG activities
<p>R33: 你可以看见所有学生的学习成绩吗?</p> <p>LIU33: 不是所有的, 我可以看见其它学校的平均分, 还有区里的平均分, 然后你这个班级成绩在区里的位置。</p>	exams
<p>R34: 您 2014 年来这之后又没有参加过什么培训?</p> <p>R34: 参加过压轴题的分析编写, 区级教研室组织的。就是综合分析一下中考的趋势以及那些重点难点, 以及压轴题编写的时候涉及到的知识点和面以及最常出现的最值得考的一些东西吧。</p>	Exam paper writing
<p>R35: 怎么培训?</p> <p>LIU35: 他主要是给一个题目, 比较典型的, 然后就是分析一下编写的意图, 因为中考卷都是市级的。然后也会让你编写</p>	ibid
<p>R36: 您平时怎么备课?</p> <p>LIU36: 我现在备课基本上都是周末备课</p>	Lesson preparation
<p>R37: 你怎么掌握量, 就是预测你的教学进度?</p> <p>LIU37: 都是安排好的啊, 每天走到哪里, 都有一个, 就是不是说我今天到学校里了我才知道哦今天我要教到哪里, 不是这样的, 我一个星期的量都已经安排好了, 五天的量我都知道了</p>	ibid
<p>R38 :是谁安排得?</p> <p>LIU112: 就是按照统一的安排, 一开始就制定好的。一个年级组, 比如说我和高老师, 还有张江的老师, 就会商量讲到哪里。讲到哪里, 然后, 但是它也有灵活性, 你比如说这个知识点比</p>	ibid

较慢，我就可以暂且放一到两节课.	
R39：所以你备课就是在家了 LIU39：对，用电脑，我一般不手写教案。	ibid
R40：用电脑写教案？ LIU40：不，我教案就是直接写在书上面，我喜欢写在教参上，因为教参上有空白。电脑我用来查资料。比如说我今天上分式方程，不对，今天是无理方程，我就是去查一些无理方程典型的学生容易出现的问题，然后我自己再找几道题目，比较有代表性的。	ibid
R41：会在哪里找？ LIU41：大量的去搜题，就是百度文库里，我大量找题，还有一个那个中考网，也会找题，就是中考里面出现的那些问题对吧，还有我们以前有的那个闸北课件，闸北课件组。就是相当于一个所有的可见打一个大包，我也会去查阅。然后有时候还在网上查阅一些，还有一个好像是莲生课件，就是会去看。在平时教学中，说实话，我比较懒，都不用什课件。	The sources for resources

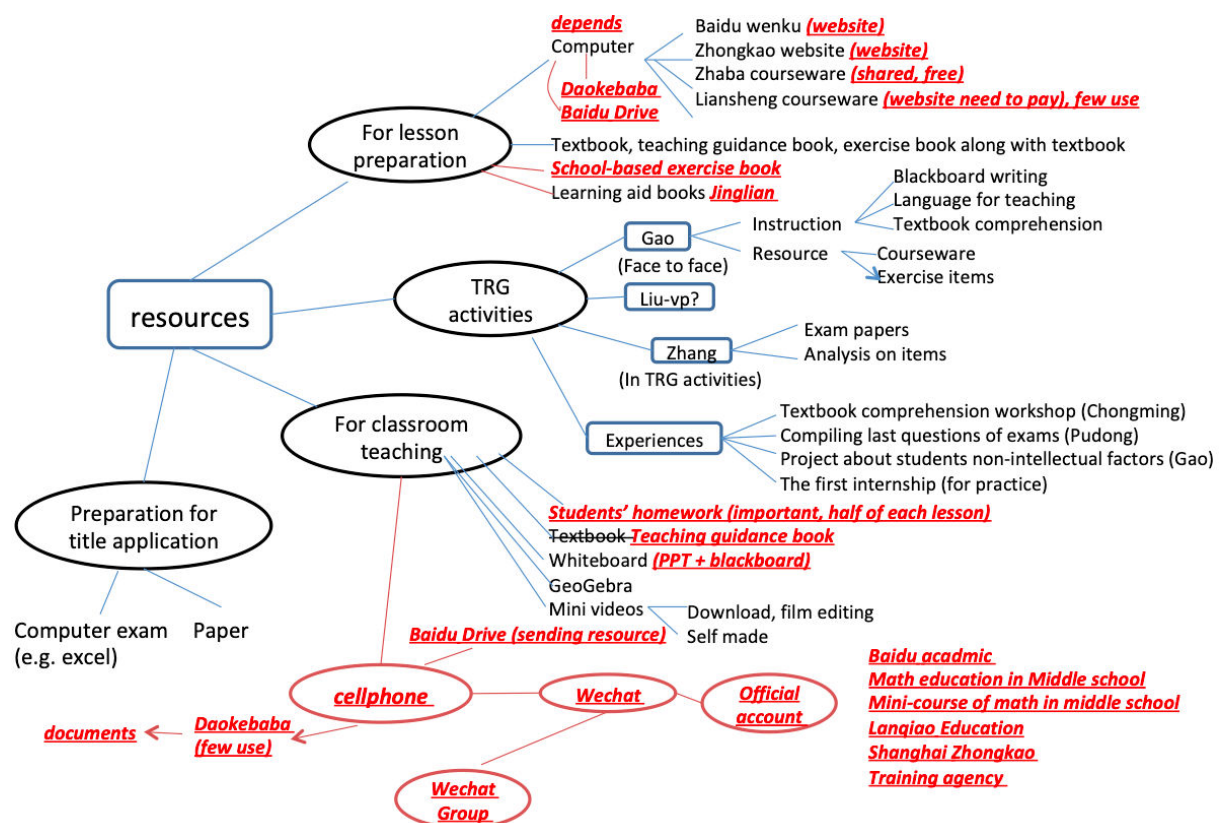
1.4.2 Inferred Mapping Resource System (IMRS) of LIU (April 2017)

English translation



1.4.3 Reflective IMRS (R-IMRS) of LIU (April 2017)

English translation



1.5 First interview with Yao on March 2017

In 16th March 2017 afternoon, an interview with Yao was made after the first MOKE discussion, in Gao's office. 49 Questions were asked mainly focus on (1) the resources used for this open lesson; (2) instructions from Gao; (3) her resources usually used for her daily teaching and the sources of these resources.



Picture 2.2. Interview with Yao

1.5.1 Selected transcriptions, translation and marks

Among the 49 questions/answers, 20 of them were selected and kept in the following table with three columns: the selected transcriptions in Chinese (on the left), the English translation (in the middle) and the marks (on the right).

Selected transcriptions in Chinese	English marks
R1: 你今天上午上的课, 用到的资源有哪些? YAO1: 教科书, 教参, 电脑, 电脑包括什么。还有 ppt, word, 还有一个初中数学网, 里面有各个地区和版本的课件, 教案和试题。	Resources for MOKE
R2: 这些资源来自? YAO2: 我舅舅, 他在浙江做数学老师, 也是初中。	ibid
R3: 你自己定的开课题目吗? YAO3: 我开始也问了张老师, 她就是找了以前的师傅夏老师, 预备年级的石老师, 讨论决定说, 如果是在好班开课的话就讲不等式的性质, 如果是在差班的话, 就选	Deciding the topic

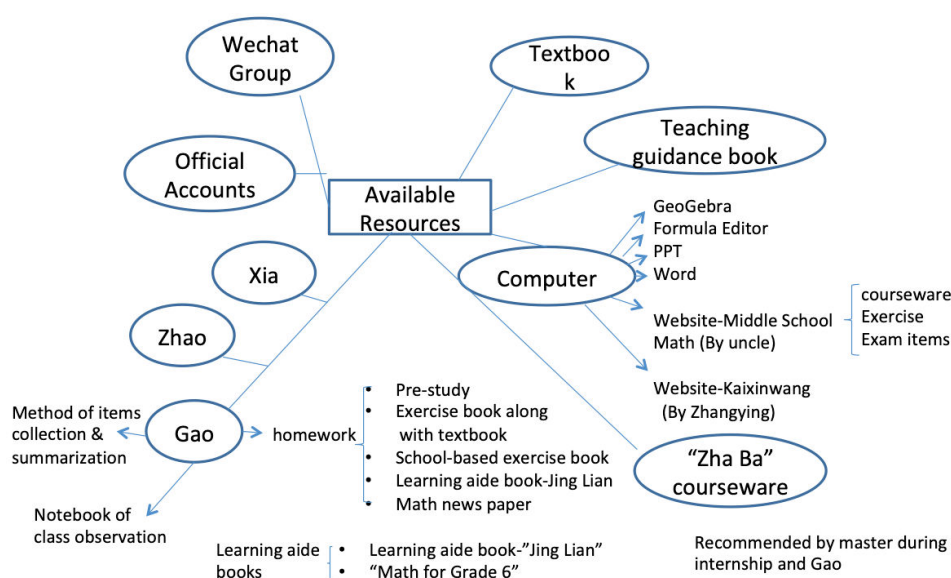
<p>后面一章，解法。因为性质的话，要求更高。后来我问了高老师，高老师想了几天，然后就后来我就问她这两个选哪个，我打算选前面一个，她想了以下，她说她也是这么想的，比较能看得出学生的层次。</p>	
<p>R4: 这是第一次磨课吗?</p> <p>YA04: 不是，我以前磨过。每次试讲的时候，就是第一年，她都会来听的。见习的时候也磨的，所以这是第 4 次，考核课我也让她帮我磨的。就是考核课我在其他学校见习的时候，上的是初一的课，她刚好教初一，然后就让我在他们班试讲的，然后她帮我看了一下，给了点建议。</p>	MOKE experiences (4)
<p>R5: 什么建议?</p> <p>YA05: 她就是说这个怎么讲，顺序编排上的问题啊之类的。</p>	Suggestions from Gao
<p>R6:高老师早上给你什么建议?</p> <p>YA06: 她觉得内容太多，一节课肯定讲不完。然后是哪个性质都讲的话，从我准备的题型来看的话，都是皮毛，没有深入。所以决定还是就讲一个性质。</p>	Suggestions from Gao
<p>R7: 习题呢?</p> <p>YA07: 今天她给了我一本，随手拿了一本参考书，然后翻开里面，然后她打开以后就说这些题目都可以用啊。就暂时按它的讲一遍。</p>	Suggestions from Gao
<p>R8: 有用教材吗?</p> <p>YA08: 没有用</p>	Usage of textbook
<p>R9: 为什么</p> <p>YA09: 我们一般是书上的例题不会作为上课的那种习题，都是作为课后的。</p>	ibid
<p>R10: 课后?</p> <p>YA010: 也不能这么说，应该说先让学生预习过了，所以一般书上的例题不采用，然后书上的例题和练习就是预习的时候已经做过了，所以上完新课的话只是让他们对对答案。</p>	ibid
<p>R11: 你一般都是在哪题啊?</p> <p>YA011: 例题啊? 其实我现在教的是预备年级，我去年听过高老师的课，所以好多例题都是采用她的，从她那边来的。还有一个就是闸北课件，不是，闸八课件，闸北八中制作的课件。</p>	Source for exercises

<p>R12: 网上的吗?</p> <p>YA012: 不是, 这是我见习的时候, 见习老师给的, 这是要买版权的。里面课件全部都有, 每一节课都有。</p>	ibid
<p>R13: 高老师有没有给过你什么资源吗?</p> <p>YA013: 有啊, 她每天不是都有备课嘛, 她就是参照那些教辅啊什么的在里面选习题, 或者自己改编一下。</p>	ibid
<p>R14: 你用教参吗? 那个官方版的配套教材?</p> <p>YA014: 不用, 那个里面没什么东西的啊, 不用那个。</p>	Usage of teaching guidance book
<p>R15: 高老师当师傅的时候, 主要教你些什么?</p> <p>YA015: 上课听课然后关键是, 我也不知道, 就像今天磨课一样啊, 语言的准确性, 然后把题讲透讲彻底, 怎么讲学生才能更明白, 我自己, 新老老师的感觉可能就是整堂课的感觉把气氛讲活, 对吧? 讲活的话其实外在的形式, 年纪大的老师的话讲的就会更……就比如张老师, 讲的语言上面没有很生动, 但是讲的你比如说变式啊, 或者是, 就是经验方面的吧, 我觉得。</p>	Helps from Gao
<p>R16: 你平时备课用到哪些资源?</p> <p>YA016: 平时就用闸八课件。然后还有上学期的, 自己有一份备课笔记, 自己写的, 手写的。再就是听课笔记, 以前高老师的课。</p>	Lesson preparation resources for daily teaching
<p>R17: 工作之后有哪些老师带你?</p> <p>YA017: 我第一年工作(2015)不是跟着高老师, 我实习(2014)的时候跟着她的, 我第一年的师傅不是她, 第一年是一个数学老师夏老师。今年是第二年又换了, 因为师傅要同一个备课组, 所以我跟着赵老师, 但是第二年基本没啥, 她不听我的课, 我也不去听她的, 因为没时间。</p>	Working with others
<p>R18: 你布置作业用什么?</p> <p>YA018: 和高老师的模式一样的, 就是预习, 练习册, 校本。然后我们那边定了一本精炼与提高。和这边的是一套的, 这边是粉皮的, 我们那个是黄色皮的。我们去年定的是报纸, 报纸的质量比较好, 题出的也很好, 但是我们老师批起来太麻烦了, 学生做起来也很头大, 要翻。</p>	Homework design
<p>R19: 还有其他资源吗?</p> <p>YA019: 哦, 还有一个资源。突然想到了。微信群。以前高老师会发一些, 比如说试卷出来啦, 哪道题有新的解法了, 她都会在里面分享。</p>	Resources from WeChat
<p>R20: 嗯, 试卷。</p>	Resources from exam papers

YAO20: 我们现在沿用的一份月考卷就是高老师出的，她教预备的时候出好了，后面就给后面的老师用了 2 年。稍微改动一些。高老师的参考书很多的，很多教辅书，市面上都能买到，我那边很多教辅书都是她给我的。

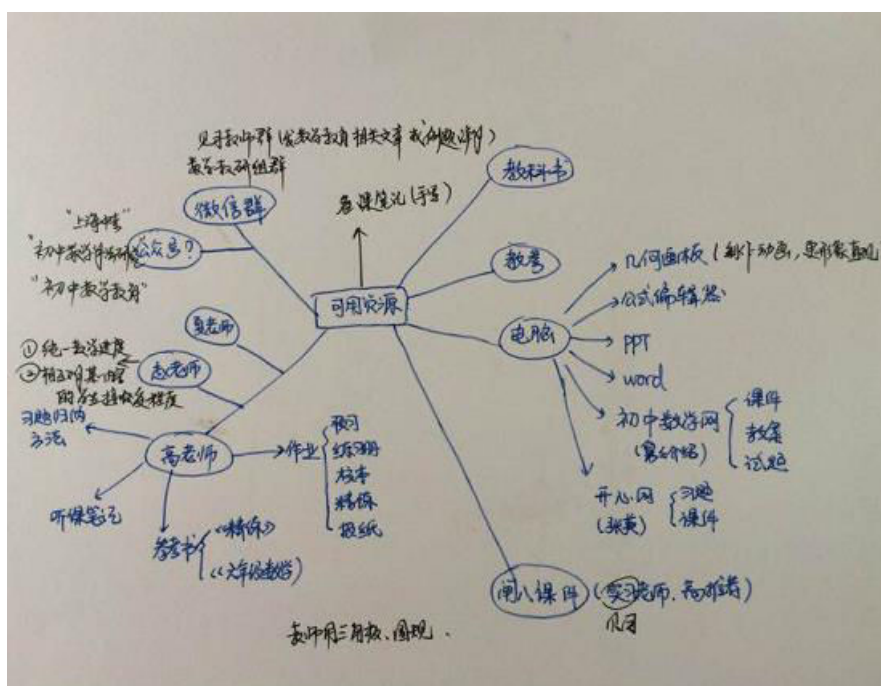
and Gao

1.5.2 Inferred Mapping Resource System (IMRS) of YAO (March 2017)

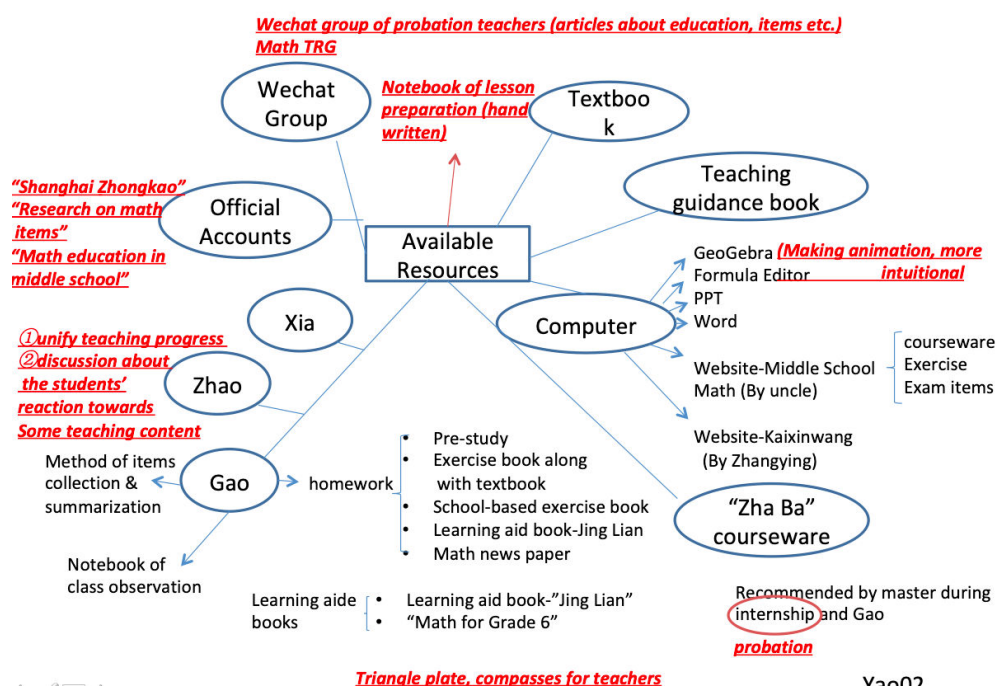


1.5.3 Reflective IMRS (R-IMRS) of YAO (March 2017)

Origin versional in Chinese



English translation



1.6 Interview with Anna on June 2017

This interview with Anna was made in 2017, for her resource system.

1.6.1 Selected transcriptions, translation and marks

Selected answers were kept in the following table with three columns: the selected transcriptions in French (on the left), the English translation (in the middle) and the marks (on the right).

Selected transcriptions in French	English translation	Marks
<p>R 6: Particulier seulement orange, on maintient orange les événements. Et une autre chose par rapport aux ressources, ressources en bleu. Et après on va voir au fur et à la mesure il n'a pas de contrainte.</p> <p>ANNA6: Alors, j'avais le manuel sans doute, le manuel de classe. Je ne me rappelle plus comment il s'appelle, je pense que c'était Pythagore. Mais je ne sais plus, oui je pense que c'était Pythagore. Si ça existe ça doit être Pythagore. Donc, voilà, c'était le manuel qui avait été choisi par l'établissement. Je me servais du Manuel. Je commençais avec le manuel. J'avais aussi les ressources, Hamm, ça se rappelait, le suivi scientifique de l'IREM.</p>	<p>So, there, it was the textbook which was chose by the school. I used the textbook. I started with the textbook. I had also the resources, it was called "the scientific suivi of IREM".</p>	<p>Manuel textbooks</p>
<p>R7 : Le suivi scientifique de l'IREM c'était quoi ?</p> <p>ANNA7 : Le suivi scientifique c'était des manuels dans des petits livres qui reprenait certaines notions, qui expliquait et qui donnait des exemples de comment on pourrait les enseigner. Donc, c'était...Là tu avais le manuel avec le cours et les exercices qu'on utilisait dans</p>	<p>R7: the scientific follow up, what was it?</p> <p>ANNA7: The scientific follow up (IREM brochure), it was (for) the textbooks, in small books, it contained some notions, it explained and gave examples of comments that how we can teach (the notions). So, it</p>	<p>IREM resources</p>

la classe. Et puis, dans le suivi scientifique c'était plus une réflexion des certains chapitres, qui permet de réfléchir de comment le mettre en œuvre, comment s'en servir, etc.	was... There you had the textbooks with the lessons and exercises you used in the class. And then, in the scientific follow up, it was more a reflection of some chapters, which reflects on how to implement, how to take it into consideration etc.	
R 10: Ok. ANNA10 : Et donc, moi j'étais au moment où ça a changé. Donc, j'étais dans une ah, dans une académie où il y avait des IUFM avant que les IUFM existent.	ANNA10: And so, me I was in a moment where this had happened. So, I was in a, in an academie which later became IUFM.	
R11 : D'accord. ANNA11 : Donc, on avait fabriqué ensemble. On faisait des cours, on faisait... On les a expliqué comment gérer une classe et etc. Donc, je pense qu'il y a mes cours.	ANNA11: So, we produced together. We did the lessons, we did... we explained how to generate a lesson etc. So, I think they were my courses.	
R12 : Il y avait des chercheurs ? ANNA12 : Non, non, avec les futurs professeurs. Tu sais la première année tu es en stage. Donc tu as moins d'heure. Et moi j'étais dans l'IUFM et dans l'IUFM le changement c'était qu'on était mélangé, plusieurs matières pourraient être mélangé pour certains cours. Et donc, on travaillait, on préparait, on avait des cours, et puis la didactique et puis nous donne de conseils.	ANNA12: ... You know the first year you are in internship. So you have less hours (in IUFM). And me I was in IUFM and in IUFM there were lots of changes and mixtures, several aspects and materials perhaps were mixed for some courses. So, we worked, we prepared (lessons), we had the lessons, and also the suggestions about didactics.	
R14 : Oui, bien sûr. ANNA14 : Parce que... Mais vraiment, celui qui m'a vraiment suivi long temps, c'est le suivi scientifique de l'IREM. (On discute des problèmes techniques)		le suivi scientifique de l'IREM resources from IREM

<p>R 15: Donc, on continue.</p> <p>ANNA15 : Donc, voilà, et puis j'essaie de me rappeler s'il y avait une brochure ou deux, en tout cas j'avais euh, j'avais adhéré à l'APMEP. Donc, j'avais adhéré à l'APMEP donc, j'avais aussi les butins qui arrivait. Tu vois les...Ah j'en ai cinq c'est très livresque, il y a beaucoup des livres.</p>		Brochures à l'APMEP
<p>R 16: Autres manuels que tu dis, il y a d'autres que tu te souviens ou non ?</p> <p>ANNA16 : Non, je ne me rappelle pas, pas des noms. Tu sais quand tu es dans un niveau tu as plein des manuels comme ici tu vois, tu as toutes les collections des manuels qui existent donc tu regardes tous les exercices, comment ce qu'ils font les cours dans les autres livres. Au début quand tu n'as pas de cours. Là maintenant, ce que j'ai fait je vais aller voir ce que j'avais fait. Est-ce que j'ai d'autres idées ? Est-ce que Cindy a d'autres idées ? Est-ce que Bruno a d'autres idées ? Sur les gens qui partagent. Mais avant au début tu as rien, donc.</p>	<p>ANNA 16: ... You know when you are in a level, you have so many textbooks you see here, you have all the textbooks collections that exist, so you read all their exercises, how do they make lessons in other books. At the beginning when you have no lessons. Then now, when I'm going to do something, I will go to see what I did. Do I have any other ideas? Does Cindy have other ideas? Does Bruno have other ideas? On thoes people who can share with. But before, at the beginning you have nothing, so.</p>	
<p>R 19: Et pour les définitions, tu prenais tout ça du manuel ?</p> <p>ANNA 19: Au début je pense oui. Je m'appuyais beaucoup sur le manuel au début. Le suivi scientifique eux, ils éCindynt uniquement certains chapitres. C'est pas tout. C'est tu vois, par exemple ils expliquent la proportionnalité, comment je peux trouver la proportionnalité.</p>		<p>Explanation on IREM</p> <p>Verb</p> <p>M'appuyer</p>

<p>R20 : Oui, bien sûr.</p> <p>ANNA20 : Il y avait un article sur les nombres relatifs que j'ai aimé bien et que j'avais beaucoup utilisé. Ils éCindynt certaines notions seulement.</p>		<p>Article from IREM: Notion explanation</p>
<p>R21 : C'était plutôt des conseils didactiques ?</p> <p>ANNA21 : Ouais, c'est plus, c'est plus "vous voulez faire ça, mais ce n'est pas juste faire ça. Vous pouvez faire ça, parce que ça travaille cette notion-là, ou parce qu'en faisant comme ça vous éviter tel ou tel écueils, etc.</p>	<p>Yes, it is more, it is more than "you can do it, but not just only do it. You can do this, because it works for this notion, or you can aviod this or this risks, etc."</p>	<p>Features of the IREM resources: More didactical suggestions, from the explanation on the notin to how to carry it out</p>
<p>R22 : D'accord.</p> <p>ANNA22 : Donc, on est vraiment sûr mettre le focus sur certaines notions difficiles et après soit le manuel il réponds, il est tout à fait dans ce...dans cette optique-là, soit tu changes et tu utilises, tu pars de cette idée pour montrer une séquence. Donc, ça c'était plus sur la (...). Bah le cours là c'était vraiment, c'était un appui pour débiter Ham.</p> <p>«</p>	<p>« ...soit tu changes et tu utilises, tu pars de cette idée pour montrer une séquence. »</p> <p>Or you change and you use, you pass this idea for <i>showing</i> a sequence</p>	<p>How to start a lesson design:</p> <p>(1) difficult notions</p> <p>(2) then two options, either the textbooks, or develop a sequence</p>
<p>R24 : Oui bien sûr.</p> <p>ANNA24 : Ou les leçons de quelqu'un d'autre. Quand je suis arrivé, j'essaie de réfléchir à qui était avec moi, quand je suis arrivée. Je ne crois pas avoir, avoir vraiment travaillé avec quelqu'un quand j'étais à (nom du collègue). Par contre quand je suis venue sur Lyon que j'ai travaillé sur. Au Bâtière, je suis arrivé sur une équipe qui travaillait déjà bien ensemble. Donc, c'est pour ça que là il y a...Il n'y a personne, il n'y a pas de personne réelle. Il y aurait à travers de</p>		<p>Second working experiences: the beginning of working together (a team who already work collectively well)</p>

cours du IEFM, tu vois d'à travers ça, il y aurait les autres stagiaires quoi.		
R27 : Et parmi ces ressources est-ce qu'il y avait ? Quelques un qui étaient essentiel pour faire ton cours ? ANNA27 : Quelques une qui m'ont suivi très longtemps c'est le suivi scientifique, ouais.		IREM suivi scientifique : Long-term used resources
R 28: On peut faire un cercle en orange, pour montrer qu'elle est...Et pourquoi tu penses qu'elle a duré aussi longtemps ? ANNA28 : Et bah, je ne sais pas, parce que je pense que c'était quelque chose qui était vraiment réfléchi, qui étaient en lien avec d'autres articles et que tu pouvais aller le chercher et lire. Et pour moi, celui-là était vraiment important. Ça vraiment c'est quelque chose, je les ai encore. Maintenant, je me sers plus, mais je me suis servi il n'y a pas aussi longtemps que ça. Et on a fait, on a beaucoup d'activité qu'on a retravaillé qui sont, qui sort des suivis scientifiques. Bon, on a fait complètement d'autres choses, mais l'idée était déjà là au départ.	And we did, we have a lot of activities that we re-worked, which were come out of the (IREM) scientific brochures.	Reflective, holds the links with other articles, provides the enter points to the research and books
R33 : Comment tu veux. ANNA 33: J'ai beaucoup utilisé Cabri, un logiciel de géométrie dynamique tu vois ?		Cabri: resources for dynamic geometry
R 39: Et aujourd'hui tu utilises Cabri ou non ? ANNA39 : J'ai utilisé Cabri très long temps, il y a Geogebra qui est sortie. Moi j'ai continué à utiliser Cabri, parce qu'on avait. Et puis parce que je l'aimais bien. Et puis, il y a tout en, tout en, fin, bref. J'ai laissé tomber Cabri, je		Change from Cabri to Geogebra, reasons on school condition, and also the habit, they had Cabri

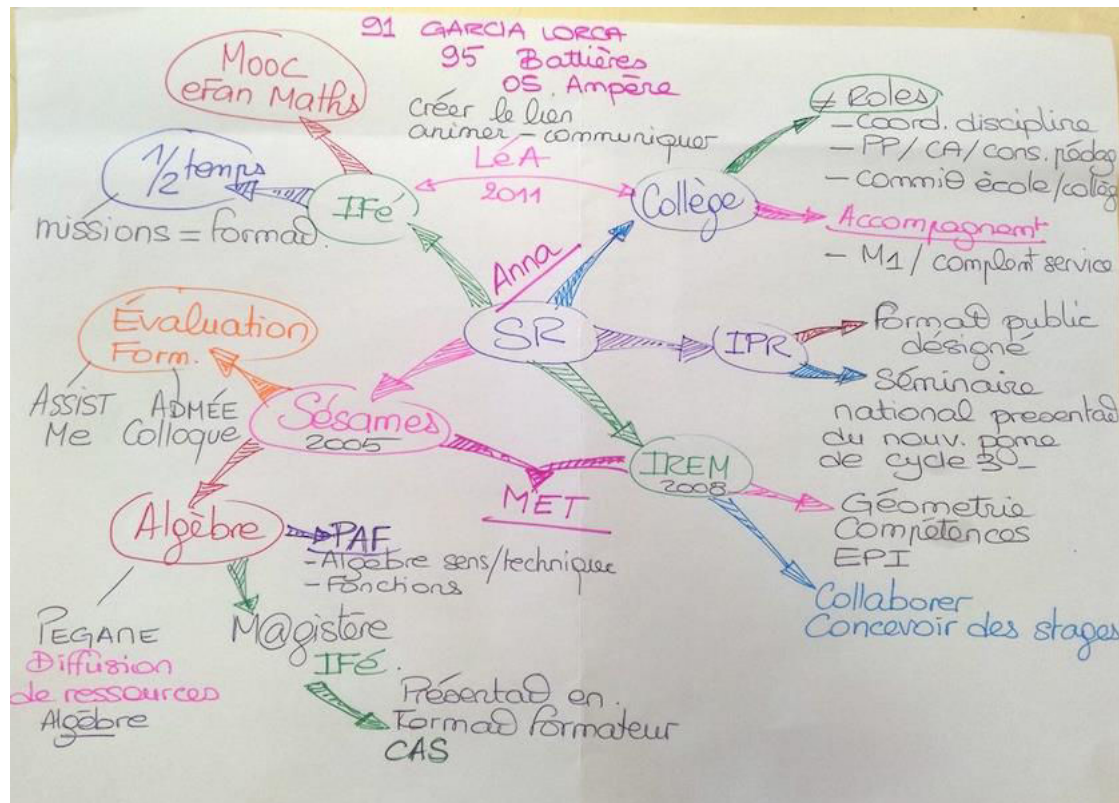
dirais que ça fait deux ou trois que je n'utilise plus. Mais jusqu'à deux ou trois ans je l'utilisais. En fait, on a pas remis sur les nouveaux ordinateurs vu que la licence, en fin, on a pas le denier. Et maintenant, on a Geogebra.		
<p>R 41: Et par rapport à ranger comment tu rangeais les ressources ?</p> <p>ANNA 41: C'était beaucoup de papier [rires]. Alors, comment je rangeais ? Je n'ai plus ça. Si j'ai peut-être un ou deux. J'avais des gros classeurs. Donc, j'avais deux classeurs pour la sixième, un plein et un vide. Et dans le plein j'avais des pochètes dans lesquelles je mettais mon cours, les ressources qui vont avec que j'agraffais. Donc, ça pouvait être quatre pochètes à graffer ou six pochètes à graffer. Je les mettais dans mon classeur dans l'ordre des chapitres que je voulais faire. Et au fur et à la mesure que je les avais faites, je les mettais dans l'autre classeur.</p>		<p>Resources en papers</p> <p>Paper resources</p>
<p>R44 : La progression tout ça ?</p> <p>ANNA44 : Voilà. Les ressources pour se rappeler d'où ça vient. Tu vois, par exemple, si j'ai mis un petit exercice et qu'il y a déjà toute une explication qui venait de butin de l'APMEP ou de suivi scientifique. Je mettais bien les ressources d'où elles venaient pour pouvoir les relire, parce que j'oublie souvent donc, pour deux ou trois ans après aller relire ce qui était. Donc, au début de l'année il en a un qui est plein et au fur et à la mesure que tu fais tes cours, tu reremplis, tu vide et</p>	<p>I put the resources well somewhere for re-reading, because I often forget it, each two or three years I will re-read it.</p>	<p>Scheme in reflecting resources</p>

tu remplis. Tu vois ?		
<p>R 45: Et ça veut dire...Donc, là c'est après utiliser ? Et ça veut dire que tu préparais tout avant l'année ?</p> <p>ANNA45 : Alors, oui, la première année j'ai dû faire que le niveau que j'ai fait, j'imagine. Et au fur et à la mesure je fais et j'ai des classeurs par niveaux. Donc, bien sûr j'ai un cours qui est tout prêt.</p> <p>Mais quand j'arrive au cours tout prêt, l'année d'après je vérifie je regarde si je veux changer quelque chose, s'il y a des nouvelles choses qui sont tombées. C'est-à-dire qu'au fur et à la mesure de l'année si jamais il y a des autres informations, moi je reglisse dans mes pochettes.</p>		<p>Scheme of refelcting</p> <p>Name: pochettes.</p>
<p>R51 : Une pochète par chapitre.</p> <p>ANNA 51: Voilà. C'est plusieurs petit pochètes accrocher. Ça c'est pour chaque chapitre. Et donc, ça c'est ici avant que ça soit fait et ici une fois que le chapitre est passé.</p>		<p>Scheme of reflecting and organizing resources</p> <p>-Classification of the resources (done or to be done, this year and next year, aotomatically reflects with notes)</p>
<p>R54 : C'était le mimographe. Quand j'étais au collège j'utilisais ça aussi avec mes profs, je les aidais à faire des évaluations, donc, voilà. Donc, ok, ça c'est pour le rangement c'est ça.</p> <p>ANNA 54: ça c'était comme ça. Et si jamais il y avait des choses à modifier, moi je modifiais et c'était repris pour l'année d'après. D'accord. Donc, voilà comme ça. Ça c'était et puis c'est devenu de répertoire, quoi.</p>		<p>Schemes in RS management</p> <p>Name :répertoire</p>
<p>R 56: C'était la première fois. Il y a d'autres échange que tu te souviens à l'époque? Quelqu'un en particulier que tu échangeais,</p>	<p>In fact that school is very difficult, and I think we thought more on the classroom gestions, but the</p>	<p>[Seine Saint-Denis] Paris : experiences in classroom organization (in practice)</p>

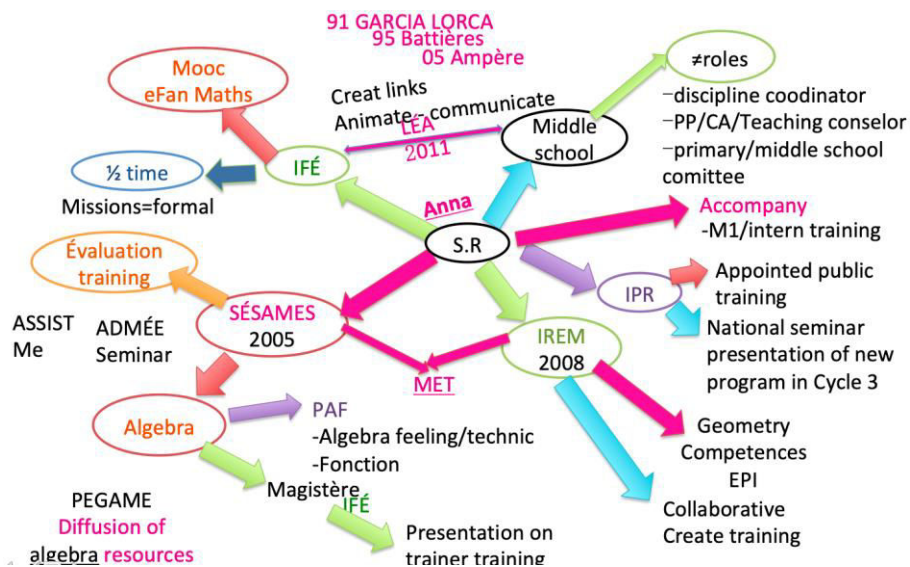
<p>parce qu'aujourd'hui tu travaille avec Cindy. Est-ce qu'il y a quelqu'un pareil à l'époque?</p> <p>ANNA56 : J'essaie de me rappeler des gens à l'époque avec qui je préparais des cours. Je ne sais plus. Je sais qu'il y avait deux jeunes, deux personnes qui est arrivé au même temps que moi. Et on avait certainement dû travailler ensemble. Mais je n'ai pas de souvenir. En fait, c'était un établissement très très difficile de [seine sait dennis], et je pense qu'on était plus sur la gestion de classe, pour travailler sur la gestion de classe pour travailler. Sur la gestion de classe je vois bien avec qui j'ai travaillé. Mais là sur les maths, c'était assez euh...Ce n'était pas chacun pour soi, mais c'était plus l'IUFM qui intervenait au départ.</p>	<p>math, is enough</p>	
<p>R57 : Et ce travail avec la gestion de classe c'était avec qui?</p> <p>ANNA57 : C'était avec un collègue de musique que c'était vraiment très très bien. Des gens de histoire et geo, des gens que je connais encore bien là. L'histoire-Geo, musique, euh, deux d'histoire-geo et un de musique. Anglais, un collègue d'anglais. Et en fait, quand on se voyait c'était plus "sur cette classe qu'est-ce qu'il faut faire pour que ça fonctionne".</p>		<p>Collective working experieces: inter-discipline cooperation on classroom management</p>
<p>R58 : Et ça a aidé à ranger le temos dans la classe c'est ça?</p> <p>ANNA58 : Oui, ça a aidé à gérer les bavardages et les incivilités...</p>		<p>Work effects of their collective work</p>

1.6.2 Reflective Mapping Resource System (RMRS) of ANNA (May 2015)

Origin drawing in French

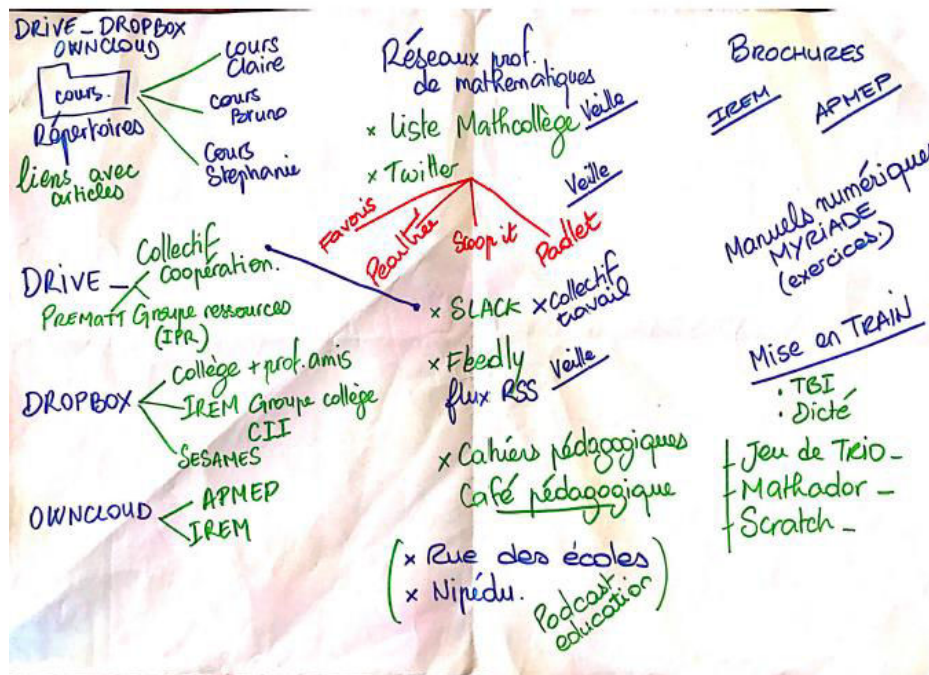


English translation

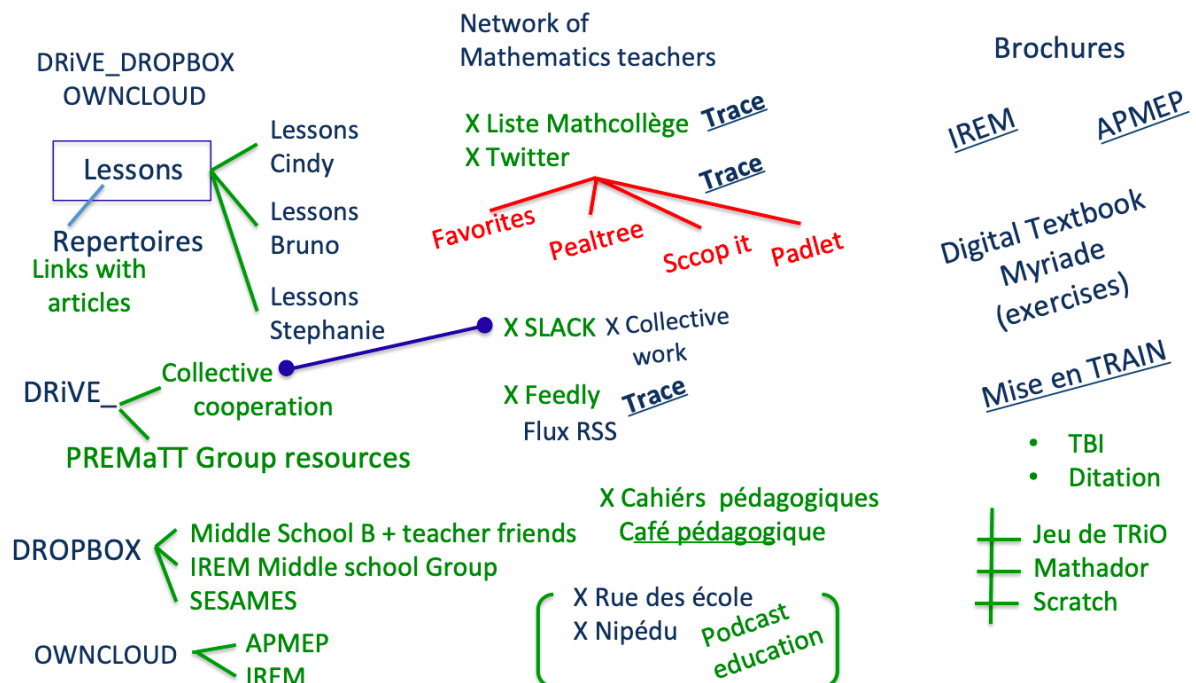


1.6.2 Reflective Mapping Resource System (RMRS) of ANNA (June 2017)

Origin drawing in French



English translation



1.7 Interview with Cindy on May 2015

1.7.1 Transcriptions

The interview was conducted in 2015, due to my French was not enough to interview completely in French, so the following transcriptions are in a mixed language.

R : I have printed the questions in French, you can answer in French.

C : On se met au bout, là, j'ai vu que la salle n'était pas ouverte. Oh, c'est gentil, ma fille va vouloir me le voler, elle adore ce genre de choses. Je vais devoir le garder précieusement pour pas qu'elle me le pique. Tu veux que je relise les questions avant d'y répondre ? Ou je réponds au fur et à mesure ?

R : Tu peux répondre seulement.

C : Je réponds seulement mais est-ce que tu veux que je lise la question ? Je lis et je réponds ?

R : Oui, bien sûr.

C : D'accord. La première : quel est mon plus haut diplôme ? Mon plus haut diplôme est une licence. Tu enregistres là ?

R : Licence, et c'est l'Université ?

C : Oui. A Lyon en 1997. Je te l'ai noté là en fait, regarde. Voilà. Ensuite j'ai commencé à travailler en tant que professeur en 2000, c'était mon année de stage. J'ai eu le CAPES en l'an 2000. En fait je t'ai re-marqué : j'ai eu la licence en 97, en 98 j'ai fait un master 1 mais je l'ai raté, en 99 j'ai raté mon CAPES et en 2000 j'ai eu le CAPES. Tu sais ce que c'est le CAPES ?

R : Oui.

C : Et après que j'ai eu le CAPES, mon année de stage était en 2000 / 2001 et j'ai été titularisée en 2001. Cela fait 15 ans que... j'ai 15 ans d'ancienneté. Avant j'étais dans un collège qui s'appelle le collège Colette. C'était un collège en banlieue lyonnaise, à Saint-Priest. De 2001 à 2006. Et je suis arrivée à Ampère en 2006. Cela fait presque 10 ans, c'est ma dixième année à Ampère. Cette année j'ai des 4^e et des 3^e. Mais par contre je peux avoir n'importe quel niveau au collège et j'ai eu tous les niveaux. L'année de stage, j'étais en seconde, c'est le premier niveau du lycée.

R : Oui. Il y a aussi cela au collège ?

C : Non. Mon année de stage, j'étais dans un lycée. Je vais te le marquer. Donc j'ai répondu aux trois questions. Alors, ma formation... La question est comment s'organise la formation en fait, c'est ça ? Quelle était ma formation ?

R : Avant de travailler.

C : Alors en fait avant de travailler, à l'époque on préparait le CAPES, donc c'était que des mathématiques, il n'y avait rien d'autre en fait. Par contre l'année de stage on était à mi-temps, ça

s'appelait l'IUFM à l'époque, Institut Universitaire de Formation des Maîtres. Donc à mi-temps on était à l'IUFM et à mi-temps on était dans un établissement. Là j'avais une classe de lycée, une classe de seconde, et dans l'organisation de la formation on avait aussi un moment où on faisait de la pratique accompagnée. Tu en as peut-être vu. C'est-à-dire qu'on allait dans la classe et on restait soit à regarder le professeur soit on préparait un cours avec le professeur et il nous regardait en train de le faire mais il restait dans sa classe. Et après, sinon, j'avais une formation, ça a duré un an. Moi je l'ai fait à Lyon et j'étais très contente, je suis très contente, non c'est vrai hein ! Les formateurs, Sera, tu la connais Sera ?

R : Oui.

C : Et bien Sera c'était une de mes formatrices en fait.

R : Mais c'est une formation pour les autres, ce n'est pas pour toi ? I mean, you train others teachers, not...

C : Now, yes, in ESPE but just in my training I was in IUFM for year and she was one of my teachers, OK ? Donc voilà, la question suivante... Cela a duré un an et c'était... qu'est-ce qui a le plus compté dans cette année ? hum... Ce que j'ai trouvé vraiment intéressant dans cette année, c'est qu'en fait on m'a donné plein d'explications, enfin non, on m'a aidée à me poser des questions. Tu vois ce que je veux dire ? C'est-à-dire qu'on m'a montré quelles questions je pouvais me poser et comment je pouvais faire en sorte après de continuer à me former, tu vois ? On m'a intéressée à plein de choses différentes, que ce soit dans la gestion de la classe ou que ce soit dans le contenu mathématiques. Moi, c'est ce que j'ai vraiment apprécié, ce n'est pas forcément avoir des réponses fermes mais plutôt qu'on me permette de pouvoir me poser plein de questions et qu'on me pousse à me continuer à me former. Et donc oui, j'ai formé des élèves, ça c'est la question, celle-ci. J'ai formé des stagiaires, de plusieurs manières. Soit en les ayant en pratique accompagnée, c'est-à-dire qu'ils viennent dans ma classe, ils font quelques cours, je les regarde, ils regardent comment je fais cours, et on prépare ensemble des cours. C'est une première forme, soit pour des master 1 soit l'année dernière j'avais un licence 3 qui faisait cela aussi et encore avant c'était des, comme moi j'avais été stagiaire, stagiaires qui venaient faire une partie de leur service comme ça. Donc ça c'est la première manière, la deuxième manière c'est des stagiaires qui sont en situation : ils ont une classe ou deux classes et moi je le tutore, on peut dire, dans l'établissement. La dernière manière c'est, comme depuis l'année dernière je suis à mi-temps à l'ESPE (c'est le nouveau nom de l'IUFM), en fait je leur donne des cours aux stagiaires, je fais des cours sur l'algèbre. Pour les étudiants et pour les stagiaires. Si tu veux, en master 1 ils préparent le CAPES : là je fais un TD, ce n'est pas beaucoup. Et après, une fois qu'ils ont le CAPES, ils sont stagiaires à mi-temps : à mi-temps dans leur collège et à mi-temps à l'ESPE et moi j'interviens soit parce que j'ai la responsabilité de certains stagiaires, j'encadre leur mémoire, ou je fais aussi certains TD.

R : D'accord. Dans le collège ils ont un professeur qui travaille comme mentor ?

C : Mentor, oui, tuteur en français. Oui. Là c'est ANNA qui est mentor des deux stagiaires. Il y a deux jeunes stagiaires qui viennent le mardi en fait. Mais d'autres années c'était moi. Donc je l'ai été, de

plein de manières différentes. Soit quand ils venaient dans ma classe, soit quand ils avaient leur propre classe et que j'allais les voir dans leur propre classe. Ensuite, la formation continue, donc... Les premières années d'enseignement, avant, peut-être jusqu'en 2008, pratiquement toutes les années j'avais des formations. Soit parce que certaines étaient proposées dans l'établissement ; comme j'étais dans un établissement difficile on avait des formations dans l'établissement en fait. Sinon je choisissais des stages : il y avait un catalogue de stages et on pouvait choisir des stages en formation continue. J'en ai fait à peu près toutes les années, sur différents domaines : soit sur des domaines mathématiques, par exemple la recherche de problèmes, soit sur des domaines plus larges, par exemple l'hétérogénéité, comment gérer le fait que les élèves ont différents niveaux. J'en ait fait presque toutes les années. Et puis après, en fait, quand je suis arrivée ici et que je suis rentrée à Sésames et puis après à l'IREM, comme on a commencé à animer des stages, et ben je n'avais plus le temps donc j'ai animé des stages mais je n'ai pas assisté à des stages : j'ai changé de position. Mais le travail dans les groupes IREM et Sésames, c'est un petit peu comme de la formation continue parce qu'on échange avec d'autres qui nous apportent des choses, etc. Mais c'est vrai que des fois ça me manque un peu de ne plus faire de stages. Voilà. Après c'était un peu, tu sais, dans l'année, quelques jours, exactement comme nous on anime, comme ce que tu as vu. Mais c'était moi qui y allais. Alors là j'ai répondu... Qu'est-ce qui est le plus important ? Et donc presque tous les ans... Ce que je trouve intéressant dans les stages, c'est le fait qu'on travaille à plusieurs, qu'on rencontre des nouveaux collègues qu'on ne connaissait pas avant, et qu'on peut travailler avec eux. Et puis il y a un apport théorique quand même, souvent, ce qui permet de nous former, d'avoir une réflexion plus profonde sur des thèmes qu'on n'avait pas forcément abordés avant. Et puis après, c'est pareil aussi, dans des termes pratiques on a un apport d'activités nouvelles, de nouvelles idées, qui nous permettent de renouveler notre pratique en fait. Voilà. Ce sont les trois points qui sont importants. La question suivante c'est sur le stage auquel tu as assisté cela fait depuis 2008 à peu près que j'anime des stages. Voilà. Pourquoi est-ce que vous faites ce travail ? J'adore cette question. Donc, déjà l'idée de faire des formations c'est parce que j'ai intégré les groupes, c'est vraiment... ça vient de là. Dans les groupes on animait des stages, donc IREM et Sésames. Sésames d'abord parce que c'est le premier groupe que j'ai intégré. Il y avait des stages organisés par l'IREM et par Sésames et donc j'ai commencé à en faire et petit à petit, au fur et à mesure... au début on nous disait « il faudrait faire ce stage, est-ce que cela vous intéresse de faire ce stage ? » et petit à petit on s'est mis à en proposer en fait. Par exemple celui que tu as vu, sur la mise en train, c'est ANNA et moi qui avons plus ou moins eu l'idée de faire ce stage. Voilà. Alors qu'au début c'était plutôt « bon il y a ce stage à faire, est-ce que vous voulez vous en charger ? » sachant qu'on est dans la conception... enfin les stages qu'on a animés, c'est vraiment nous qui les avons complètement préparés. J'ai commencé à travailler avec ANNA quand je suis arrivée au collège en fait, d'abord pour préparer des cours et puis ensuite quand on est allé dans les groupes. Mais depuis le début on travaille ensemble, tout de suite. Mais avant, dans le collège, on préparait nos cours ensemble. Donc en 2006. Où est-ce qu'on prend les ressources pour les stages ? C'est une question difficile. Par exemple à Sésames, Sylvie (qui est la chercheuse qui parraine le groupe) va nous donner par exemple des fonds théoriques, des articles à lire, des choses comme ça. Cela sert de ressources de réflexion pour pouvoir faire le stage. Après, dans les contenus, tu vois, par exemple les activités qu'on va prévoir ou les choses comme ça, ça ce sont des choses qu'on fabrique

nous. Par exemple si je prépare avec ANNA, on va travailler ensemble et dire « tiens moi j'ai proposé telle activité, est-ce que ça t'intéresse ? » et en fait on fabrique ensemble les activités qu'on va proposer. Donc voilà. Avec une ingénierie qui est un peu tout le temps la même : c'est-à-dire beaucoup mettre les stagiaires en activité, leur permettre d'élaborer des ressources, leur proposer par exemple si on veut qu'ils élaborent des exercices, par exemple élaborer plusieurs mises en train ensemble, on va leur proposer des choses qu'on fait nous et puis... pour leur donner des idées par exemple. Mais ces ressources-là, ce sont des choses qu'on fabrique nous en fait. Après, l'ingénierie de formation, c'est une chose un peu classique je pense, la manière dont on organise les choses, dont on organise la journée. On avait fait une formation avec ANNA à l'IFE, enfin ça s'appelait l'INRP avant, sur la formation de formateur et donc je pense qu'on est parti un petit peu de là aussi pour bâtir notre manière d'animer le stage, enfin d'organiser le stage. Et après, sinon, on se rencontre avec ANNA ou avec d'autres collègues quand c'est avec d'autres collègues qu'on anime. Sésames, je n'anime pas forcément avec ANNA ; Sésames des fois j'anime avec d'autres collègues. Donc on se rencontre, on réfléchit ensemble à une trame, après des fois on retravaille séparément certaines parties et après on se remet d'accord ; par exemple s'il y a une présentation à faire ou un Power Point, souvent on va commencer à le préparer chacun de notre côté, enfin un document chacun, et après on se remet en commun pour être sûr qu'on est bien d'accord sur les choses. Il y a des aller-retours en fait entre tout seul et ensemble. Quand on travaille ensemble sur les ressources, c'est ce que je disais tout à l'heure. ANNA a, comment dire, elle a une très grande culture des activités : elle a une grande connaissance de plein, plein d'activités différentes et elle sait très, très bien chercher en fait, elle trouve plein d'informations que nous, quand on cherche sur internet, on ne trouve pas les mêmes choses qu'elle. Elle sait faire des liens... En termes de contenu de ressources, enfin d'idées de ressources, elle va être vraiment d'un très, très grand apport. Après, je pense qu'on se complète quand on travaille ensemble parce que l'idée de base de la ressource souvent, je trouve, vient d'elle mais par contre après on va la travailler ensemble, on va débattre, négocier... Et je pense que ça, ça fait avancer notre réflexion et finalement dans la forme finale je pense que j'ai participé autant que ANNA. Mais par contre c'est vrai qu'au départ, souvent, l'idée de l'activité, enfin le thème... ANNA... alors elle me dit que c'est parce qu'elle est plus vieille, je ne suis pas sûre que cela soit ça mais... voilà. Souvent ANNA a cette idée de départ et après voilà, ça permet... comme une veille scientifique en fait. Elle a cette veille où elle guette, où elle trouve des choses. Après, dans l'organisation, je pense qu'on fait les présentations ensemble, on fait le déroulement ensemble. Je pense que des fois en termes de plan, souvent, on aboutit à une idée où finalement on arrive à faire avancer le plan des présentations ou le plan... parce qu'on a vraiment travaillé toutes les deux dans ce terme-là. Sur l'échange de ressources, en effet on a une Dropbox, on a un Drive, un Google Drive, on a plusieurs... En fait moi la Dropbox n'est pas assez grosse donc en fait on a plein de plateformes différentes. Et là maintenant on a aussi un Framapad, Frama je ne sais pas quoi, comment ça s'appelle ? Je ne me rappelle plus comment ça s'appelle. ANNA te le dira.

R : C'est un disque en ligne ?

C : Oui, c'est un Cloud, c'est une autre marque de Cloud. En fait on a trois Cloud différents. Mais c'est juste une question de taille. Ce n'est pas... C'est limité en taille donc on est obligé de mettre des

trucs... Mais le principal c'est Dropbox.

R : Trois Dropbox ?

C : Non, une Dropbox, un Google Drive, et un autre truc dont je ne rappelle plus... Mais qu'on vient de prendre. Un truc Framapad.

R : Et le contenu est le même ?

C : Non, le contenu n'est pas le même. Parce que sur le Google Drive on a, par exemple avec ANNA ce qu'on a préparé, elle t'en a parlé, pour Hatier, l'éditeur. Elle t'a dit qu'on travaillait pour faire des ressources pour un éditeur ? Tu sais ce que c'est un éditeur ? C'est quelqu'un qui fabrique des manuels. Nous on travaille pour Hatier.

R : C'est le nom du manuel ?

C : Oui, c'est le nom de l'éditeur. Au début, tu sais peut-être pas, on a... ils nous ont proposé de faire un manuel scolaire mais en fait notre équipe n'a pas été retenue et là ils nous ont proposé quand même de continuer à travailler sur des cartes mentales et sur des mises en train, pour une plateforme en ligne. Donc ça ce sur le Google Drive. Sur le troisième truc, pour l'instant on n'a presque rien parce qu'on vient de l'ouvrir il y a 15 jours. C'est nouveau. Et sur la Dropbox on a tout le Sésames, tout l'IREM et tous nos cours. Les cours du collège. Et moi j'ai l'ESPE aussi, que j'ai partagé avec ANNA.

R : Et le Google collège est pour les autres professeurs aussi ?

C : Oui. Les cours du collège, les autres professeurs du collège et d'anciens collègues les ont aussi. Quand un collègue vient on partage. Tu vois, le collègue de maths, on lui partage aussi. Alors, comment j'ai appris à travailler les ressources ? Hum... Je pense que d'une part dans la formation de départ on nous a fait travailler sur ce qu'il fallait regarder dans la ressource : l'activité de l'élève, essayer de prévoir les erreurs qu'il pouvait faire, réfléchir sur les objectifs de l'activité, est-ce que vraiment les questions comme elles sont posées vont aller dans le sens de l'objectif ? donc il y a une part de formation de départ. Et puis après je pense que c'est sur le tas. Passée cette formation de départ je n'ai jamais eu d'autres formations. Moi, par exemple, les premières années d'enseignement, quand je préparais mes séquences et les activités, à chaque fois que je faisais l'activité je me faisais une petite page où je marquais les erreurs nouvelles que j'avais découvertes, ce qui n'avait pas marché, ce qui avait marché, pour pouvoir après améliorer la ressource, poser différemment les questions, etc. Mais voilà, il n'y a que dans la formation initiale que j'ai appris à faire ça. Les compétences nécessaires pour travailler les ressources ? Je pense que pour travailler une ressource, il faut être à l'écoute des élèves parce que finalement, souvent, la première fois qu'on essaye une activité, même si quelqu'un d'autre l'a fait avant nous, souvent ce n'est pas extraordinaire parce que même si quelqu'un d'autre nous a dit « les élèves vont dire ça etc » on ne sait pas bien comment réagir, comment orienter, comment mener vraiment précisément l'activité pour aboutir exactement à ce qu'on veut. Donc je dirais que finalement, pour pouvoir améliorer nos ressources, pour pouvoir retravailler dessus, il faut la faire en classe et être à l'écoute des élèves et après pouvoir en discuter avec d'autres gens. Des fois par exemple quand je fais une activité ou que ANNA fait une activité, on en parle, ou dans le groupe

Sésames on en parle, et en disant « moi j'ai fait cette activité-là, les élèves ont réagi comme ça » et puis ça permet après d'améliorer l'activité, de retravailler l'activité, peut-être de changer des questions ou de la mettre à un autre moment dans la progression, etc. Donc je dirais l'écoute des élèves et le travail avec d'autres professeurs, le travail collectif. Est-ce que je peux décrire mon travail à l'école ? Tout mon travail ? Cette question-là... In this school ? Everything ? Every task ?

R : Every task.

C : J'assure les cours. Est-ce que tu veux que je décrive comment j'assure mes cours ?

R : Oui. La 4^e et la 3^e. Et combien de classes ?

C : Trois. Parce que je suis à mi-temps à l'ESPE. J'assure mes cours. Comment dire ? Elles sont difficiles parfois, tes questions. Il y a à la fois une part de... Il faut avoir bien sûr préparé les cours ; ensuite il y a une part d'explication des consignes, de faire passer les consignes ; ensuite il faut faire attention à bien laisser du temps aux élèves pour faire les activités qu'on a demandé ; et après, une grande part du travail consiste aussi à arriver à animer les mises en commun c'est-à-dire à voir comment chaque élève peut apporter quelque chose. Par exemple quand on cherche une activité : comment est-ce qu'on va faire circuler la parole ? comment est-ce qu'on va faire en sorte qu'une nouvelle connaissance émerge de l'activité qu'on a faite ? Donc ça c'est plutôt avant d'institutionnaliser la connaissance. Après, bien entendu, il y a des moments où on va écrire dans le cahier de leçon, vraiment institutionnaliser fermement la connaissance. Et après, des moments d'entraînement où là ça va être plus... par exemple je vais plus circuler dans les rangs, aider les élèves un à un, et puis à ce moment-là, par exemple, sur les corrections de ce type d'activité ce sont les élèves qui iront par exemple au tableau, ils corrigeront et moi après je prendrai un petit temps avec les élèves en disant « regardez bien la correction, pensez qu'il ne faut pas faire telle ou telle erreur » mais ce sera plutôt quelque chose de plus court. Ce n'est pas la même chose que le débat après l'activité où là vraiment les élèves vont avoir à échanger des idées, à avancer ensemble en fait. Ça, c'est pendant l'heure de cours, ça suffit ou il faut plus de choses ?

R : C'est ça.

C : Après, est-ce que tu veux que je dise en plus ce que je fais en-dehors des cours ?

R : Yes

C : Le LEA c'est l'IFE qui... et le collège en fait. LEA ça veut dire Lieu d'Education Associé donc le collège, avec un peu le lycée, ça ne marche pas très bien en ce moment. Mais le LEA en fait, c'est le collège qui travaille pour l'IFE d'une certaine... on est censé travailler avec l'IFE sur des thèmes mais... D'autres années j'ai été responsable du LEA, comme ANNA l'est maintenant, mais là cette année je n'ai pas l'impression d'avoir fait quelque chose pour le LEA. Cette année on a travaillé sur notre projet, c'est ... sur l'évaluation mais c'est plutôt ANNA qui a travaillé dessus et moi, l'année dernière on avait bâti des ressources pour faire... pour les 4^e sur l'algèbre mais finalement on a un peu travaillé dessus mais on n'a pas beaucoup repris, on ne s'est pas filmé.

R : Dans ...il y a aussi une partie de Sésames ou IREM ?

C : Non.

R : Seulement IFE ?

C : Oui. Non, après, c'est une étude européenne donc c'est Icare d'ailleurs mais par contre le dossier qu'on a fait pour le LEA, on l'a fait en disant qu'on travaillait sur l'évaluation.

R : Icare c'est ?

C : Le laboratoire. Sésames c'est un groupe, ce n'est pas le même. Icare c'est le laboratoire ; dans ce laboratoire il y a Sara et donc le groupe Sésames est relié à Icare par Sara

R : A chaque fois je vais à la réunion de Sésames et ils sont...

C : On est au laboratoire Icare, oui. En fait Sésames dépend de Icare mais IFE est le financeur. D'accord ?

R : Donc le travail IREM....

C : IREM c'est séparé. L'IREM est financé par la DAFOP c'est-à-dire la formation continue. Et Sésames est financé par l'IFE. Tu vois, Sésames est dans Icare. Le LEA en fait, pour continuer à avoir des financements de l'IFE Sésames s'est mis dans le LEA, a fabriqué un LEA. Après dans l'école, moi je suis professeur principal de 3^e donc je m'occupe des élèves, je fais des projets mais qui n'ont pas forcément à voir aux mathématiques. Je ne sais pas si tu veux que j'en parle aussi.

R : Le projet avec LEA ?

C : Cette année, moins. Cette année on a moins travaillé dessus. Après j'ai un projet par exemple sur les élèves en difficulté avec un professeur de sciences physiques et un professeur d'EPS. Voilà, tu vois, je participe à d'autres choses qui ne sont pas forcément pas que pour les mathématiques. J'ai beaucoup aimé la question suivante. Donc en fait non, je n'ai pas de bureau, non je n'ai pas de table personnelle dans l'office commun, non je n'ai pas d'ordinateur personnel, et non je n'ai pas de portable. Je n'ai rien de tout cela. Alors j'ai un ordinateur dans ma salle mais par contre, tu vois, par exemple ce matin on ne peut pas aller dans ma salle parce qu'il y a quelqu'un d'autre qui y est : je partage ma salle avec d'autres gens donc en fait je n'ai pas d'endroit... Tu vois, on est ici, dans une salle commune. Par contre il y a un VPI (vidéoprojecteur interactif)...

R : Dans la salle d'étudiants ?

C : Oui, dans la salle de classe. Les livres de classe, on peut les avoir ici ou on nous les donne. Après on a, sur le réseau informatique, toutes les applications dont on a besoin et puis si on veut aussi on a la salle informatique ou on a des tablettes aussi qu'on peut emprunter et prendre avec nos élèves, mais pour l'instant je n'ai jamais utilisé.

R : Cette salle est pour tous les enseignants ?

C : Oui, la salle ici est pour tous les enseignants. Tout à fait. Attends, je vais chercher un kleenex.

Donc voilà... Et après finalement, on utilise la Dropbox, tu vois, pour repartager. Souvent quand on fait quelque chose on le met sur la Dropbox, l'autre peut le prendre. Par exemple en 3^e on fait que des devoirs communs donc il y en a un qui fait le contrôle et tout le monde le donne pour ses classes. Qu'est-ce que j'utilise ? Le VPI tous les jours, tout le temps ; l'ordinateur qui est dans la salle forcément ; après j'utilise aussi des manuels de classe ; par contre sur les sites je n'utilise pas... des fois j'utilise comme ressource le manuel Sésamaths, des fois je projette des exercices mais en fait moi je n'aime pas trop le manuel Sésamaths donc en fait souvent je prends des petites parties et je les change : je m'en sers plus parce que cela me fait une base et puis après je modifie pour que cela me convienne et je projette cela. Mais je l'utilise très peu tel quel. Est-ce qu'on a d'autres ressources en commun ? Au niveau des maths ou au niveau... ? En fait, grosso modo, sur la Dropbox on est tout mélangé, on partage beaucoup de choses. Moi je partage tout, après par exemple ANNA aussi partage tout, après Fabien qui vient d'arriver met des choses mais pour l'instant avant il n'avait pas organisé tous ses cours pour les mettre dans la Dropbox donc il n'a pas tout mais il suffit de lui demander et après il partage.

R : Combien de fichiers ? Par exemple un fichier pour seulement toi, ANNA, Fabien et un autre pour tous les mathématiques ?

C : Non, on partage tout avec tous. Même plus. Par exemple...qui est là depuis cette année, toutes les classes qu'il avait, on lui a ouvert la Dropbox pour qu'il puisse avoir accès à tout ce qu'on a fait.

R : Et aussi avec les enseignants d'autres disciplines ?

C : Pour les autres disciplines non, parce que... enfin on a d'autres dossiers en commun, si on travaille sur quelque chose avec eux ; par exemple le professeur de sciences physiques et d'EPS avec lesquels je travaille, j'ai une Dropbox avec eux. Ou sur des documents communs on a une Dropbox pour le collège qui est commune à plein d'enseignants. Par contre les choses que pour les maths, elles sont partagées entre tous les collègues de maths et même ce n'est pas rare que d'anciens collègues gardent l'accès à la Dropbox et continuent à aller piocher des choses s'ils ont besoin. Toutes les activités, tout, s'ils ont besoin. Pour les autres groupes, donc... ça j'ai déjà répondu. Donc l'IREM, oui ; LEA, pas trop. On essaie de se voir cette année le jeudi, avec les profs de maths. Le jeudi de 11 à 12. Mais tu es déjà venue. Mais on ne se voit pas forcément tout le temps. Et puis sinon, c'est vrai que comme je fais partie de l'autre projet avec le professeur d'EPS et de sciences physiques, on se voit régulièrement une fois par semaine aussi, pour préparer des choses, pour préparer le projet. L'IREM, j'ai commencé à travailler en 2008. Le Sésames en 2007. Comment je suis devenue membre ? Pour Sésames, c'est ANNA qui m'a proposé, parce que ANNA y était avant. Et pour l'IREM ce sont les collègues de l'IREM qui nous connaissaient qui nous ont proposé. Les deux ce sont des collègues qui nous ont proposé en fait. Le travail dans ces groupes est de plusieurs sortes. Soit d'élaborer des exercices, élaborer des ressources : on a travaillé sur certains problèmes, des choses comme ça, où on a échangé en se disant qu'on pourrait... concrètement la fabrication de l'activité. C'est une première partie. Ensuite il y a une deuxième partie qui serait sur l'élaboration globalement de documents. Par exemple cette année à Sésames on essaie de présenter une brochure dans laquelle on essaierait de présenter notre travail. Cela peut être des temps de coordination en fait, on se met d'accord, on se répartit le

travail, on regarde ce que chacun a fait pour le commenter, etc. On a aussi écrit des articles, donc là c'est pareil, on va en discuter pendant les groupes. Et puis on prépare des stages. Il y a un temps aussi de travail en commun sur la préparation de stage. Je travaille avec ANNA à l'IREM et au Sésames.

R : LEA ?

C : Pour le LEA aussi, oui. Mais c'est vrai que le LEA est intégré dans le Sésames. Enfin disons que c'est Sésames qui travaille pour le LEA. Quand est-ce que j'ai commencé à travailler avec ANNA ? En 2006, quand je suis arrivée au collège. Et sur quelles activités je coopère avec elle ? Je pense sur la conception d'activités.

R : Sur Sésames.

C : Oui, sur l'IREM.

R : Sur Sésames, quels projets ou tâches ?

C : Alors cette année, une brochure. Mais chaque année on a des projets différents. On a fait trois articles au fur et à mesure des années, animé des stages et cette année une brochure. It's like un small book with three parts to explain choice with activities we, teachers, propose at the end. So we must write the first part, second part, third part etc and then describe activities and describe the tasks for the pupils, pupil's reactions and then take some pictures and explain. OK ? It's not very easy to speak english. Tous les collectifs m'influencent. Soit parce que... De trois manières je dirais. La première, en effet, en apportant concrètement des sortes d'activités auxquelles je n'aurais pas pensé, des activités que je ne connaissais pas et qu'on propose ou qu'on échange dans les groupes. D'une deuxième manière : parce qu'on discute ensemble de ces activités donc le travail collectif d'élaboration. Et puis ensuite aussi sur la manière de voir les choses des autres enseignants. Par exemple le travail que je fais avec le professeur d'EPS et de sciences physiques : on est des matières différentes donc on ne travaille pas, on n'a pas les mêmes rapports avec les élèves, on ne va pas proposer le même type concrètement de tâches à faire aux élèves et donc cette ouverture d'esprit-là aussi apporte et elle modifie le travail, la manière de travailler sur les ressources. Donc tous les collectifs. C'est bon ? Où est-ce que je prépare mes cours ? Je prépare mes cours pendant les vacances, à la maison, ça peut être avec ANNA ou toute seule, et je prépare aussi mes cours le soir ou le weekend à la maison, en semaine ce serait plutôt le soir, après le coucher des enfants, 21h / 23h. Là c'est si j'ai besoin de temps. En fait il y a plusieurs choses à préparer. Soit je vais préparer une séquence complète : donc ça j'essaye, si je veux rechercher plein d'activités, refabriquer une séquence complète, je vais le faire pendant les vacances plutôt, pour avoir du temps pour vraiment passer plein d'heures là-dessus, ça donne un cadre général sur un thème, il faut vraiment du temps, je le fais pendant les vacances. Mais je ne re fais pas toutes les séquences complètement chaque année, je ne rechange pas toutes les activités parce que des fois, quand on fait une activité une année il faut quand même la faire plusieurs fois avant d'être sûre, avant de se s'en lasser et avant d'être sûre d'avoir tout compris de cette activité et d'avoir tout pu exploiter. Donc ça c'est la première manière. Après, le soir, par exemple je vais juste... j'ai modifié mon plan de séquence et il faut que j'élabore la fiche d'activité par exemple, ça c'est le papier que je vais donner aux élèves, ou ce que je vais projeter au

tableau : ça je le fais le soir, cette élaboration-là. Et puis ce que je vais faire aussi, je le fais plutôt le vendredi et le weekend cette année... le vendredi je n'ai pas cours de 11h à midi et ce que je fais c'est qu'au collège je prends l'heure de 11h à midi et je cadence mes cours pour la semaine suivante. C'est-à-dire que ma séquence est pensée avant et en fait je vais dire « je suis dans ce thème-là donc lundi je vais faire telle chose avec les élèves de telle classe, je vais faire ça puis ça » donc je planifie sur la semaine ce que j'ai fabriqué en amont. Tu comprends la différence entre les deux ?

K : Un peu.

C : I try to explain this in english ? So... I build the all sequence like « equations » or « proportionality » ; I build this during holidays and not weekends because it means lot of time to think about stuff. And then, every week, I... all for the next week. I put all the stuff I built in the plan.

R : And you share with... ?

C : No, no.

R : You use your own lesson plan ?

C : Yes. I get a progression on the year, it's the same for all the teachers but one hour after one hour...

R : You can decide.

C : Yes, I decide. I ask Fabien for example « I'm doing this, what are you doing as mise en train ? » and we just discuss and I take ideas or so I can do this before this, etc. But all schedule processing for the week I'm doing this alone. And just at the end of the week for the next week.

R : And also you can share the lesson plan ?

C : Yeah but I'm doing this on Pronote. You know this software for all the stuff ? And I'm doing this « on Monday I'm doing this, on Tuesday I'm doing this » to be online for the pupils. OK ? So the academic year plan, we do it together but we don't discuss ...to change some stuff but I think we just agreed. It's a couple of hour discussion with ANNA and Fabien and perhaps if there is a new teacher at the begining of the year we just try to discuss with them if they want to change some stuff. So we can. It's very...

R : ... hard.

C : Yes.

R : They gave me only this and I need to make the questions on my own.

C : It's very different because if I must search for some news activities, build the activities with the idea I found in Bulletin vert de la APMEP, you know Bulletin vert de la APMEP ? last year for example I found a stuff on the théorème de Thalès, then I take the idea and I spent a lot of hours to build the activities, it's very long, if I don't want to change all the stuff for the notion it's not so long : I change perhaps the activities but small parts so it's not very long. It depends on the year, if I'm not happy with the stuff. I think I've answered this question.

R : Yes.

C : Yes, I'm working during my holidays.

R : Tu travailles sur le travail qui demande ?

C : Sur quoi je travaille tu veux dire ? Je n'ai pas compris ta question.

R : On the work which needs a lot of time ?

C : Oui, ce qui demande plus de temps.

R : English is better.

C : Oui, je travaille sur ce qui demande le plus de temps et souvent on essaie de travailler au moins une fois ou deux avec ANNA. Là avec ANNA on va travailler sur les stages ou sur des ressources par exemple pour Hatier. On va travailler sur des choses un petit peu extérieures parce que cette année avec ANNA on n'a pas de niveau en commun. Par contre quand on avait des niveaux en commun, on travaille, on échange sur des activités pour nos élèves. Donc on va travailler différemment. Après, souvent je travaille au début de l'été, quand je range mes cours, là je prends un petit moment pour essayer de voir quelles activités je pourrais changer, pour essayer de prévoir, et souvent à la fin de l'été (au milieu j'ai parfois un petit peu de temps) mais à la fin, la dernière semaine, je vais travailler toute la semaine aussi pour être prête pour plein de chose, pour voir ce que je peux modifier, etc. Voilà. Et puis sur les petites vacances, je travaille toujours forcément au moins 3 jours, 4 jours. Euh non, je n'ai jamais appris aux autres comment fabriquer des ressources. Je pense que des autres collègues, des autres disciplines par exemple, j'ai plus travaillé sur la manière d'organiser la classe, le travail en classe, que sur l'élaboration de ressources. Je ne crois pas, je n'ai pas souvenir d'avoir travaillé sur comment élaborer des ressources.

R : Mais dans le nouveau programme il y a les intra...

C : Les EPI, oui, mais les EPI finalement... On va travailler en commun sur des thématiques mais finalement on va réfléchir... En fait on n'a pas encore fait mais tu as raison. Tu vois, je réfléchis par exemple avec deux autres collègues des autres disciplines où c'est presque comme un EPI : pour l'instant le plan de séquence par exemple, moi le plan du cours enfin de l'heure, c'est moi qui l'ai fait parce que j'avais besoin de noter des choses. Après il y a un autre collègue qui l'a modifié et puis on a discuté en disant comment est-ce que l'on va présenter cela, mais finalement pour l'instant on a juste commencé à discuter et c'est vrai que tu as raison, pour les EPI il va falloir aussi fabriquer des ressources en commun. Mais l'instant, à part ça, je ne l'ai pas encore fait. Avec les professeurs de mathématiques je partage mais pas trop avec les autres, sauf sur le projet particulier que je fais avec les autres. Oui, on collabore avec les autres professeurs de mathématiques. Donc ça je t'ai déjà répondu à peu près et je t'ai répondu aussi avec les autres disciplines. Tu sais ce que c'est l'EPS ? C'est le sport. J'aime beaucoup cette question. Alors collecting c'est ANNA, moi je suis bonne à adapting et ...mais collecting c'est ANNA.

R : C'est parfait pour l'équipe.

C: D'où viennent les ressources ? D'où viennent mes ressources... de l'IREM, des brochures, de l'APMEP, ça c'est pour les activités, les idées d'activité, des groupes de recherches. Par contre pour par exemple des exercices d'application ou d'entraînement, ça je prends soit dans les livres ou je modifie, ça peut être Sésamaths, des fois je modifie des choses moi-même mais je me base sur les activités des livres pour les entraînements en fait. Quand j'ai besoin de ressources je cherche vraiment dans les brochures et avec ANNA. C'est vrai. 5, ça fait beaucoup. Moi je pense que vraiment, en tout cas ce que je conseille aux stagiaires, je vais le dire plutôt dans ce sens-là, ce que je conseille aux stagiaires quand ils cherchent des ressources, c'est vraiment les brochures IREM et les brochures de l'APMEP. Voilà. Les publications de l'IREM, de l'APMEP, parce que c'est là où on trouve vraiment plein d'idées. Et puis parce que ce sont des choses... les gens qui les proposent ont réfléchi et ont une approche des mathématiques qui est proche de la mienne. Je n'ai plus du tout de papier. Non. Je ne vais pas dire ça. Par exemple sur le projet avec le professeur d'EPS et de sciences physiques, comme c'est nouveau et que je n'ai jamais fait ça, j'ai imprimé mon cours sur papier. Sinon je n'imprime jamais mon cours sur papier. En fait que je le fais, je l'ai en tête et puis sinon je me le mets sur l'ordinateur et tout est sur l'ordinateur. Je n'imprime jamais rien, j'ai des gros classeurs avec tout plein de vieilles activités et je ne les utilise jamais, jamais. Puis maintenant... avant on avait besoin de matériel physique. Par exemple quand on n'avait pas de vidéoprojecteur on avait un rétroprojecteur, tu sais ce que c'est ? Une lampe avec un miroir et qui projette au tableau. Par exemple on faisait des découpages et on montrait le découpage ou alors on préparait un transparent et on écrivait dessus, maintenant on n'a plus besoin. Donc en fait c'est pour ça que je n'ai plus besoin de papier. Je fais très peu de photocopies pour les élèves puisque je projette ce qu'on fait et eux prennent des notes, ils écrivent. Donc je n'ai presque pas de papier. Sur la Dropbox. Je garde tout ça sur la Dropbox partout, tout le temps. La littérature, qu'est-ce que tu appelles la littérature professionnelle ?

R : Par exemple des articles... Ou des livres professionnels. Des magazines.

C : Dans les magazines, c'est le Bulletin vert de l'APMEP, je suis abonnée. Et puis l'autre, les magazines de l'APMEP. Et après, en fait, je vais plutôt lire, c'est souvent Sylvie qui nous conseille des lectures. Et puis moi de mon côté il m'est arrivé, mais c'est plus pour l'ESPE en fait, quand j'ai les stagiaires, de relire d'autres articles qu'on conseille par rapport à ça. Et après, par exemple, je vais avoir les documents, dans la littérature professionnelle on peut peut-être compter les documents d'accompagnement des programmes, des choses comme ça, donc ça oui, je consulte ça. Mais souvent ce sont des choses qu'on m'a conseillées en fait de lire. Sylvie nous conseille beaucoup de lire des choses, elle nous envoie des articles, etc. Après il y a différentes choses parce que l'APMEP je vais plutôt chercher des idées d'activité, des idées, voilà et après des articles comme les articles de Sylvie, ça va être plutôt des choses qui permettent de réfléchir à de l'information, de réfléchir à un autre niveau en fait. Après ça influe aussi dans la classe parce que par exemple il y a 15 jours on travaillait avec une collègue du groupe Sésames sur un article de Chevalard et donc en fait en lisant l'article ça permet après de faire des liens avec des choses qu'on fait donc ça ne s'applique pas directement mais par contre ça permet plus globalement de réfléchir à la manière dont on enseigne, de lire ces articles. Donc ça, ça va avec en fait. Pour la classe finalement, moi j'ai répondu un peu à l'autre question, c'est aussi finalement cette littérature professionnelle qui sert surtout à me former moi et j'espère que ça me

permet d'être une meilleure enseignante. Non professionnelles, alors qu'est-ce que c'est les ressources non-professionnelles ?

R : Par exemple, YouTube, Facebook...

C : Alors j'utilise assez peu. Si, des fois par exemple je vais utiliser des petits vidéos qui sont sur YouTube mais c'est quand même des choses... enfin des choses proposées pour l'enseignement en général. Ar c'est vrai qu'il y a des gens sur des sites internet qui proposent des petites vidéos qui servent de support à des activités donc je vais pouvoir utiliser ça mais ça reste quand même... Oui, ce n'est pas institutionnel, ce n'est pas des chercheurs mais par contre ce sont quand même des gens qui proposent des activités de maths. J'utilise quand même principalement des choses sur les maths. Pour ma formation à moi, je ne crois pas que j'utilise des choses, pas de choses non professionnelles. Alors, 5 ressources qui sont importantes pour moi, qui m'aident dans mon travail ? What kind of ressources ?

R : par exemple le web...

C : Ah des sites web !

R : Livres, forums...

C : Pas de forums, je suis un peu old school. Des choses que j'utilise régulièrement...

R : Par exemple quand tu veux rechercher les ressources pour la préparation de classe, où est-ce que tu cherches ?

C : Euh, l'IREM, l'APMEP...

R : C'est plus professionnel.

C : Oui. Après, il y a beaucoup de choses qu'on développe parce que, tu vois, qu'on va s'être échangé dans les groupes en fait. Tu vois par exemple, on a un collègue, Olivier et lui il a toujours plein de nouvelles idées et c'est pareil, moi je vais essayer de me saisir de ses idées à lui. Moi finalement je vais plus travailler de manière collaborative qu'en cherchant sur des sites internet. Mais par exemple, quand je retravaille un nouveau thème, on a des brochures, je vais plutôt travailler là-dessus ou s'il y a le site internet qui va avec, sur le site internet. C'est plutôt ça. Et puis vraiment je vais piquer des idées aux gens. Je ne suis pas très bonne pour chercher, je te l'ai dit, je ne suis pas très bonne pour chercher les ressources moi : j'écoute ce que les gens me disent et je me saisis de ce qu'ils proposent. Voilà. Non, je n'ai pas de choses qui ne sont pas populaires. Pour les évaluations sommatives, souvent en fait je reprends des exercices que j'ai déjà faits en modifiant, par exemple des exercices qu'on aurait fait en classe je vais proposer un peu le même genre d'exercice et parfois pour me simplifier un peu la vie, si ce sont des choses d'application, dans l'évaluation sommative il y a des applications, à ce moment-là je vais par exemple reprendre des exercices qu'il y a sur Sésamaths et les modifier. Si je ne les aime pas, je modifie tout. Et puis sinon, par exemple en 3^e je vais beaucoup prendre des activités du brevet, du DNB, et je vais modifier : je vais inventer un énoncé qui est proche, ou je vais modifier, des fois les images qui sont au brevet ne sont pas très bien donc je vais aller chercher sur le web d'autres images pour faire un truc un peu plus sympa. Critères de choix des ressources... Comment je

décide si une ressource est bonne ou non : si elle développe l'initiative chez les élèves. C'est vraiment la question de la tâche de l'élève et est-ce que l'élève va prendre des initiatives ? Voilà. Est-ce que ça va lui permettre de se rendre compte que c'est utile ce qu'on fait, de comprendre ce qu'on fait, c'est vraiment tourné par rapport à l'élève en fait. Et ce n'est pas, euh, ce n'est pas... l'intérêt des élèves c'est vraiment l'idée qu'ils comprennent ce qu'on fait, qu'ils y prennent du plaisir aussi, mais plutôt qu'ils y prennent du plaisir parce qu'ils comprennent ce qu'on fait. Je pense qu'apprendre est une grande source de plaisir. Oui, bien sûr, je suis les programmes nationaux, tout à fait, et les choses qui sont proposées, oui, tout à fait. Franchement, le fait que ça plaise aux élèves de parler d'un sujet qui leur plait, ça rentre très peu en ligne de compte, mes intérêts personnels non plus. Des fois pour rigoler ça peut être dans une activité quelque chose, si je veux mettre un truc un peu drôle, des fois je peux mettre quelque chose, faire une blague, mais sinon non. Par contre, valeurs véhiculées dans la ressource : c'est plutôt l'idée de comment cette ressource va permettre aux élèves de construire une idée de la notion correcte. C'est plutôt dans un objectif d'apprentissage des élèves, c'est vraiment ça. C'est pour ça que je choisis une ressource : comment est-ce qu'elle va permettre aux élèves de comprendre ce qu'on est en train de faire, et de construire la notion. Ouais. Impact du déplacement papier / numérique... Numérique. Moi je vais préférer lire dans une brochure, voir dans le papier, mais par contre après, moi je vais fabriquer que du numérique. Donc j'aime bien avoir le papier pour regarder et après le numérique pour fabriquer. Si, le déplacement du papier au numérique, moi pour l'instant j'en suis à juste me poser des questions sur comment je vais pouvoir modifier les choses, je n'ai pas résolu. Par exemple sur la trace écrite de leçon, l'institutionnalisation de la notion, pour l'instant je continue de faire un cahier papier donc les élèves écrivent. Enfin tu vois, j'écris au tableau et ça je me dis est-ce que vraiment c'est intéressant ? est-ce que je pourrais organiser ça différemment avec un support numérique ? ça fait plusieurs années que je me pose la question mais pour l'instant je n'ai pas réussi à changer, à choisir. Tu vois, à un moment donné je me disais qu'on pourrait par exemple avoir un groupe d'élèves, tu sais qu'ils sont en groupes dans ma classe comme ANNA, qui pourrait écrire la leçon et puis moi je corrigerais des choses et puis après ça ferait une ressource pour tout le monde. Sur une plateforme par exemple tous les élèves auraient accès à cette plateforme avec la ressource mais qu'on n'aurait pas besoin forcément d'écrire en classe. Mais après je pense que pour certains enfants, le moment où on est en classe et où on se met d'accord sur la notion est important. Parce qu'après chaque activité on fait des bilans, on fait des petits... on dit ce qu'on a appris mais par contre le moment où on se met d'accord tous ensemble sur « voilà ce qui est important dans cette notion-là » je pense qu'il est aussi important à mener en classe. Mais est-ce qu'il y a besoin de l'écrire ? est-ce qu'il y a besoin de donner une feuille qu'on colle dans le cahier, Là aussi le support papier est là et ça pour l'instant je me questionne mais je n'ai pas de réponse et je n'ai pas fait de choix non plus. Je ne sais pas, est-ce qu'ils pourraient avoir un portfolio numérique par exemple dans lequel ce serait dedans ? Je ne sais pas encore.

R : Je sais que ANNA pratique un MOOC : est-ce que... ?

C : Moi je ne suis pas dans le MOOC, non. Par exemple Magister, parce que Magister c'est aussi ça mais Magister c'est plutôt ANNA qui l'a conçu. On a relu mais Magister c'est plutôt vraiment ANNA qui s'en est occupé. La brochure qu'on est en train de préparer avec Sésames, ça c'est... ça sert.. C'est

comme Magister mais sur un papier. La suivante... Alors là tu vas m'expliquer.

R : C'est fabriqué par un professeur et le mot ressort « computer » « textbook »... aussi il a un disque and I asked her to link others ressources. This one is the same but more complex.

C : Alors moi il faut que je dessine le mien ? You want the ressources in the center ?

R : As you wish. If you are drawing a picture to represent all ressources what will you ? You can use as the ressources like this profesor, the computer at the office, the computer at home...

C : I start with Dropbox, perhaps I will start with... Do you understand if I write « séquence » ? It's OK ? A work around the notion ? Yes ? I don't know how to write it in English so in French. Activities... I like. Which I want to go on. A utiliser... Modifications... Nouvelles activités... Brochures... APMEP... Collègues... Grosso modo, voilà. Ce n'est pas fini. Alors je vais marquer... Première fois puis après, hop ! ça devient... je les utilise une fois et après ça devient des vieilles activités, que je continue à utiliser mais que je modifie, et ça tourne car des fois j'en ai marre donc je change. Première fois et adapter. Parce que je ne prends jamais telle quelle une activité, je la modifie tout le temps. Par contre après, modifications en fonction des élèves, réactions, difficultés et des échanges groupes collège, collègues... Voilà, hop. Donc ça c'est pour les activités, et de l'autre côté je vais mettre programmes parce que c'est quand même... Et puis documents accompagnement, c'est officiel. Institutionnel je te marque, tu comprends ? Institutionnel. Alors ça, ça fait construire la séquence. C'est sur le web tout ça. Je n'ai pas de support papier, c'est dématérialisé. Et après... qu'est-ce qui manque ? Après il y aurait l'évaluation. Qu'est-ce que j'ai comme ressources où il y a des évaluations ? Je vais le mettre avec, dans la séquence il va y avoir les objectifs, c'est ça qui donne les objectifs en fait, l'organisation générale, euh, une trace écrite / leçon, et puis des applications et donc ça c'est sur la Dropbox, c'est numérique. Tout ça finalement, je vais prendre une autre couleur, ce n'est peut-être pas bien comme flèche ça, par contre tout ça finalement ça va là-dedans : ça, ça va pour ça, les activités, tout ça je le mets dans un même document et tout va être regroupé. Là j'ai un document où il y a tout. Mais vraiment je mets tout dedans. Après je vais avoir des petits documents des fois pour les élèves mais un document avec tout ça en fait : l'objectif, l'organisation générale, trace écrite de leçon, les applications, les activités...

R : C'est pour chaque semaine, ou chaque mois ça ?

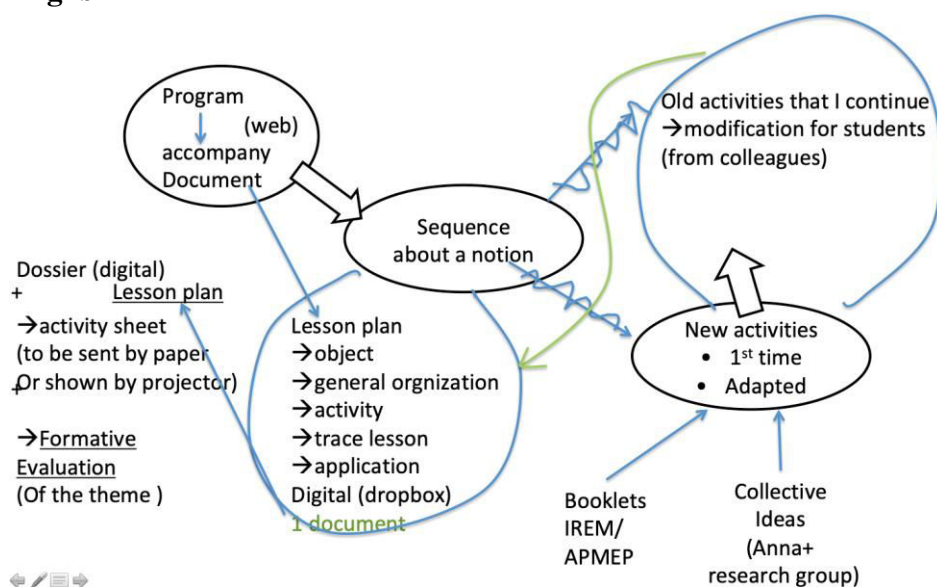
C : C'est vraiment sur une notion. Chapter. Je marque comme ça. But chapter is not just two weeks, we just goes on the notion all over the year with mises en train. Donc ça c'est un document et après j'ai un... sur toute cette séquence je vais avoir un dossier. Ce document là est dans un dossier, dans le dossier je vais avoir (dossier numérique dans la Dropbox) je vais avoir le document, et puis après je vais avoir les fiches d'activité, tu comprends ? plus fiches d'activités, à distribuer ou à projeter, des fois je distribue, des fois je projette. A distribuer papier ou à projeter. Plus évaluations formatives sur le thème. Voilà. Donc tout ça c'est dans un dossier. Je marque comme ça « lesson plan » on va dire que ça s'appelle le « lesson plan ». C'est le bazar hein ! lesson plan + fiches d'activité + évaluations formatives, tout ça c'est dans un même dossier. You want me to show my Dropbox ?

R : Oui.

C : Cela fait beaucoup de choses, c'est pour ça qu'on a d'autres choses. Là tu vois, c'est ma Dropbox pour le collège. Après, dans les cours, là j'ai quelques trucs qui sont en bazar mais sinon tu vois j'ai une organisation par niveau et puis je te montre par exemple... Tout est numérique en fait, les contrôles, mes dossiers...

1.7.2 Reflective Mapping Resource System (RMRS) of Cindy (May 2015)

Origin in English



1.8 Lexicon of the teachers' naming systems

This section presents a tentative translation of the systems used by the teachers for naming their resources, from their own language, Chinese. This has been a mean for deepening our analysis of our data. This is to be linked to the naming system research (see more in 3.2, and part of this analysis had already been presented in a paper (Wang, Salinas & Trouche, 2019).

In a first part, we give the Chinese names in alphabetic order in Chinese, with pinyin, the English translation, and who proposed them, trying to make sense of the meaning of the whole chain of characters as well as of the meaning given by the context. For example, G20 in the first line means that this term comes from the 20th answer of Gao (G) in appendix 1.1.

In a second part, we try to give some perspectives for going from an alphabetic order to a systematic organization of these names.

B

白板 (bái bǎn) (Electronic White Board) (Appendix1.2_GAO12)

备课组(bèi kè zǔ) Lesson Preparation Group (LPG) (Appendix1.1_GAO20, GAO23, GAO38)

备课组长(bèi kè zǔ zhǎng)(leader of LPG) (Appendix1.1_GAO40)

笔记本(bǐ jì běn)(notebooks) (Appendix1.1_GAO49)

笔记本电脑(bǐ jì běn diàn nǎo)(laptop) (Appendix1.1_GAO49)

C

测试卷 (cè shì juàn) (test paper) (Appendix1.2_GAO27)

橱子(chú zi)(cabinet) (Appendix1.1_GAO49)

错题 (cuò tí) (mistakes) (Appendix1.2_GAO19)

D

单独辅导(dān dú fǔ dǎo)(individual instruction) (Appendix1.1_GAO53)

动态(dòng tài)(trends) (Appendix1.1_GAO31)

叠课(dié kè)(two continuous lessons given together) (Appendix1.1_GAO54)

E

二十三题(èr shí sān tí) (final question in the exam⁸) (Appendix1.2_GAO44)

F

反思(fǎn sī)(reflection report) (Appendix1.1_GAO56)

辅导与训练(fǔ dǎo yǔ xùn liàn) (instructions and training) (Appendix1.1_GAO2, GAO11, GAO15) (Appendix1.2_GAO25)

复习课(fù xí kè) (review lessons) (Appendix1.1_GAO16, GAO19)

G

⁸ The final question in the exam paper, often appears in mathematics and physics exams, with characteristics of high score, high difficulty and require more comprehensive ability

跟岗学习(gēn gǎng xué xí)(full time training)⁹ (Appendix1.1_GAO32)
巩固练习(gǒng gù liàn xí) (exercises for consolidation) (Appendix1.1_GAO4)
公开课(gōng kāi kè) (open lesson) (Appendix1.1_GAO29)
公众号(gōng zhòng hào) (official account) (Appendix1.1_GAO29)
工作手册(gōng zuò shǒu cè)(work book) (Appendix1.1_GAO49)

H

会议笔记(tīng kè bǐ jì)(notebook for meetings) (Appendix1.1_GAO49)

J

基础题(jī chǔ tí) (elementary exercises) (Appendix1.1_GAO15)
集体备课(jí tǐ bèi kè) (collective lesson preparation) (Appendix1.1_GAO20)
教案(jiào àn) (lesson plans) (Appendix1.1_GAO3)
教材(jiào cái) (textbook) (Appendix1.1_GAO13, GAO15, GAO30, GAO49, GAO52)
教材全解(jiào cái quán jiě) (the full explanation of the textbooks) (Appendix1.1_GAO2)
教具(jiào jù)(teaching instruments) (Appendix1.1_GAO49, GAO50)
教学参考书(jiào xué cān kǎo shū) (teaching guidance book) (Appendix1.1_GAO2)
教学进度(jiào xué jìn dù)(teaching progress) (Appendix1.1_GAO23)
教研活动(jiào yán huó dòng) (Teaching Research activities) (Appendix1.1_GAO25)
教研员(jiào yán yuán) (Teaching Research Officers) (Appendix1.1_GAO30, GAO31)
教研组活动(jiào yán zǔ huó dòng) (Teaching Research Group activities) (Appendix1.1_GAO25, GAO56)
教育机构(jiào yù jī gòu) (education agencies) (Appendix1.1_GAO30)
交流学习(jiāo liú xué xí) (exchange) (Appendix1.1_GAO32)
借班(jiè bān) (borrow class) (Appendix1.1_GAO4)
金典(jīn diǎn) (the name of a publishing house) (Appendix1.1_GAO11)
经验(jīng yàn) (experience) (Appendix1.2_GAO29)
经验交流(jīng yàn jiāo liú) (experience exchange) (Appendix1.1_GAO25)
卷子(juàn zi)(exam paper) (Appendix1.1_GAO31)
精炼(jīng liàn) (selecting and practicing)(Appendix1.3GAO2)(Appendix2.2_YAO9)

K

课本(kè běn) (textbooks) (Appendix1.1_GAO2, GAO17, GAO18)
课表(kè biǎo) (course schedule) (Appendix1.1_GAO53)
课程(kè chéng) (courses) (Appendix1.1_GAO29, GAO30, GAO53)
课程标准(kè chéng biāo zhǔn) (curriculum standard) (Appendix1.2_GAO32)
课后习题(kè hòu xí tí) (after-lesson exercises) (Appendix1.1_GAO5, GAO8)
课件(kè jiàn) (courseware) (Appendix1.1_GAO3)
课题(kè tí) (research project) (Appendix1.1_GAO39)
课外书籍(kè wài shū jí) (extracurricular books) (Appendix1.1_GAO1)

⁹ It is a mode similar like internship, if the training period lasts one week, then the visiting teacher (or the to-be-trained teacher) will be arranged to follow a local teacher (generally an experienced one, as his/her mentor), all the mentor's school work during whole week (from the morning till afternoon), including observing the lessons, attending the meetings, etc.

考试试卷(kǎo shì shì juàn) (exam paper) (Appendix1.1_GAO31)

L

例题(lì tí) (examples) (Appendix1.1_GAO5, GAO8, GAO13)

练习册(liàn xí cè) (exercises book along with the textbook) (Appendix1.1_GAO15, GAO17, GAO18)

练习题 (liàn xí tí) (exercises) (Appendix1.1_GAO13)

练习(liàn xí) (exercises) (Appendix1.1_GAO24)

练习课 (liàn xí kè) (exercise lesson) (Appendix1.1_GAO4, GAO16)

M

目录(mù lù)(table) (Appendix1.2_G44)

模一(mó yī)(first practice exam) (Appendix1.1_GAO31)

模二(mó èr)(second practice exam) (Appendix1.1_GAO31)

面批(miàn pī)(face to face correcting) (Appendix1.1_GAO53)

面批作业(miàn pī zuò yè)(face to face homework correcting) (Appendix1.1_GAO4)

名著(míng zhù)(masterworks) (Appendix1.1_GAO49)

P

批作业(pī zuò yè) (marking homework) (Appendix1.1_GAO53)

评课(píng kè) (lesson evaluation) (Appendix1.1_GAO25)

Q

期中(qī zhōng)(mid-term exam) (Appendix1.1_GAO31)

期中考试(qī zhōng kǎo shì) (mid-term exam) (Appendix1.1_GAO23)

期末(qī mò)(final exam) (Appendix1.1_GAO31)

S

上一届(shàng yī jiè)(former graduating classes¹⁰) (Appendix1.1_GAO11)

上一年级(shàng yī nián jí)(former grade) (Appendix1.1_GAO11)

试卷(shì juàn) (exam paper) (Appendix1.1_GAO23, GAO31, GAO49)

视频(shì pín)(video)(Appendix1.2_GAO38)

试题(shì tí)(exam questions) (Appendix1.1_GAO31)

试题订正本 (shì tí dīng zhèng běn) (notebook for exam questions) (Appendix1.2_GAO19)

手机(shǒu jī)(cellphone) (Appendix1.2_GAO37)

书(shū) (textbook) (Appendix1.1_GAO8, GAO17)

书(shū) (extracurricular books) (Appendix1.1_GAO10, GAO11, GAO12, GAO14)

书(shū) (books) (Appendix1.1_GAO10, GAO49)

书籍(shū jí) (books) (Appendix1.1_GAO2, GAO11)

书架(shū jià)(bookshelves) (Appendix1.1_GAO49)

随堂课(suí táng kè) (regular lesson) (Appendix1.1_GAO4)

上海中考网(Shanghai Zhōng Kǎo Wǎng) (website for Shanghai high school entrance exam)¹¹ (Appendix1.1_GAO31)

¹⁰ The grade 9 is called graduating classes, namely the terminal classes in middle school.

T

题(tí) (questions) (Appendix1.1_GAO2)

题(tí) (exercises) (Appendix1.1_GAO16, GAO23)

提高题(tí gāo tí) (exercises for improvement) (Appendix1.1_GAO15, GAO16)

题目(tí mù)(exercises) (Appendix1.1_GAO2, GAO10, GAO15, GAO16)

题目量(tí mù liàng) (exercise quantity) (Appendix1.1_GAO15)

题型(tí xíng)(question types) (Appendix1.1_GAO2)

听课(tīng kè) (lesson observation) (Appendix1.1_GAO25, GAO27, GAO32)

听课笔记(tīng kè bǐ jì)(notebook for lesson observation) (Appendix1.1_GAO49)

同步学典 (tóng bù xué diǎn) (synchronize learning) (Appendix1.2_GAO26)

图书馆 (tú shū guǎn) (library) (Appendix1.2_GAO69)

拓展题(tuò zhǎn tí) (exercises for expansion) (Appendix1.1_GAO15, GAO16)

W

晚自修(wǎn zì xīu)(evening self-learning session) (Appendix1.1_GAO53, GAO54)

网(wǎng) (Internet) (Appendix1.1_GAO28)

网盘(wǎng pán)(cloud disk) (Appendix1.1_GAO49)

网上教研(wǎng shàng jiào yán) (online teaching research) (Appendix1.1_GAO25, GAO26, GAO27)

问题(wèn tí) (problems) (Appendix1.1_GAO5, GAO24)

问题(wèn tí) (questions) (Appendix1.1_GAO5, GAO23, GAO53)

问题(wèn tí) (matter) (Appendix1.1_GAO5)

问题(wèn tí) (issue) (Appendix1.1_GAO25, GAO31)

文章(wén zhāng) (articles) (Appendix1.1_GAO29)

微信(wēi xìn) (Wechat) (G28) (Appendix1.2_GAO37)

微信平台(wēi xìn píng tái) (Wechat platform) (Appendix1.1_GAO28, GAO30)

午自修(wǔ zì xīu)(noon self-learning session) (Appendix1.1_GAO53, GAO54)

X

习题 (xí tí) (exercises) (Appendix1.1_GAO13, GAO19)

现场听课(xiàn chǎng tīng kè) (on spot lesson observation) (Appendix1.1_GAO27)

校本(xiào běn) (school based exercises book) (Appendix1.1_GAO17)

新课(xīn kè) (new lessons) (Appendix1.1_GAO16, GAO19)

信息(xìn xī)(information) (Appendix1.1_GAO31)

学校作业(xué xiào zuò yè) (school work) (Appendix1.1_GAO5)

学而思(xué ér sī) (TAL Education)¹² (Appendix1.1_GAO30)

学生成绩(xué shēng chéng jì) (student's exam results) (Appendix1.1_GAO49)

学生笔记(xué shēng bǐ jì) (notes made by students) (Appendix1.2_GAO16)

Y

压轴题(yā zhóu tí)(final question in the exam¹³) (Appendix1.2_GAO14)

¹¹ <http://www.zhongkao.com>

¹² TAL Education: <http://brand.speiyou.com>.

预习作业(yù xí zuò yè) (preview work) (Appendix1.1_GAO5, GAO8)

Z

早自修(zǎo zì xīu)(morning self-learning session) (Appendix1.1_GAO53)

中考(zhōng kǎo) (high school entrance exam) (Appendix1.1_GAO28, GAO31)

资料(zī liào) (documents) (Appendix1.1_GAO10, GAO11, GAO49)

总结(zǒng jié)(summary report) (Appendix1.1_GAO56)

作业(zuò yè) (homework) (Appendix1.1_GAO4, GAO18, GAO49, GAO53)

作业问题(zuò yè wèn tí) homework problem (Appendix1.1_GAO53)

Notes for 1.8.1:

Gao used different names to name the same thing, for example:

(1) textbook

- 书(shū) (textbook) (G8, G17)
- 课本(kè běn) (textbooks) (G2, G17, G18)
- 教材(jiào cái) (textbook) (G13, G15, G30, G49, G52)

(2) exercises:

- 题(tí) (exercises) (Appendix1.1_GAO16, GAO23)
- 题目(tí mù)(exercises) (Appendix1.1_GAO2, GAO10, GAO15, GAO16)
- 习题(xí tí) (exercises) (Appendix1.1_GAO13, GAO19)
- 练习(liàn xí) (exercises) (Appendix1.1_GAO24)
- 练习题(liàn xí tí) (exercises) (Appendix1.1_GAO13)

(3) a special exam question:

- 压轴题(yā zhóu tí)(final question in the exam¹⁴) (2G14)
- 二十三题(èr shí sān tí) (final question in the exam¹⁵) (2G44)

(4)general exam question:

- 题(tí) (exam questions) (Appendix1.1_GAO2)
- 试题(shì tí)(exam questions) (Appendix1.1_GAO31)

She also use the same name infer differen things:

(1) 问题(wèn tí)

- 问题(wèn tí) (problems) (Appendix1.1_GAO5, GAO24)
- 问题(wèn tí) (questions) (Appendix1.1_GAO5, GAO23, GAO53)
- 问题(wèn tí) (matter) (Appendix1.1_GAO5)
- 问题(wèn tí) (issue) (Appendix1.1_GAO25, GAO31)

She had different type of exercises:

- 例题(lì tí) (examples) (G5, G8, G13)

¹³ The final question in the exam paper, often appears in mathematics and physics exams, with characteristics of high score, high difficulty and require more comprehensive ability

¹⁴ The final question in the exam paper, often appears in mathematics and physics exams, with characteristics of high score, high difficulty and require more comprehensive ability

¹⁵ The final question in the exam paper, often appears in mathematics and physics exams, with characteristics of high score, high difficulty and require more comprehensive ability

- 课后习题(kè hòu xí tí) (after-lesson exercises) (G5, G8)
- 基础题(jī chǔ tí) (elementary exercises) (Appendix1.1_GAO15)
- 提高题(tí gāo tí) (exercises for improvement) (G15, G16)
- 拓展题(tuò zhǎn tí) (exercises for expansion) (G15, G16)

From her explanation, there are different types of lessons:

- 新课(xīn kè) (new lessons) (G16, G19)
- 练习课 (liàn xí kè) (exercise lesson) (G4, G16)
- 复习课(fù xí kè) (review lessons) (G16, G19)
- 公开课(gōng kāi kè) (open lesson) (G29)
- 晚自修(wǎn zì xīu)(evening self-learning session) (G53, G54)
- 午自修(wǔ zì xīu)(noon self-learning session) (G53, G54)
- 早自修(zǎo zì xīu)(morning self-learning session) (G53)

Gao assigned different work for her students:

- 预习作业(yù xí zuò yè) (preview work) (G5, G8)
- 作业(zuò yè) (homework) (G4, G18, G49, G53)
- 学校作业(xué xiào zuò yè) (school work)
- 面批作业(miàn pī zuò yè)(face to face homework correcting) (G4)
- 错题 (cuò tí) (mistakes) (2G19)
- 试题订正本 (shì tí dīng zhèng běn) (notebook for exam questions) (2G19)
- 学生笔记(xué shēng bǐ jì) (notes made by students) (2G16)

Resources for and from collective

教研员(jiào yán yuán) (Teaching Research Officers) (Appendix1.1_GAO30, GAO31)

备课组长(bèi kè zǔ zhǎng)(leader of LPG) (Appendix1.1_GAO40)

上一届(shàng yī jiè)(former graduating classes16) (Appendix1.1_GAO11)

上一年级(shàng yī nián jí)(former grade) (Appendix1.1_GAO11)

activities:

教研活动(jiào yán huó dòng) (Teaching Research activities) (Appendix1.1_GAO25)

教研组活动(jiào yán zǔ huó dòng) (Teaching Research Group activities) (Appendix1.1_GAO25, GAO56)

听课(tīng kè) (lesson observation) (Appendix1.1_GAO25, GAO27, GAO32)

网上教研(wǎng shàng jiào yán) (online teaching research) (Appendix1.1_GAO25, GAO26, GAO27)

现场听课(xiàn chǎng tīng kè) (on spot lesson observation) (Appendix1.1_GAO27)

评课(píng kè) (lesson evaluation) (Appendix1.1_GAO25)

跟岗学习(gēn gǎng xué xí)(full time training)¹⁷ (Appendix1.1_GAO32)

¹⁶ The grade 9 is called graduating classes, namely the terminal classes in middle school.

¹⁷ It is a mode similar like internship, if the training period lasts one week, then the visiting teacher (or the to-be-trained teacher) will be arranged to follow a local teacher (generally an experienced one, as his/her mentor), all the mentor's school work during whole week (from the morning till afternoon), including observing the lessons, attending the meetings, etc.

交流学习(jiāo liú xué xí) (exchange) (Appendix1.1_GAO32)
经验交流(jīng yàn jiāo liú) (experience exchange) (Appendix1.1_GAO25)
备课组(bèi kè zǔ) Lesson Preparation Group (LPG) (Appendix1.1_GAO20, GAO23, GAO38)
教学进度(jiào xué jìn dù)(teaching progress) (Appendix1.1_GAO23)
集体备课(jí tǐ bèi kè) (collective lesson preparation) (Appendix1.1_GAO20)
借班(jiè bān) (borrow class) (Appendix1.1_GAO4)

Resources:

工作手册(gōng zuò shǒu cè)(work book) (Appendix1.1_GAO49)
会议笔记(tīng kè bǐ jì)(notebook for meetings) (Appendix1.1_GAO49)
听课笔记(tīng kè bǐ jì)(notebook for lesson observation) (Appendix1.1_GAO49)
总结(zǒng jié)(summary report) (Appendix1.1_GAO56)
反思(fǎn sī)(reflection report) (Appendix1.1_GAO56)

Mobilephone:

App

教育机构(jiào yù jī gòu) (education agencies) (Appendix1.1_GAO30)
学而思(xué ér sī) (TAL Education)¹⁸ (Appendix1.1_GAO30)

Wechat

微信(wēi xìn) (Wechat) (G28) (Appendix1.2_GAO37)
微信平台(wēi xìn píng tái) (Wechat platform) (Appendix1.1_GAO28, GAO30)
公众号(gōng zhòng hào) (official account) (Appendix1.1_GAO29)
文章(wén zhāng) (articles) (Appendix1.1_GAO29)
视频(shì pín)(video)(Appendix1.2_GAO38)

For students:

面批(miàn pī)(face to face correcting) (Appendix1.1_GAO53)
面批作业(miàn pī zuò yè)(face to face homework correcting) (Appendix1.1_GAO4)
名著(míng zhù)(masterworks) (Appendix1.1_GAO49)
单独辅导(dān dú fǔ dǎo)(individual instruction) (Appendix1.1_GAO53)
叠课(dié kè)(two continuous lessons given together) (Appendix1.1_GAO54)
错题(cuò tí) (mistakes) (Appendix1.2_GAO19)
试题订正本(shì tí dīng zhèng běn) (notebook for exam questions) (Appendix1.2_GAO19)
学生笔记(xué shēng bǐ jì) (notes made by students) (Appendix1.2_GAO16)
作业问题(zuò yè wèn tí) homework problem (Appendix1.1_GAO53)

¹⁸ TAL Education: <http://brand.speiyou.com>.

1.9 Logbook of teaching resources usage

This appendix shows logbook designed for teachers (Gao, Liu and Yao). I sent 20 copies to each of the three and asked them to fill it at the end of their daily work for one month from May to June 2017, the last month of that semester. Zhang was not involved because she was in a work traveling that month. The resources are from the interview with Gao, Yao and Liu.

The following shows the Chinese version and English translation.

- Logbook for teaching resources usage in Chinese

教学资源调用日志

日期: _____

教学内容: _____

课堂教学·资源		是否用到	备注补充
教室资源	电子白板		
	投影仪		
	几何画板		
	PPT		
纸质资源	教材或教参		
	教材配套习题册		
	校本练习册		
	学生作业		讲解所花时间?
	教辅书		
其它资源?			
备课·资源		是否用到?	备注补充
官方资源	教材		
	教参		
	教材配套习题册		
	课程标准		
	考试大纲		
	其它官方资料?		
校本资源	校本习题册		
	学校提供的其它资源?		
教辅	精练		
	辅导与训练		
	同步学典		
	完全解读		
	报纸		
	试卷		
	其它教辅?		
电脑	网站	网 站 名 称?	

	应用程序		
	闸八课件		
手机	微信	公众号?	
		微信群?	
		同事个人	
	其它 app		
自有资源	听课笔记		
	自己整理的习题		
教研组活动 启示	同事交流讨论		
	听讲座或 240 课程		
	听课磨课经历		
其它资源?			

- Logbook for teaching resources usage translated in English:

Daily logbook for teaching resources usage

Date: _____

Teaching content: _____

Resources for classroom teaching		Used or not	Notes
Resources in the classroom	Interactive Whiteboard		
	Projector		
	GeoGebra		
	PPT		
Paper resources	Textbook and teaching guidance book		
	Exercise book along with the textbook		
	School based exercise book		
	Homework		How much time on it?
	Learning aid books		
Other resources?			
Resources for lesson preparation		Used or not	Notes
Official resources	Textbook		
	teaching guidance book		
	exercises book along with the textbook		
	Curriculum standard		
	Exam standard		
	Other resources?		
School-based resources	school based exercises book		
	Other resources provided by school		

Learning-aid materials	Jinglian (selected exercises)		
	instructions and training		
	synchronize learning		
	Complete explanation		
	Newspaper		
	exam paper		
	<i>Others</i>		
Computer	Website	Name of it	
	App		
	<i>Couseswere of Zhaba</i>		
Cellphone	Wechat	Official account	
		Wechat group	
		Individual colleague	
	Other app		
Personal resources	notebook for lesson observation		
	Personal exercise notes		
LPG/TRG activities	With Colleagues		
	Lecture or courses		
	Lesson observation or MOKE activities		
Other resources?			

Appendix 2

Transcription of teachers' collective lesson preparation videos

This appendix 2 contains four sections, including three transcriptions of Chinese teachers' MOKE videos (2.1 and 2.2), and two French collective lesson preparation videos (2.3 and 2.4)

2.1 Transcriptions of first MOKE activity

The first MOKE activity happened in 16th March 2017, among three teachers (Gao, Yao and Zhao). This discussion was in Yao's office (grade 6, in the urban campus) after the lesson, including totally 154 dialogues. Video lasts 24:43 minutes 43 seconds. Discussion mainly focused on the suggestions for Yao's lesson plan improvement.



Picture 2.1. Gao was ready for the MOKE discussion with materials ready in front of her: her lesson observation note, her iphone, and the printed students' worksheet

Texts for transcription in Chinese:

1GAO: 你觉得题目量可以吗?

2ZHAO: 题目量我觉得可以, 但是形式太单调了, 一直在做题讲题做题讲题做题讲题, 作为平时课我觉得没问题, 但是做公开课那就太单调了, 没有新意, 小朋友到最后也没兴趣了。要么在练习上面再设计一下。第二个, 如果就讲这一条性质的话呢, 那么前面可以搞的活泼一点, 不等式性质 1 嘛, 拿个天平过来, 反正我们就讲这一条性质嘛。

3GAO: 可以啊, 学校天平有的啊?

4ZHAO: 有的, 实验室肯定有的啊, 可以搞的生动一点

5GAO: 这个可以的

6ZHAO: 这就定下来就是讲的是性质 1 啦, 就是这个操作的东西放一点进去, 把气氛搞的活泼些。在后面的练习, 后面的练习其实蛮好的

7GAO: 那这样的话, 后面的练习就要少掉一点了。

8ZHAO: 对

9YAO: 就是最后那个 x 大于 a , 还是 x 小于 a , 我是发现时间不够了, 时间还有剩余, 那个感觉不是很顺, 而且解法.....

10ZHAO: 这个不怕, 这个可以放到最后面

11GAO: 对, 放后面, 把它备用

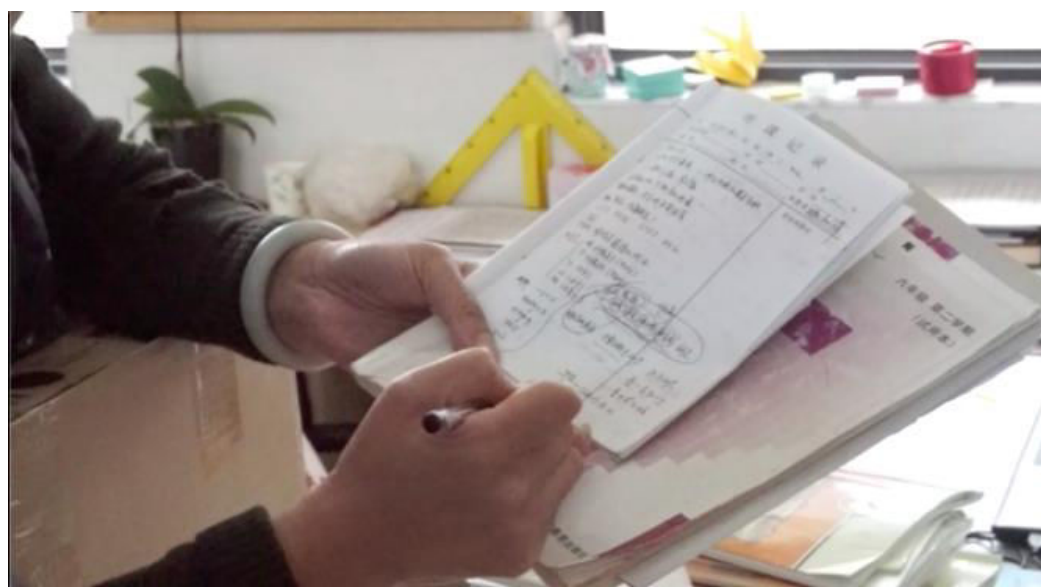
12ZHAO: 可以备用

13GAO: 可以准备着

14ZHAO: 对。然后前面的我就觉得这些练习, 到时候设计成比赛, 比如说, 大家都做, 给 5 分钟做, 做好以后, 为了调动课堂气氛, 做好, 按小组统计, 这个组错了多少, 那个错了多少, 互相改, 马上反馈, 完了统计一下, 哪个小组做对的最多, 第一名, 小朋友就喜欢这样玩一玩啊。

15GAO: 就是玩一玩

16ZHAO: 还是要把课堂气氛搞的再生动一点。题目我就是觉得这些题目还蛮好的, 就是性质 1 也可以, 就再, 再想一想, 环节当中。这样的话, 你就可以, 首先把第一块内容, 不等式呢, 用不等号连接啊, 这些不等式的语言啊, 你可以稍微再那个一点点 (指着自己的听课笔记 04: 07)



Picture 2.2 16ZHAO lesson observation notes of ZHAO (04: 07)

你这个判断做好了以后, 对吧, 哪些事不等式哪些不是不等式, 先用常规语言, 先讲概念这些, 这个时候不等式的性质放前面一些, 然后再让他们比较.....

17GAO: 一开始的时候, x 是正负数, 学生表示不出来。其实可以引导一下。2 是正数, 为什么? 因为 2 比 0 要大。比 0 大, 就是 x , 就是 2 大于 0, 正数都比 0 大。因为一开始上来, 这是一个陈述, 一个肯定的句子, 它们一下子和不等式就搞不清楚, 没有一种关联性。然后你说的不等式性质 1 页说错了, 是不等号方向不变, 你写的是不等式不变, 不等式方向不变 (拿自己的手机) 你看, 我有照片为证 (笑), 这是你写在黑板上的 (笑)。应该是不等号方向不变。看到了吧 (05: 00)。



Picture 2.1 17GAO A picture shown by Gao about Yao's mistake (05: 00)

18ZHAO: 其他倒是没什么问题。到了判断.....然后不等式, 然后是再介绍.....常规的正数负数非负数, 介绍一下, 然后再用不等式表示, 用不等式表示嘛, 你举三个例子 (看自己的笔记), 我觉得这里面可以稍微穿插一些, 穿插一个小型的练习.....还是再汇总在一块儿最后做一个练习。(06: 14 用笔指着自己的笔记) 就是这里用不等式表示好了对吧, 你这个正数讲完了以后就用它表示, 这种语言都搞好了对吧, 那就直接探究不等式了。



Picture 2.1 18ZHAO notes made by ZHAO (06: 14)

19YAO: 我刚讲的时候我看见直接到这，就是突然间中间断了.....探究的时候我发现

20ZHAO: 你就是这两个衔接的地方对么

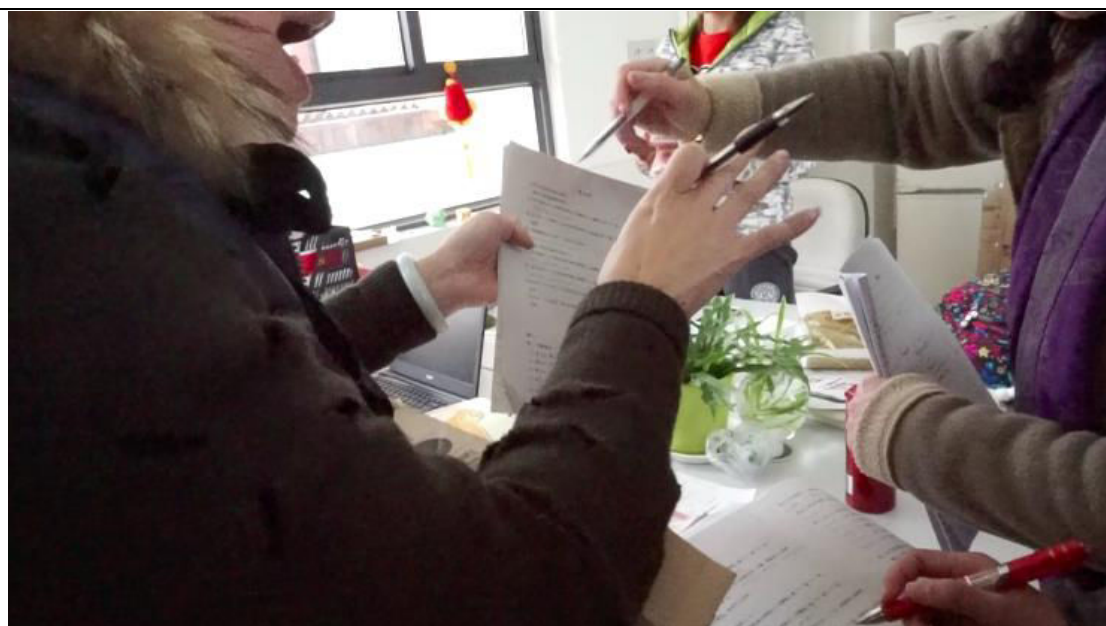
21YAO: 对对对

22ZHAO:好像没什么可以再加进去的了

23YAO: 但是我.....联系前面学生学到的.....不等式和等式只有一字之差，那么性质是不是也一样呢

24ZHAO: 这个反正是细节，到时候再，再加进去好了，不等式性质 1，然后探究，你说它这张纸上（拿着学生卡），探究这条性质的时候，实际操作，你说这个先后顺序是怎么样子的啊，给你工具

25GAO: 那么这个就不要要了（07: 27 拿笔指着学生卡的第一条）



Picture 2.1 25GAO Pointing the exercise on students' learning plan (07: 27)

26ZHAO: 给它工具

27GAO: 对的啊, 放开式的, 给它工具, 这种数据就不要了啊, 对吧, 然后通过论证.....

28ZHAO: 不是, 不是, 我的意思是给工具, 也给这个格式, 你认识天平.....

29GAO: 你的工具是一组, 还是每一组都有一组

30ZHAO: 就是啊, 每一组有一组就太多了

31GAO: 量太大了, 然后教室布置那就不是数学课了, 那是物理课了实验课了

32ZHAO: 那么, 其他的, 小姚这道题目呢 (指着学生卡), 就是不要去提示他们, 这三个步骤, 让他们自由的自己去做, 先不要讲, 先看他们怎么做, 一二三, 把你们整个探究过程上台汇报, 不要分开了。

33GAO: 对的, 不要分开了

34ZHAO: 就是拿给他们做, 他们做的出来的

35GAO: 其实 5 等于 3 这个大于号, 不要去给他, 这是 5, 然后横线, 填上一个适当的 不等号, 然后下面再看三个数据, 就是赵老师讲的, 整个活动是一个系列的

36ZHAO: 对的, 就是全程你不要参与

37YAO: 我不要参与啊

38ZHAO: 不要参与

39GAO: 然后上来让他们汇报一个过程就可以了, 对的。否则就是感觉你牵着鼻子走。

40ZHAO: 对的, 如果, 如果这个探究好, 在纸上探究好了以后, 你给个天平, 看哪个组能在天平上呈现以下这个道理, 那么学生他去演示了

41YAO: 那么..... (低头在学生卡的纸上写)

42ZHAO: 操作.....

43YAO: 这个直接填在横线上?

44GAO: 这个 5 大于 3 他们肯定会咯 (8m52)

45YAO: 然后这个式子就不要给他们咯?

46GAO: 给啊

47ZHAO: 给的, 这个过程你是给的啊

48YAO: 那这些要不要给?

49ZHAO: 哪个?

50YAO: 就是减去.....

51GAO: 这个就不要了啊 (那笔在姚的纸上画), 多加一个 0, 这组就不要了, 那有+, 有-, 有 0, 包括一切数, 对吧.....作为整个一个活动的

52ZHAO: 对, 作一个活动, 不要.....过程当中呢你根本就不要去管他们, 你就让他们上台总结, 最后发现规律, 如果学生上来总结的非常好, 马上就结束, 然后说谁能用我们的天平来解释一下这个性质, 操作, 让他们做给他们看

姚: 还有一个我刚刚 (指着学生卡), 两个班级都是这样, 写一个不等式, 他们就做了后面一个, 这个不写

53GAO: 这不是写了吗, $3 > 2$

54YAO: 他们就是这样写的 $5+1$

55ZHAO: 这个你不要去管他们

56GAO: 你在这个学习卡上, 你自己写嘛, 动手操作写一个不等式, 一个横线 (ZHAO: 对的) 第二个, 两边同时加上一横线, 然后 (赵: 告诉他们) 告诉他们给他们提示要他们做什么 (ZHAO: 对的), 步骤是什么, 你给他一个完成的提示嘛, 他就会写了啊.....好, 这个前面的可以用这个, 体验法

57ZHAO: 哎对, 让他们操作去嘛, 好了以后再用天平来验证, 这个过程就丰富一点

58GAO: 然后你的时间有空余的.....

59ZHAO: 先天平.....

60GAO: 用 20 分钟, 从前面的内容到论证出来基本性质, 要 20 分钟差不多啊? (ZHAO: 嗯), 然后后面还有差不多 20 分钟要一个讲题的过程.....你要是用操作的话, 时间就多一点点

61ZHAO: 嗯, 多一点点, 很方便的, 天平就是拿掉一样的东西, 不是有砝码吗, 大家都拿掉一个 20g 的砝码, 再加上一个, 很快的

62YAO: 那他们比如说, 写的那部分, 重量是没有, 那么差的班可能反应不过来

63ZHAO: 哪个啊?

64YAO: 就比如说同时加上多少, 比如说一个砝码或者是两个砝码, 但是这个写的比如说 11, 没有 11 (的砝码), 怎么办?

65ZHAO: 没关系的

66GAO: 他们有这些数值, 20g, 10g, 5g, 一样的啊

67ZHAO: 这个你不要担心的, 他会上来给你演示的, 他先, 反正一个天平, 一个砝码, 然后把整个不等式性质 1 的演示给我们看一遍, 那我相信下次你放开的时候, 肯定能出来的, 先来不等式性质 1, 拿个同一个砝码, 大家都拿一样的.....

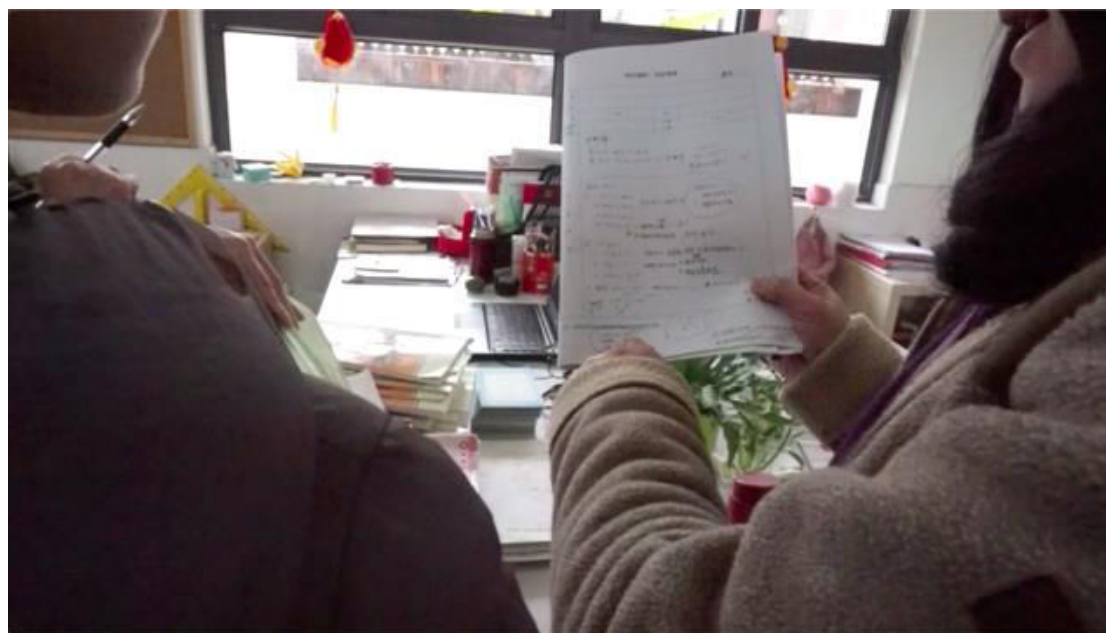
68GAO: 做的第一件事情就是加 (赵: 对) 上面各一个.....

69ZHAO: 对, 一个 50g, 一个 20g, 第一次, 各加 20g, 还是哪头重 (笑)

70GAO: 然后他在调整的过程中, 你再顺手给他一个 5g 的

71ZHAO: 然后你再看减怎么样, 这样好

72GAO: 然后你的语言一定要精准一点, 有的时候你讲的比较.....还有几个问题 (指着自己的听课笔记), 一个是.....你看, 学生讲大数减小数, 这是蛮好的, 对吧 (看赵), 然后你又追问了不等式的性质来解释, 这很好, 因为这堂课讲的就是这个, 但是后面的语言, 就是 $x+y<0$, 有负数加负数是负数, 其实再规范一点, 就是同号相加取.....对吧, 因为它不仅仅局限于符号, 同号也是, 把法则重复一下, 那么这组题, 内容告诉你, 就是不等号的填写可以使用不等式的性质, 其实也可以通过运算性质来完成, 你这一组的目的是为了告诉学生不等号的判断, 不止局限于性质一, 对吧, 也可以运用一个法则, 同号得正, 异号得负, 你没有讲, 对的, 你的总结, 一个没有, 然后就是后面的这一组题, 后面的这组题的难度是高, 但是你的书写 (板书) 上应该列竖式 (高用手势笔画), 竖式让他对照着看 (ZHAO: 对的), 1, 右边没有了, 减去 1, $-3x$ 到 x 是增加了 $4x$, 语言上是增加减少, 不是加减, 然后你只检测了左侧, 你没有监测右侧, 你就顺其自然右侧是成立的 (13m16 手指自己的听课笔记),



Picture 2.1 72GAO Showing her notes to YAO (13:16)

其实是不对的, 你一定要右侧, 同时也要去检验, 发现她也是相同, 然后用法则, 两边同时加上 $4x-1$ 所以不等号方向, 不变, 话要完整。你今天黑板上只讲了左侧, 右侧就顺其自然默认它成立, 其实是不对的, 对学生而言, 左右两侧一定要同时检验, 以

达到它不等式性质的一个.....反复强调它的一个性质，同时.....

73YAO: 还有一个，今天不是在纸上写吗，下次打到 ppt 上面，黑板满了，怎么办？

74GAO: 你不是下面还留了一小块地方，专门写例题啊，

75YAO: 字母就不写咯？字母呢？

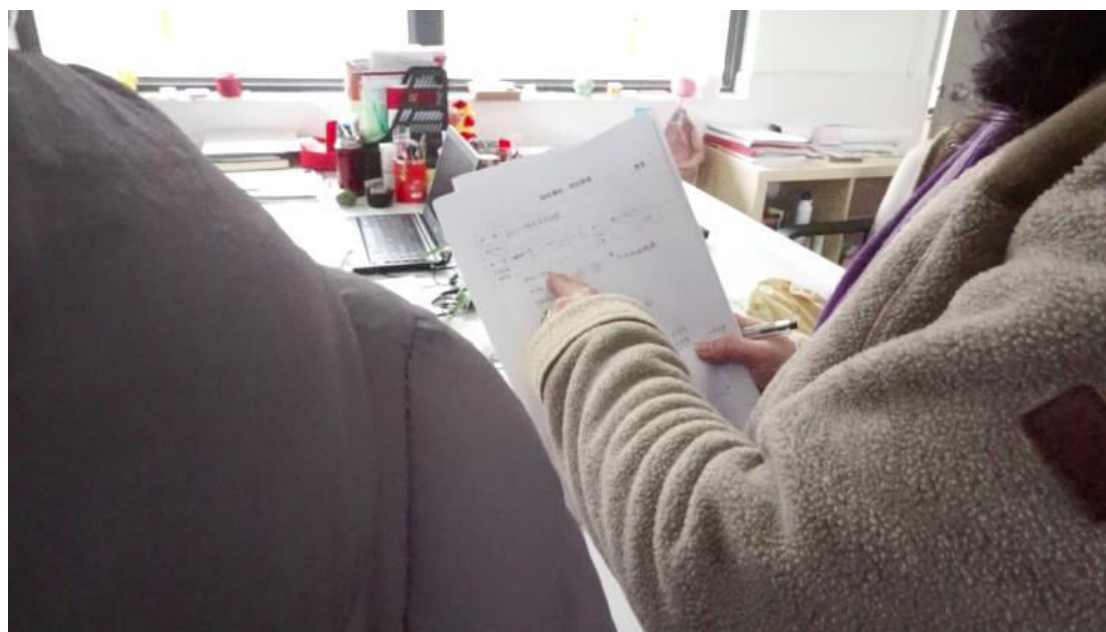
76GAO: 字母你就不要写，黑板上一个定义，对吧，一个性质，性质下面留了一个空白的地方，这就是写板书了，就是在分析这些题目的时候，你因为写在纸上了，实际上一定要用例题啊

77ZHAO: 投影蛮好的

78GAO: 对，投影比较好，因为解决了你板书的问题，对吧，而且还有一个颜色的问题，对吧，然后你就是列竖式，写在这个下面，对着镜头让学生看见，两边同时加減，两边同时加減，所以就强调一个加減的问题，你就只检测了左侧，你右侧没有监测

79YAO: 这个的话，2 班有可能答的出来，但是理由可能说不.....

80GAO: 对啊，这是规范啊，这节课其实就是纠正学生语言的规范性的问题，对吧，课是很简单的，你要边上课边纠正学生的，你这个课嘛就是要加强学生的语言的一个严密性，严谨性，要学会让学生说话，对吧。还有一个东西啊（15: 07 指着自己的笔记），超级链接。



Picture 2.1 80GAO Showing her notes to YAO(15: 07)

这个啊你可以做成超级链接，因为学生认识第二个，因为你没有做超级链接，所以第二个就显实不出来了，对吧，就是点到这个链接就能显示一个不等式，这样的，你呢，你是一下子就出来的。你是按顺序，但是学生不是按顺序说的。

81YAO: 那这个点出来，那下面那个也要一个个点出来啊。

82GAO: 不用啊，你把这个做成超链接，下面的不等式分成 4 条啊，每一条对应的啊，然后把链接做到图片上去，点个图片就出来，点个就出来，这个不太常见的，停车场

里，对吧，这个限速 30 的牌子，因为高速公路上这个字太小，直观性也比较差，你这个不要写 30， 限速 30 很少见的，只有隧道里才是 30，改成 80 或者 100.

83YAO: 这个是图片，变不了。

84ZHAO: 你这个图片是截图来的？

85GAO: 你用 PS 覆盖上去就好了啊。或者你在网上找啊，限速标志啊，对吧。还是比较多的，对吧。那万一学生时候我只认识中间这个，那你就比较尴尬了对吧，不等式就引不出来了。

86YAO: 我在网上看到过一个视频，就是用了天平，里面不是含有字母的式子么，他里面就是放了两个粉笔.....

87GAO: 用的什么？

88YAO: 粉笔

89GAO: 那前提得是完整的粉笔，还是用砝码比较好一点

90ZHAO: 对，砝码好一点。

91GAO: 当然有轻重的。然后啊，你这个定义啊（16: 43 指着笔记），就为什么，就过的很快。



Picture 2.1 91GAO Showing her notes to YAO (16: 43)

你在这里，这里错了就打个叉，那么为什么，你多问学生一句为什么，那么其实就是重复定义，不等号连接，它这没有不等号，它只是一个代数式，对吧，这还不是代数式，只是一个式子，只有三个字母嘛。没有用，缺少不等号，对吧，然后后面因为它用的是等号，用不等号连接的才是不等式，对吧，这是强化定义，因为这一整节课中，你只有这一道题目是强化定义的。对吧。

92ZHAO: 还有这个，这个练习（17: 24 手指），怎么变形的，放到最后一块了



Picture 2.1 92ZHAO Pointing out the exercises on students' learning plan (17: 24)

93GAO: 嗯

94YAO: 不是还有一个吗

95ZHAO: 还有哪个, 你今天是到这里结束的对么?

96YAO: 还有一个

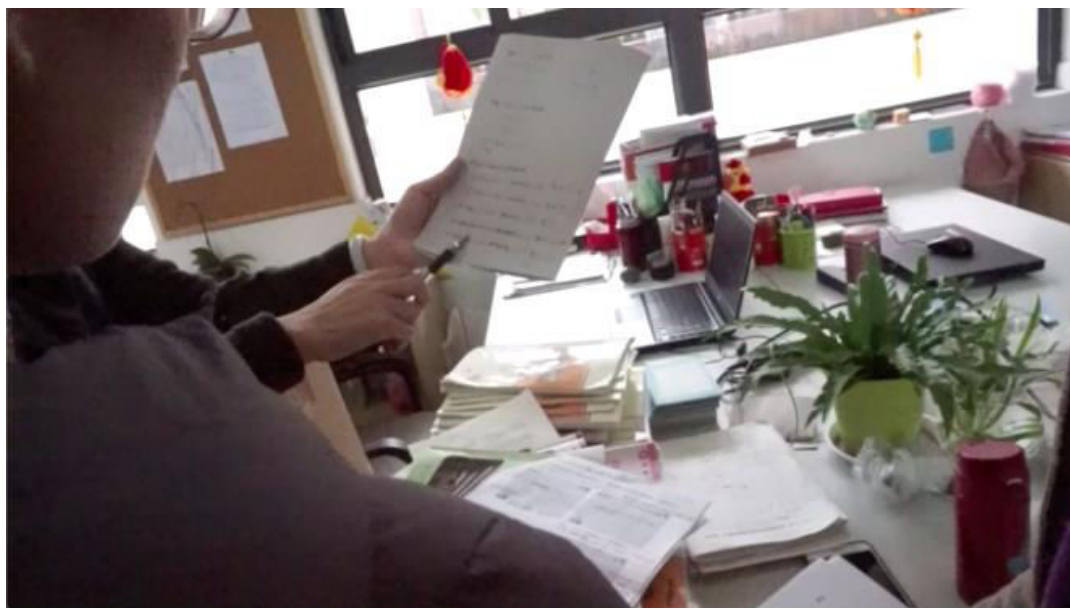
97ZHAO: 还有一个, 哦, 还有一个模仿 (17:37 手指课件) 是吧?



Picture 2.1 97ZHAO Pointing Yao's teaching plan (17: 37)

98GAO: 我估计你要是做了实验的话, 估计这个模仿肯定来不及做了。

99ZHAO: 那么这点能来得及上吧? (17: 43 指着学案)

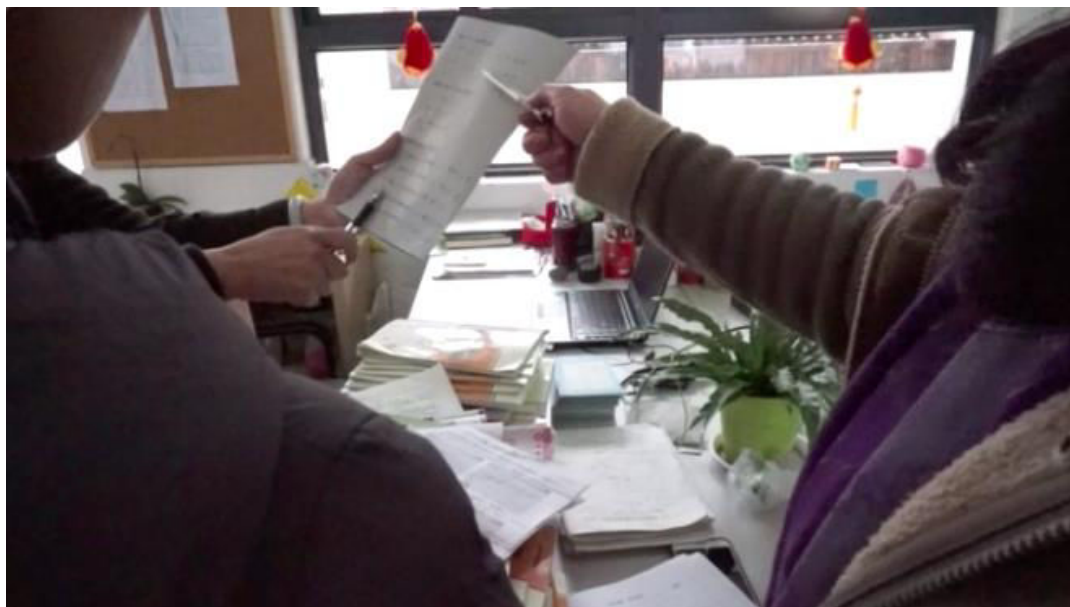


Picture 2.1 99ZHAO pointing the students' learning plan (17: 43)

100GAO: 这个应该来得及的

101ZHAO: 哦，那就上到这个地方，上到这个地方，你就加一个小练习进去，学生肯定要做的啊。

102GAO: 其实这个题目，因为是手写的，其实这些题目（17: 58 手指学生作业单）也应该放时间让学生去做。



Picture 2.1 102GAO Pointing the students' learning plan (17: 58)

你是只让一小部分学生在讲，大部分学生没事做，这样来不及嘛，都在学习卡上，（题目）留在学习卡上，应该让学生做一下，因为你本身是小组竞赛的嘛，可以让学生自己讨论一下。其实有很多学生自己还是没搞懂。

103ZHAO: 没搞懂的

104GAO: 哎, 对的, 因为你只叫了个别学生在参与, 没有全部。你给他们人手一张, 那么人人参与了.....

105ZHAO: 那么她现在性质, 整个性质探究结束了啊, 那么, 第一步是做, 你第一步是做什么? 这个? (18: 45 手指作业单)

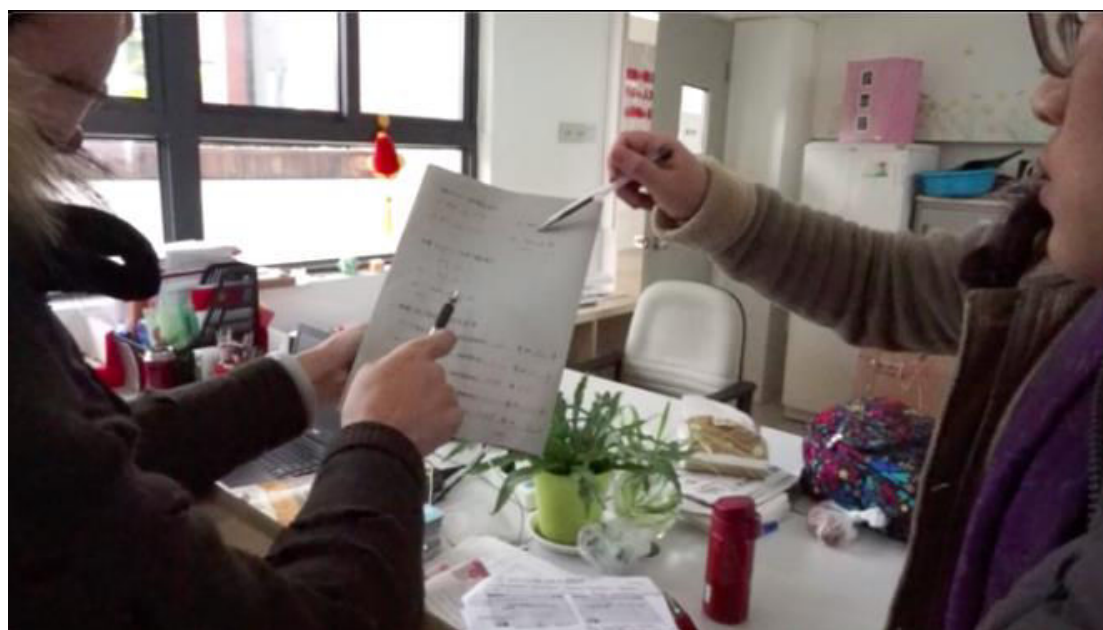


Picture 2.1 105ZHAO Pointing the students' learning plan (18: 45)

106YAO: 判断

107ZHAO: 哦, 这块, 你先是判断。判断给了几个, 3 个是吧? 判断好了以后, 是不等式填空, 再是不等式填空。

108GAO: 对的, 这块 (19: 05 手指作业单练习第二题) 用的是这个性质



Picture 2.1 108GAO Pointing the students' learning plan (19: 05)

109ZHAO: 而这里是综合了 (19: 07 手指作业单练习第三题)



Picture 2.1 109ZHAO Pointing the students' learning plan (19: 07)

110GAO: 对的

111ZHAO: 这两个以后做了这个? (19: 11 手指作业单练习第三题)



Picture 2.1 111ZHAOa Pointing the students' learning plan (19: 11)

那么你的问题就是, 这判断之后就是三个层次的练习 (19: 17 手势)。



Picture 2.1 111ZHAOb Pointing the students' learning plan (19: 17)

不对，是4个层次了，前面先判断，然后填空2个.....

112GAO: 前面那个是例题啊，这些才是练习。

113ZHAO: 好的，那么，这个例题，讲完

114GAO: 嗯

115ZHAO: 然后这个当做练习（3个），3个层次的练习，三个层次的练习（沉默）

116GAO: 你是怕练习做不完？

117ZHAO: 我是怕做练习的时候太枯燥，太多了。

118YAO: 对，就是一直让他们做题

119GAO: 预备年级的学生不就是不断重复强化吗？没事的，我觉得这个.....

120ZHAO: 那么你后面还准备安排一个小的测验吗？

121GAO: 你是说反馈吗？

122ZHAO: 对，就是你就在你这边判断不等式里，选出个1-2道，对吧，不等式的性质，填空也好，包括你这样的题目，弄点小题，最后用个5分钟，反馈。

123GAO: 反馈了现场回馈答案。

124ZHAO: 对，最好马上就对答案，然后小组出来，比赛拿出第一名。所以，你这里面（20: 31 手指作业单练习第一题）看看能不能压缩掉一块



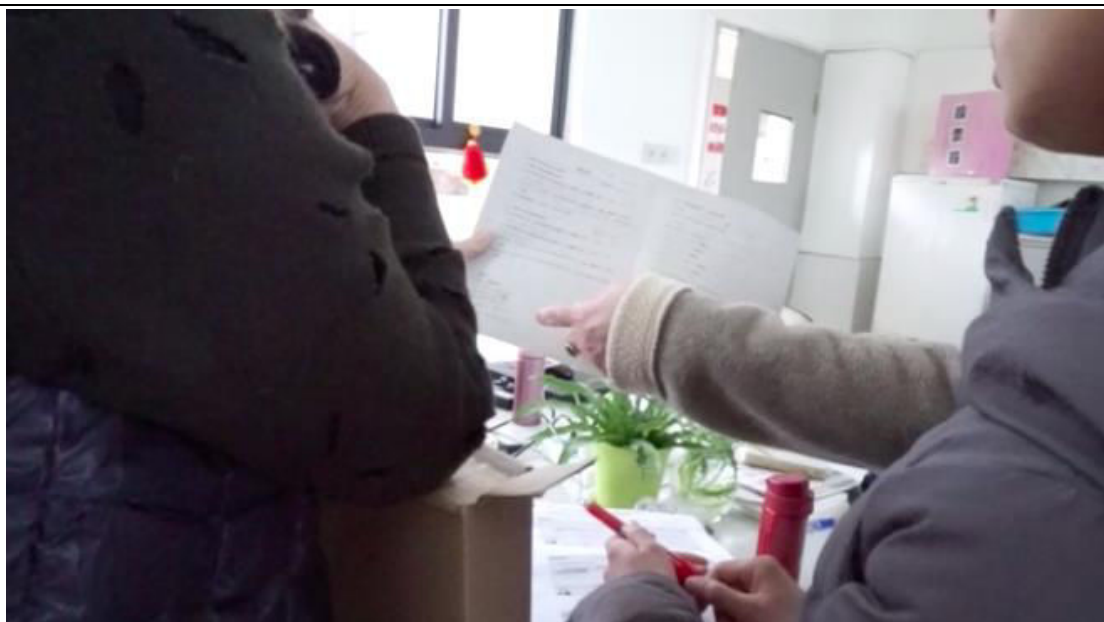
Picture 2.1 124ZHAO Pointing the students' learning plan (20:31)

125YAO: 就是，这一块和这一块（20: 36 手指作业单例题）有点重复的。一个是判断，一个是自己填。



Picture 2.1 125YAO Pointing the students' learning plan (20: 36)

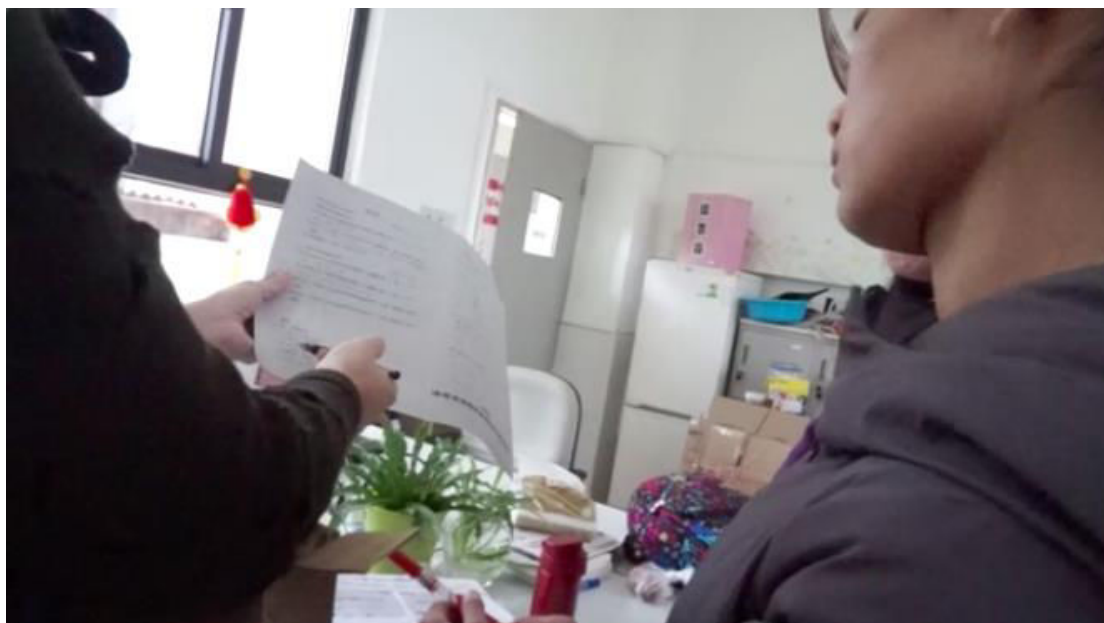
126GAO: 不，因为你这边（20: 47 作业单例题手指）有一个 no 的，因为我们上课一直是 yes yes，都是肯定的，这里还是需要让他们知道一个 no 的，知道为什么不是。



Picture 2.1 126GAO Pointing the students' learning plan (20: 47)

你是通过例题先规范他们的语言叙述。

127ZHAO: 然后呢, (20: 59 手指作业单练习第二题) 这两个练习, 实际上是这道反而更难



Picture 2.1 127ZHAO Pointing the students' learning plan (20: 59)

128GAO: 是的

129ZHAO: 而且是加了字母, 对吧

130GAO: 你把这两个题目顺序换一下吧

131ZHAO: 对, 换一下。

132GAO: 这个呢, 旁边用一下竖式的对照。你的还都是那样的, 其实都是一个竖式 (21:

28 在自己听课笔记上演示板书)

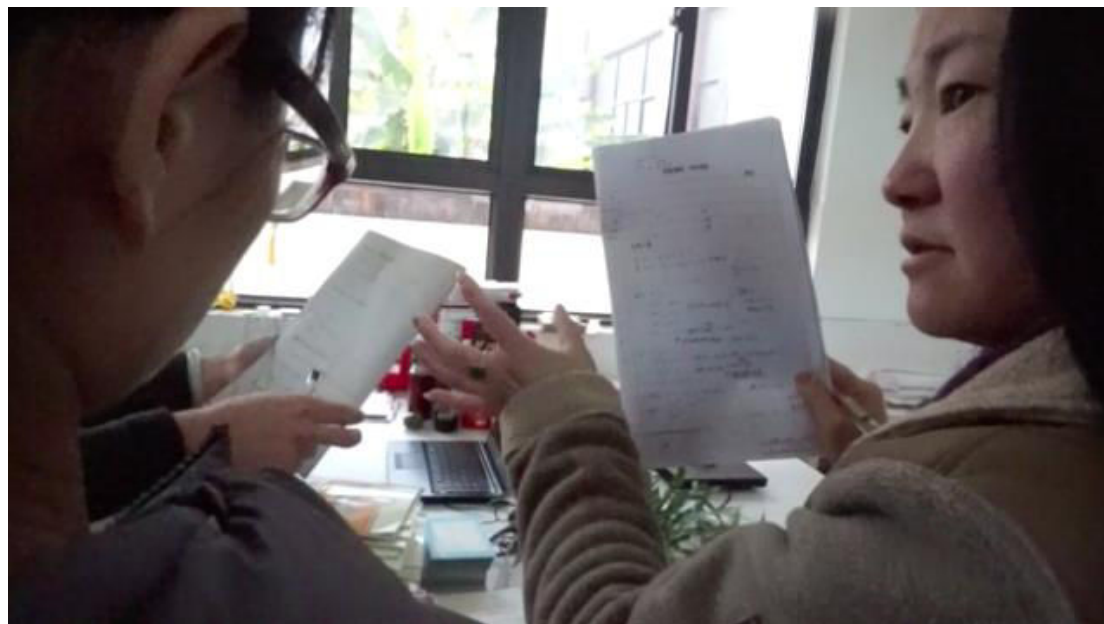


Picture 2.1 132GAOa Showing her notes to YAO (21: 28)

m 小于 n, 那 $2m$ 就是 $m+n$, 那其实就是让学生观察, m 到 $2m$ 是什么? 其实就是 $m+m$, 然后从左边加 m, 右边也是加上 m, 那这样, 同时得到哦, 不等式两边同时加上一个 m, 不等号的方向不变

133ZHAO: 你这里如果是竖式啊, 那你下面可能就方便了。

134GAO: 对啊, 这样其实也是在提示学生怎么去思考, 你用横式, ppt 里的话, 学生的思维方式不一样的, 竖向的 (21: 46 摆出上下手势) 学生会有一个对照的形式。



Picture 2.1 132GAOb Showing her gestions to YAO (21: 46)

135ZHAO: 对的可以的, 那其他题目, 这些应该很快很快的。

136GAO: 对, 快点过掉, 只要他们把过程讲清楚就可以了。

137ZHAO: 对, 很快我们就过掉。

138YAO: 那是让他们一个个做, 还是说直接小组一起做?

139GAO: 就是一下, 一个个做站起来讲啊

140ZHAO: 你可以就, 一边讲一边给他们填嘛

141GAO: 对啊, 比如 (22: 15 手指作业单习题第一题) $m-4 < n-4$ 的原因。



Picture 2.1 141GAO Pointing the students' learning plan (22: 15)

不等式两边, 一定要强调, 不等式两边同时减去一个数, 不等号方向不变, 然后让他们坐下就好了。第二道题是小于号, 你问他们为什么, 然后他们说不等式两边, 如果他没有强调这个不等式两边同时加上或减去一个数不等号方向不变, 那就帮他.....对吧, 其实就是很快, 就是强化这句话的运用, 不断的去强调这句话的印象, 直到这节课完成, 知识点完全掌握为止。对吧, 简单的课就要突出它的一个重点。然后第二题, 瞬间就发现了, 诶, 他的一个, 式子, 原来除了用不等式性质 1 以外, 还可以用我们以前学过的, 运算法则, 运算性质来进行判断

142ZHAO: 灵活的运用

143GAO: 对。

144ZHAO: 不要死用, 要强调灵活

145GAO: 对的, 强调了知识点的不唯一性。

146ZHAO: 第三个么, 再.....

147GAO: 对, 这里就是一个拓展了, 就放开式的了, 让学生自己从中, 不是直观的, 而是通过算法, 来看结果。对吧, 更要, 因为你前面已经有了一个竖式的对照, 这样就可以缓解这里的难点问题, 它也会列一个竖式, 对比左边和右边。这里么更需要(竖式)了对吧?

148ZHAO: 对。

149YAO: 那这题目，是让他们看，还是我读？我一直在读的。

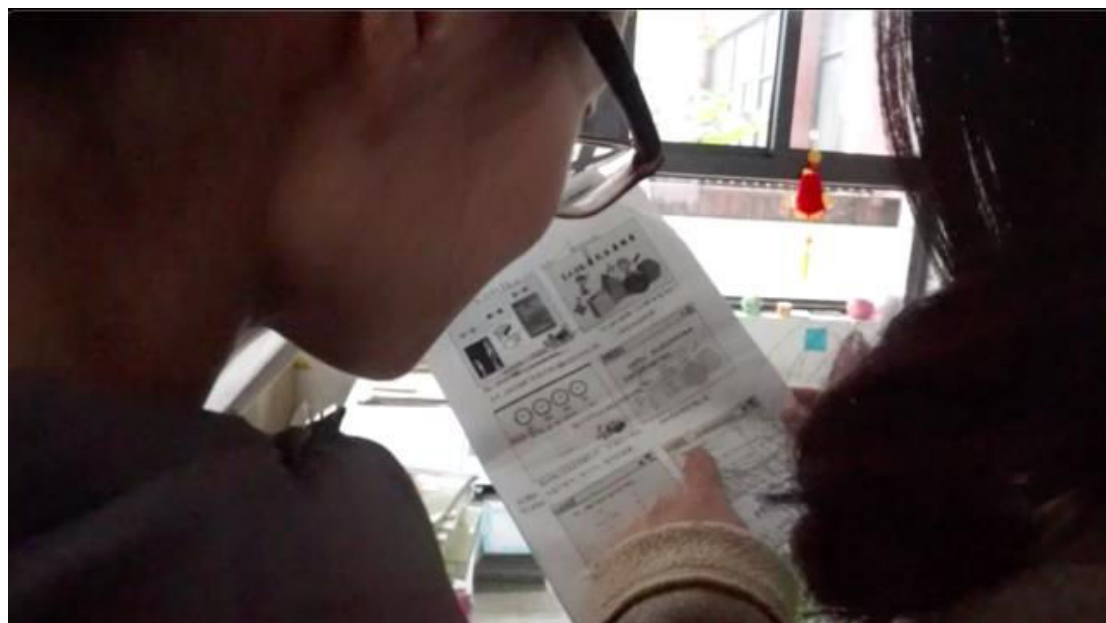
150GAO: 读不读其实无所谓的，有的时候上课习惯，我有时候上课的时候也读题的。关键就是，你在上课的时候一定要听学生，听同学们讲的是什么，你有的时候尽顾着自己（笑），想着现在我要讲什么，下面我要讲什么，学生讲了什么，你就是，对吧。上来第一句，我记得……我就是记得学生说是小于等于，对吧……

151ZHAO: 对

152GAO: 说了小于等于，然后你显示的是大于等于，那么下面的学生就一下没反应了，蒙了。对吧，就是上来第一道题啊。

153ZHAO: 对的，有的，第一题。

154GAO: (24: 19 手指课件习题页) 你 ppt 上不是这道题。



Picture 2.1 154GAOa Pointing Yao's lesson plan (24: 19)

不低于，一个是强调不低于的意思，对吧，不低于的意思（24: 27 在课件便上手写批注）



Picture 2.1 154GAOb Writing suggestions on Yao's lesson plan (24: 27)

不低于是的意思是什么，对吧，然后（学生说） x 是小于等于，你也是说，嗯， x ，啪一下子，显示出来， x 大于等于。这其实学生就蒙了，但是因为有人听课，他们不敢讲，没人听课的话他们就要指出来了，所以你要听他们讲了什么东西的。

2.2 Transcriptions of second MOKE activity



Picture 2.3 Second MOKE discussion

There are 324 dialogues in this intense 40 minutes. This discussion happened inside the whole math TRG, eight teachers participated.

GAO: math teacher of grade 8

YAO: math teacher of grade 6

ZHANG: math teacher of grade 7, math TRG leader

LIU: math teacher of grade 8, office-mate of Gao

LX: the vice president of this middle school who was in charge of teaching, math teacher of grade 6

SHI: math teacher of grade 6

SHANG: a new teacher who used to work as a high school math teacher, math teacher of grade 7, office mate of ZHANG

QIAO: an intern math teacher, who used to work in a privatetutoring company (Chinese TAL Education Group)

Texts for transcription in Chinese:

1GAO: 我来说一下，这个砝码，（对姚）你这次用了以后，难受吧？这个呢是在她第一堂课的时候是没有用的，这个是我们磨课的时候，因为赵老师说，课堂比较单调，所

以就建议加一个操作实验，所以就在这个砝码加了进去，但是我今天看了觉得，这个过程好像也有点.....

2LX: 我提一个建议。你可以用一个.....

3GAO: 微视频?

4LX: 不，你可以用一个不等号，做一个不等号。你左边和右边放不一样，然后倾斜了 (0: 43 手势)，然后两边再放一个，那么就用这个不等号，演示一下。



Picture 2.2a 0: 43

5GAO: 什么意思?

6LX: 可能.....

7ZHANG: 就是那边重了 (0: 55 手势)，然后用一个大于号



Picture 2.2b 00: 55

8LX: 或者就是你让她在显示屏上,画一个不等号最好(01: 02 用手里学生作业单表示),然后翘起来。



Picture 2.2c 01: 02

或者说是,你看你贴在上面都可以(01: 11),那么就会更加形象一点。



Picture 2.2d 01: 11

9GAO: 那其实刚刚在上课之前我就问了她一个问题,如果是说 5 大于 3 对吧(01: 22 手势),我跟他说了两遍加上不同的数,不等号的方向还是不变的呀。



Picture 2.2e 01: 22

10LX: 还是不变的

11GAO: 对呀

12LX: 这个不等号.....还是不对

13GAO: 那你这样, 这节课就下不去了呀, 对吧

14YAO: 对

15GAO: 所有后来我就让她截一段微视频啊

16SHI: 那个有吗? 咱么那个闸八课件里, 就有.....

17ZHANG: 不是, 就是我觉得啊, 你这个天平的东西, 仅仅表示的是重和轻, 只是重量上的重和轻, 其实只是大小上面的.....

18LX: 用天平的话, 我觉得后面还有一句话我觉得.....

19ZHANG: 那你这个.....是高还是矮.....

20LX: 这个放了.....对吧..... (02: 01 手势)



Picture 2.2f 02: 01

21GAO: 不是，她是想表达……字母！

22LIU: 对的！字母！

23ZHANG: 我本来以为她是要证明，同时加上 a

24LX: 啊~

25ZHANG: 我想，同时加上 a ，这怎么去操作啊

26GAO: 同时加上 a ，她是拿了两根形状大小一模一样的粉笔来的……

27ZHANG: 对啊，问题就是，预备班他们没有学过用字母表示数，到了初一（7 年级）才学的，那初一的学生就会问你“那 a 如果是负数呢”，那就不是加了，是减了，对吧。

28YAO: 嗯

29ZHANG: 然后呢，你这个拿实物举例的时候，你这个 a 取的都是几克，几克，都是整数啊，砝码啊，对吧。就是我刚才就提到了，因为天平体现出来的是一个轻，一个重，是重量上的比较吧……

30LX: 对啊对啊对啊

31ZHANG: 但是你前面还有身高的比大小啊，或者长短的大小，或者什么的大小，有很多比大小的东西，所以天平只是其中的一个特例……所以我个人感觉，好像用天平，好像也不能特别的说明什么东西。

32GAO: 另外呢，你这个直观性比较差，太远（手势 3: 18）



3: 18

33LIU: 对, 除非你能做到每个孩子每个手里都有一个天平……

34GAO: 那不可能, 这可不是物理课……去, 截个微视频。你到网上去看一下, 我刚才看了一个, 但是视频还要进一步剪辑的。

35YAO: 是微视频?

36GAO: 对的, 去剪辑一下的。

37LX: 那个, 你微视频……这就要干嘛

38GAO: 穿插在(课)里面啊, 学生就不用……还有这个, 上次(磨课)我们提过的……

39ZHANG: 天平只是判断大小啊, 大于, 小于……

40 留的晚: 对, 所以啊, 我的意思……我的意思, 要加一个不等号……

41ZHANG: 对啊, 所以学生这个, 重了就大了, 轻了就小了……

留的晚: 不啊, 你如果说天平这个改装一下, 大于号, 这样, 翘起来……



04: 20

42GAO: 你要求太高了

43LX: 不不的, 你不会拨一下嘛, 弄上去以后, 两边同时加上, 那个两千克砝码, 对吧, 这个不等号还是不变的对吧, 还是大于……

44YAO: 没有, 刚才高老师说的也对的, 这边加上 2, 这边加上 1, 也还是不变的……

45GAO: 方向不变啊

46YAO: 还是不变的

47GAO: 不等号的方向是不变的, 方向呀……

48ZHANG: 不是啊, 现在你这个视频, 你这个天平到底要起到什么作用?

49LX: 不是啊, 现在现在你这个天平主要是为了引出你这个不等式来, 同时加上, 或者减去相同的数, 对吧, 那现在是什么, 高老师讲的是什么, 那我现在要阐述的是同时加上相同的数, 不是不同的数, 对吧?

50YAO 姚: 对。

51LX: 对吧! 那我现在就不可以加, 加一个, 要么加一个 3, 对吧, 讲的就是加上相同的数, 这又没什么, 对的, 加 1, 加 2, 对吧, 它还是小, 是还是小, 对吧 (手势 05: 25) 但是我现在要强调的是下面有一个数, 加的是同一个数, 对吧, 同一个数, 不是两个数, 不同的数是没错的, 多了, 还加一个, 少了再加一个, 看还是少呀, 这又没错的, 就你这东西 (天平), 放在上面太小了, 而且不形象。你旁边如果能做一个, 用白纸做一个, 可能更形象一点, 反正这个事情呢, 你自己看。



05: 25

52ZHANG: 你这条性质1, 引入的时候是.....你再回忆一下, 是怎么引入的?

53YAO: 用等式性质来用的.....

54ZHANG: 是先然他们回顾了等式的基本性质?

55YAO: 嗯

56ZHANG: 我个人觉得啊, 既然你性质引入是用等式性质引入, 那么在定义当中也应该相同, 是不是在定义当中, 也应该是用等式来调出不等式.....就是说, 我的想法啊, 这样可能更统一, 你前面举的例子, 前半段我觉得很精彩, 因为你完全是通过学生感兴趣的, 很生活化的, 那些生活中的数学引入的, 然后呢我在想, 在这个引入的 $\text{pm}_{2.5}$ 这个事实当中, 能不能里面也有等于的例子, 那么把它们都给学生罗列到这里以后, 来看哪些是我们学过的, 那么这些是等式, 哪些是我们没有学过的, 那么这些是不等式, 对吧, 就是从等式和不等式的关系入手, 那么这就是, 定义当中等于就是跟等式搭过桥了, 然后在学习性质的时候, 我们依然还是从学过的等式入手, 这样。

57LX: 就是她从不等式的性质那她就用过等式的性质了啊, 对吧

58ZHANG: 不是, 我是说定义那块

59LX: 对啊

60ZHANG: 我是说定义

61LX: 对啊, 我知道

62ZHANG: 不是说性质

63LX: 总体来说还可以, 细节的地方再看看

64ZHANG: 前半部分我觉得挺顺的, 所以你的天平只是想去再验证一下, 其实不是拿它去证明什么, 而是知道了这个性质, 拿它去验证一下, 哦, 对的。还有一点我觉得你应该注意一下, 就是书上的符号语言, 因为你的板书上只有.....性质上只有文字语言,

缺少一个符号语言，我觉得你应该在符号语言这块注意一下，因为你看你让，你所有让学生做的地方都是用的符号语言.....

65YAO: 可是这样就是，黑板写满了以后，我不知道，你看那不是有一个例题吗，我不知道擦了以后.....

66ZHANG: 就是在你做的题下面写写就行，就是，你那个屏幕是一边，对吧，可以拉开一点

67YAO: 那边那一块呢？

68SHI: 你上周五在哪个屋上课？

69YAO: 在初三那边的教室好像.....

70LX: 啊，你不是，你在那个多媒体教室

71ZHANG: 我个人认为呢，这个文字语言还是蛮重要的，因为我们数学课上，其实不断的强调数学语言，文字语言，符号语言，图形语言，这三种语言之间的转化，作为代数课的话，这图形语言可能少一些，但是你呢，符号语言和文字语言这块应该是.....而且你前面有一块练习很好，就是反反复复在考验他，你给了他们文字语言，怎么转化成符号语言，或者反过来，你给了他符号语言，看他们怎么转化成文字语言，这两种语言之间不断的进行转化。

72SHI: 有一个大题.....

73ZHANG: 对的，那么就是板书上呢，我觉得，应该把这个两个语言同时体现出来。因为学生的题目，你后面给出来的都是这种大于小于这种符号语言。

74LX: 她的这个根本上还是体现出来了，你看她那个上面写的很好

75ZHANG: 对啊，但是她在性质那块没有，就好比.....

76LX: 啊对啊，这个性质下面好像也有的对吧有法则

77ZHANG: 对啊，性质下面有法则，那肯定要把法则用符号语言写一遍的

78LX: 那是对的，对对对，你没写出来.....

79GAO: 她是没地方写（11：04）



11: 04

80LX: 没地方写了, 嗯, 但是你这个题呢

81LIU: 那你写的紧一点嘛

82ZHANG: 对啊, 你写的紧凑一点吧

83GAO: 你要穿的(高跟鞋)跟再高一点

84LX: 写的板书往上移一点

85ZHANG: 你那个不等号, 下面的那个地方空的太大了

86YAO: 我在想要么这个不等式性质写在下面.....

87ZHANG: 哎, 实际上呢, 难点是性质, 你那些不等式呢, 不等号呢, 有哪些符号呢?

88GAO: 要么不等号就不要了, 这个版书上, 因为 PPT 上本来就有, 但是你没把它写出来

89ZHANG: 这不是重点, 重点是性质 1

90LX: 这个不等号还是要写的

91ZHANG: 就这样好了你重新排版一下, 这边是定义.....

92LIU: 其实这些都是小事

93LX: 对

94LIU: 能写下, 只要你想写一定能写下, 侧面放个小黑板就好了啊

95ZHANG: 可以写的了

96YAO: 没有

97LIU: 什么没有? 哪个没有?

98GAO: 小的楼下没有, 那么用大的好了啊, 教师里哪有那么大一块啊, 都是那么小的

99LIU 刘：你把你的不等号写那么一块黑板上去不就好了吗

100LX：对，她要去上课的地方就是旁边有个是吧？

101ZHANG：初三教室旁边的

102GAO（对 LIU12：15）：你觉得好看哇？她上课的时候在那里（左边），然后跑到那里（右边）去写，你现在写完了你知道好看了呀，刚开始写的时候，啊这里全是空白，然后跑到那里去写，你觉得合理吧？



12：15

103LIU（摸着头笑）

104GAO：你现在写完了是觉得好看了啊

105ZHANG：但是我觉得这节课高跟鞋稍微有一点影响

106LX：对的对的

107GAO：就是再写的高一点，对，问题是比较根本的地方，对。

108ZHANG：还有一个问题呢，举的例子当中呢，是不是增加一些含分数小数的，因为你举的这些练习，小组竞赛啊，这几块里面呢，主要集中在整数，对吧（LX 点头），分数啊小数啊这些可以放进去，让他们知道所有学过的数的范围都可以。

109LX：分数小数在后面的小组PK里面

110SHI：这个容易，你说观察，让他们……我觉得他们观察不出来的

111ZHANG：观察不出来的

112SHI：我感觉你能不能设个，4个m加起来，我也不知道，那个观察，学习差的观察不出来的

113YAO：字母嘛是不是太多了

114GAO：那道题不要了，本来还在性质1嘛，还没有到后面一个复习巩固的阶段，你先

强化，上一次那道题不是这个.....

115ZHANG: 你闯关3，这道是同时加3咯？这道是同时减去.....

116GAO: 负3，对加上一个负数就是同时减去一个正数

117ZHANG: 对吧，这道题我觉得.....对，这第二道题嘛我觉得是没有必要的

118GAO: 这是她刻意改的，上次没有这道题

119YAO: 这是同时加上一个r啊

120GAO: 加减的变化不是这堂课的重点啊

121ZHANG: 你性质里同时加上或者减去，对吧，那么你就不要同时去.....你同时减去，你这里就搞个正数

122SHI: 减就是减，不要同时加上负数

123ZHANG: 对吧，你就不要在这个地方去，让他们脑子绕弯了，你要实现的目的就是告诉他们不等式的性质怎么用

124GAO: 这个 $3+4x<-5$ ，得到的是 $4x<-8$ ，对吧，那道题

125ZHANG: 那么学生嘛，你像这种判断题，他们解不出这个是对的，是错的，那么要引导他们完整的把这个思路过程说一遍

126YAO: 那么就是要把不等式的性质也要说一下

127ZHANG: 对的对的，要引导他们把那个性质要完整的说一遍，是加的就是加，是减的就是减，那么第一个人第二个人在你引导过程当中可能得多花点时间，那么后面的同学就多听了几遍其他同伴是怎么回答的，那么他们就会模仿（留的晚：对）他站起来以后就会说了，因为.....就是尽量让他有一个完整的叙述，那就是把这条性质完整的放进去叙述，刚才的后半段因为不是很顺利，可能你说的就比较多一点，对吧，就是代替他们说，是因为什么什么什么，可能那个班级学生好一点的话，引导一两个，后面的学生就基本上自己去说了。

128GAO: 对了，你这个就不要了，这个上节课都没有的，你加了这个，这个要了学生反而，对吧，他们解释的挺好的，你这个要了引导学生，学生反而会误解，对吧，那就不要了，就直接留问题就好

129ZHANG: 就自己写一个不等式

130GAO: 对的，上次就是一个学生

131LX: 我觉得这里都写了也可以，就是这个两问对吧，你看他们说话说的其实不够完整，比如说吧，5 大于 3 （手势 16: 46），然后呢



16: 46

然后两边同时加上 2，那就一个变 7，一个变 5，他们只是 5 大于 3，所以 $5+2$ 大于 $3+2$ ，这个完整说就是 7 大于 5，你到最后还是要的，对吧，表述最后，我觉得表述要完整，包括你那个样子的

132GAO: 她的问题不是这个结果，她的目的是不等号的方向不改变啊

133LX: 对啊，方向不变，但是学生最后讲的时候吧，完整的叙述表达，对吧，啊原来是 7 大于 5，所以这个.....

134ZHANG: 就是看到结果

135LX: 对的

136ZHANG: 所以前面有个小孩举了个例子， x 大于 2.....

137LX: 对的对的，就是我觉得新教给学生一个东西，最后表述的地方一定要注意让他达到标准，就像刚才张英那样，你如果.....

138GAO: 但是刚才这样，你如果 x 大于 2 的话也能解释啊

139ZHANG: 但是写出 x 大于 2 的人，往往.....自己也说不清楚（笑）

140LX: 不啊，这个东西，你前面我觉得，你前面在引导学生讲的时候，要让学生讲完整，学生上来讲的时候，他有些模糊的叙述，你要引导他讲完整...这个呢有时候学生的接受能力不是很强

141ZHANG（问SHI）: 你刚刚有没有去看你们班那些平时接受能力强的学生怎么样啊？

142SHI: 我没去看，我看到的那几个做的一塌糊涂，那这个情况我跟你讲，放作业里做，他们搞不清楚的

143GAO: 这节课的整体结构还是可以的

144LX: 总体结构是可以的

145ZHANG: 前半段我觉得还是可以的, 非常好的, 前半段可以作为范本 (笑)

146LX: 刚刚张英讲的这一块你要留意一下.....

147ZHANG: 她讲的正好是 (LX.....), 正好是一个场景里面

148YAO: 那我还要不要, 就是, 我不是让他们回顾等式性质1嘛, 回顾之后, 我不是说, 不等式和等式只相差一个字嘛, 那么性质是不是也是类似呢, 他们如果说会的话.....

149GAO: 那也不能等价, 因为你不等式还有性质3呢

150LX: 这种不能

151GAO: 对啊, 这样的话, 性质3就容易出问题

152LX: 这种性质不能等价类推的

152GAO: 这个你就一笔带过吧, 因为你也没在黑板上写

154LX: 这个东西你不能代的

155GAO: 不等式性质, 这个等式性质有2个, 不等式性质有3个, 他们的对立性就是差的.....

156ZHANG: 就是引呢, 你还是从等式性质去引, 对吧, 就是他们还是要让他们去复习的, 然后我们今天再尝试学习不等式性质1, 看看会是什么结果, 不要先入为主, (性质) 都是一样的, 对吧.....

157YAO: 嗯.....

158GAO: 你把天平的那部分内容再调整一下

159ZHANG: SHANG, 你的 (意见)?

160SHANG: 我是来学习的 (20: 10笑)



20: 10

161ZHANG: 不要这么谦虚

162SHANG: 就是我以前其实都没有, 没有关注过这些, 我觉得挺好了, 就是我觉得后面孩子们.....有点, 有点, 有点, 是不是时间比较紧, 有点讲的快

163ZHANG: 我的理解啊, 前半部分是生活化, 而且呢就是纯粹是一个用不等号来表示, 就是相对来讲比较简单东西, 因为你到后面呢, 进入性质 1 了, 它的变化就多了, 很灵活了, 所以就是, 一下子, 学生的这种素质就看出来了, 对吧, 就是脑子不是够用用的班级学生到后面就明显的, 就是

164SHI: 代数式, 变化, 还有那个呢, 你回答的就是那个什么呢, $2m$ 小于 m 加 n 这个就比较好了, 这个 2 个大于一个加个小的, 这个他们就搞不清了, 脑子要好一点这块.....这一块, 我觉得, 如果他们是要, 其实光你说, 因为是第一节课, 其实也无所谓了, 但是要是观察什么的, 这个方法是不行的, 他们肯定什么都观察不出来的

165ZHANG: 但是我看练习册上呢, 他就是有这种联系题的, 比如说啊, $4m$ 加 3, 那个, $4n$ 加 3, 就是它前面已经有一个系数了, 这个是不是应该是下节课的?

166GAO: 对, 有乘法

167ZHANG: 有乘, 反正你题目当中再搞个, 搞一点, 就是里面含分数的

168YAO: 就是闯关 1 里面的

169GAO: 把系数都改成加减 (22: 07), 就是减 3 变成减三分之一好了, 一样的啊



22: 07

170ZHANG: 对的, 就是减 3

171YAO: 那么这个减 4, 要不要在这里也加个.....

172GAO: 题目量差不多了, 你不要再加了

173YAO: 不啊, 我意思是这个减是简单的嘛, 那简单的已经有了, 那这里要不要?

174GAO: 还要继续要, 巩固练习, 要的

175ZHANG: 不一定要简单, 你稍微变化一下就行

176SHI: 那个肯定比这个反应要快多了, 那两个班(笑)肯定要比这个反应快

177YAO (笑): 是的

178GAO: 还没讲完呢这节课, 对吧?

179SHI: 还有两道题对吧?

180GAO: 她铃响了以后还在讲呢

181SHI: 哦, 哦, 就是小组 PK 了呢对吧

182YAO: 当时 GAO 老师说, 当场让他们做然后小组 PK 一下

183ZHANG: 这是书上的例题啊?

184GAO: 不是, 是后面发下去的一个, 课堂反馈是吧?

185YAO: 嗯

186GAO: 给 3 组发下去的

187YAO: 还是让他们直接翻到正面啊, 然后交换互相评一下?

188GAO: 那随便你了, 你要当场得出结果嘛, 那就当场去做了, 对吧, 但是你这时间来得及吗?

(沉默 4s)

189ZHANG: 那我就觉得索性, 像这个第四道题啊, 刚才史老师也说了, 只有灵活, 脑袋够用的才能看出来 $m+n$, 那么你不就是像这种题, 这个题, 因为它是加上或减去一个代数式了, 对吧, 你不如把这种加上或减去一个代数式换成第四道这种题, SHI 老师, 你觉得呢?

190YAO: 这个题, 要不然就给这样吧 (24: 08), 这里给弄简单一点



24: 08

191GAO: 你这里, 你说错了, 不是 a 加负 3, 应该是负 2 加 a , 所以你引导错了 (张笑), 所以学生没听懂啊, 你只是把减号变成加号, 加负 2, 没有用的啊, 你是 -3 小于 -2 啊……

192ZHANG: 是两边同时加上 a

193GAO: 对啊, 因为她语言表达, 就变成了 a 加 -3 , a 加 -2 , 其实学生理解没问题, 应该讲 3 加 a , -2 加 a , 把它两边同时加上一个数, 这里是你自己在语言的一个误导……这个我因为这里, 不记得了……

194ZHANG: 你这个是非题里的, 不等号这是一个数, 加上或减去一个式子, 那么到这里呢, 可以安排一个, 不等式已经是式子了, 都是字母了, 那么你两边呢, 同时加上或减去还是一个相同的字母, 就是, 这全部都是字母了

195SHI: 就是, 式加数, 对吧, 接下来都是式子加上字母

196ZHANG: 对啊, 你就是这样题型也有啊, 但是你这道题呢, 其实稍微脑子灵活点的也能看出来这道……

197SHI: 那么这就是减去啊

198ZHANG: 对吧, 就是减去……你最后一道简单的

199YAO: 就是这种简单的……

200ZHANG: 对! 其实你就是再把法则放进去, 就是那个字母的法则其实让他们, 那个法则不是 $a+m$ 大于 b 加 m , 对吧, 你其实可以换一个字母, 就是法则, 对吧, 你也可以换

201YAO: 那这个加法呢, 是不是可以换一个式子更清楚点

202ZHANG: 对啊, 这个是可以的啊

203GAO: 那这个可以看成 -3 加 n

204SHI: -2 加 n

205GAO: 对, 你体现了两边同时加上一个相同的数就可以……

206ZHANG: 所以就是说强调一个, 他们要学会前后关联, 要看着前面去思考, 而不是孤立的只看后面一个, 对吧, 就是先要判断前面一个, 不等号方向, a 大于, 然后再发展到后面, 你已经就是这种题就是, 前面已经……前后……QIAO呢?

207QIAO: 我啊 (笑)

208GAO: 你看你那里写的板书 (26: 30)



26: 30

209GAO: 你看你那里写的板书 (26: 30) 最后一行, 负1加4x大于1加4x, 这个是一个原则性的问题, 你是两边同时.....她(YAO)在分析的时候, 直接把不等号写上去了 (26: 52走到黑板前) 你这个不等式不成立了啊

210YAO: 哦哦哦, 懂了懂了懂了

211GAO: x大于

212YAO: 下面那个不能写x大于

213ZHANG: 她这是-1加4x大于

214GAO: 这里是-1加4x, 这里是1加4x, 然后她说不等号方向不变, 其实你这个减啊写在边上啊, 加上3, 加上3, 学生就能直观的看到啊, 你嘴巴讲呢就过掉了, 这里也是, 加上一个, 就是减去1加上4x了, 对吧, 这里也是, 减去1加上4x, 这个箭头没有画, 但是学生能从直观上看到一个变化

215ZHANG: 这个就更复杂了, 因为是一个多项式了

216SHI: 对 (笑), 对, 更复杂了 (27: 32摆手)



27: 32

217ZHANG: 对, 两边同时加上或减去一个多项式了, 那首先你要在两边, 要先弄个单项式的, 然后再.....

218GAO: 前面你一元一次方程讲了吗?

219YAO: 讲了

220GAO: 对啊, 那一元一次方程不是一样的道理吗

221ZHANG: 但她是放到不等式

222SHI: 那我要是教的话, 我肯定教他们这么做的啊 (27: 50)



27: 50

223GAO: 你这个做法更复杂了, 你把不等式变成方程了, 加个字母, 这个题目就更复杂了

224YAO: 那就是两个字母了

225GAO: 你不是把不等式变成方程了吗, 这就混淆了

226SHI: 这个我觉得.....

227ZHANG: 其实我跟你们讲, 这个学生啊, 预备(年级)和初一年的学生, 问他们移项的依据是什么(摇头)

228SHI: 他们不知道的

229ZHANG: 他们不知道的

230GAO: 因为有的时候, 教的时候就简单化, 没有教好他们, 就是告诉他们从这里移到那边

231ZHANG: 移项, 在小学里就教了

232GAO: 没有, 小学不教的

233YAO: 有些小学

234GAO: 小学的教法应该是(用笔比划28: 27)加数, 加数和, 求一个加数, 用和减去另一个加数, 是这么教的, 不用移项的, 用移项是老师, 在外面机构里的老师那么说。



28: 27

235ZHANG: 小学里，小学里面说，要移项，要变号啊，老师就是说.....

236GAO: 这是外面机构里说的

237ZHANG: 那为什么要变号呢？他们说不出来的

238GAO: 小学的那个方程是，被减数，减数，差，被除数，除数，商

239ZHANG: 那我们是在什么时候说的啊？

240SHI: 就是现在说的啊

241GAO: 在这之前啊

242SHI: 等式的一元一次方程啊

243ZHANG: 它是两边同时加上同时减啊

244GAO: 对啊，它是通过等式的性质1之后

245ZHANG: 我是说，我们的等式性质是哪里开始学的？

246GAO: 就是这一课之前

247SHI: 这一课之前，一元一次方程之前

248GAO: 就是现在才教

249ZHANG: 等式的基本性质

250GAO: 其实它是可以的

251ZHANG: 等式，等式的基本性质，等于也是刚刚结束的

252YAO: 对

253ZHANG: 所以他们的脑子里是要给他们过一下的啊，前面刚刚学的东西，很多人，

一定（笑）一定在脑子里

254GAO: 但是讲完这块内容，后面就是一元一次不等式了啊

255YAO: （点头）嗯

256GAO: 你这个也是必须要讲的啊……（对SHI）你一元一次方程先讲了吗？

257SHI: 讲了

258GAO: 讲了嘛，你上课的时候，字母一定有的咯，肯定有的啊，这个不是，觉得这个难的，关键是一个，学生的一个观察的问题

259SHI: 有的脑子就弯进去了

260GAO: 有的时候，能力差不表示我们可以不用教啊

261SHI: 这个是观察不出来的，我觉的观察不出来的

（沉默3s）

262GAO: 反正，大概就是，不要改动太多了，没有太多时间，明天，后天，你自己再试试。

263ZHANG: 我个人的想法呢，就是这个闯关这种题型呢，可以再少一点，精简到2道就差不多了，然后呢，你宁可把前面基本的信息想想怎么用，可能题量上能少，然后题目形式上变化再多一点……就是刚才讲到的，形式上的，各种各样的，可以再增加那么两三道，后面呢再压缩一点，我个人觉得啊

264YAO: 嗯

265ZHANG: 因为你这个课呢刚上性质1，那么后面呢还有性质2和性质3，那么3条性质都教完了，后期有一点感觉的基础上，再来稍稍变化比较，多项式啊怎样的，可以……再下去

266YAO: 嗯

267ZHANG: 刚刚第一个性质，不要把……固然有一批学生是能反应的，你想啊，但是有更多的同学，那万一，你教这节课是针对最好的一个班，但是你要是针对普通班级的话，那其实大多数孩子还是，这道题反应还是要……

268SHI: 需要时间

269ZHANG: 要时间的，所以基本上，还是要把中心花在前面的基本的题目上去，花样多一点，让他们锻炼一下，就是操练这种题型

270YAO姚: 那练习这块呢我就留一道加，一道减，一道难一点的

271ZHANG（沉默4s）: 这一块呢，我觉得可以稍稍内个一点（沉默5s）我反正个人感觉啊，我觉得，你看(32:04指着学生学案)，这两道题可以合并成一道，这两个也可以弄成一个，这样要求就差不多了。



32:04

272GAO: 你反馈第三题就不对, 1-a, 1-b, 里面涉及到不等式性质3了

273ZHANG: 前面讲性质1, 是花了多长时间?

274YAO:.....

275ZHANG: 就性质1之前?

276YAO:

277ZHANG: 好像1刻钟?

278GAO: 上次讲了20分钟 (33: 01看自己的听课笔记)



33: 01

279YAO: 上次讲了20分钟

280ZHANG: 就是包含了性质1, 总结出来, 提炼出来, 花了20分钟?

281YAO: 点头

(集体沉默40秒)

282GAO: 你没有闯关3, 这个后面的PK根本没法进行, 你这个时间.....

283ZHANG (笑)

284GAO: 不够的, 你这个题目难度很高啊, 那个选项a, 负a负b本来就是不等式性质3了, $a < b$, 然后负a负b就已经不等式性质3了, 还要涉及到绝对值, 还要涉及到平方

285ZHANG: 平方

286GAO: 对吧, 因为你刚接触到不等式, 学生, 平方一定是非负数, 学生这个概念还没有完全建立起来, 你只有最后一个式子是.....

287YAO: 我上课的时候讲了

288SHI: 我也讲了, 那有些人还是不知道啊

289GAO: 对啊, 因为你要涉及到, 平方一定是非负数啊, 然后呢现在就是1加上就会大于等于1啊

290SHI: 现在月考里有这么一道题的

291GAO: 对吧, 然后你那个三分之二x等于负三分之一x, 还要让x大于0, 你没有那个闯关3的题目做铺垫的话, 这道题出不来的

292YAO: 那这个怎么.....

293GAO: 你可以印在另外一张纸上啊, 至少能够保持它(导学案)的完整性啊, 你不要写小组PK了啊, 就写成课堂反馈就好了啊, 也是由浅入深, 让一些差的学生也能下手, 不要一堂课下来, 10道题8道题做不出来, 那你这堂课就失败了

294ZHANG: 你(SHI)把书拿过来

295GAO: 你反馈的目的就是这堂课下来, 绝大多数学生都能听懂, 10道题的正确率至少百分之80到90, 对啊, 这是反馈, 你PK的目的不是让他们PK死啊

296SHI (37: 19大笑)



37: 19

297GAO: 对啊, 把他们都PK晕了, 你这堂课不就等于白上了吗, 对吧, 你弄个5道题, 至少要, 错一道没关系, 那要错3道.....

298ZHANG: 就像, 就像书上这个例子, 也可以举在里面, 喏(指着教材37: 35), 它本身, 给你的一个不等式里面, 本身就有一个性质在里面了, 对吧, 然后对吧, 就是类似于书上这种, 对吧, 像这种类型, 也可以



37: 35

299GAO: 再说了, 你这个本身也没有这个竞赛的气氛, 所以不要搞什么PK了, 就课后反馈

300YA: 哦

301GAO: 对啊, 你前面一点竞赛的气氛都没有, 你一下子搞PK, P不起来的, 你还是老老实实的

302ZHANG: 其实你布置的, 你布置的那道回家作业, 他们倒是蛮有兴趣的

303GAO: 哎, 就是“我是不等式”

304ZHANG: 对, 不等式当中, 怎样用文字来描述, 这个其实还挺好

305GAO: 这个还是可以的, 就是太匆忙的就是

306ZHANG: 如果这个主题在课堂上, 拿出来议一议, 那么撇开咱们教学, 还蛮好玩的

307GAO: 对, 你后面要有时间的话, 就不要搞反馈PK了, 就着重讲这个, 哪怕就让他讲一点点, 对吧(对ZHANG)

308SHI: 以“我”的口吻讲

309GAO: 也同时就是对这堂课的一个小结了。

310SHI: 对, 你这个蛮好的, 他们会觉得这个蛮有意思的

311ZHANG: 就是我今天学了以后, 你能不能用到生活里去, 对吧, 解决生活问题

312GAO: 那也弄个小高潮啊, 你一PK, 一反馈, 然后就死了, 又回到原点了, 对吧

313ZHANG: 这个PK还是停留在, 还是前面的部分, 怎样用不等式来表示

314LIU: 而且我觉得你语速有点快了, 你语速蛮快的

315GAO: 这个问题不大, 因为她有文字啊, 没有文字, 那么讲速很快, 基本上一点都

没听清

316LIU: 对!

317GAO: 带文字的话就好一点, 因为他们就是耳朵在听, 眼睛在看, 那还好

318LIU: 反正从头到尾, 我就是只听到了“我是不等式”

319ZHANG张: 她(YAO)跟你性格是不一样的

320GAO: 她(LIU)看不清黑板(笑)

321ZHANG: 她(LIU)很孩子气的, 上课的时候很活泼可爱的, 她(YAO)比较严谨, 就是比较, 比较那种, 理性的, 不是那种, 但是你前面那段呢, 因为你那块准备的就是很贴近学生生活, 他们很感兴趣, 所以他们就是一开始就是表现的啊, 就是很, 很投入的那种, 一提到他们生活当中, 他们就来劲了。

322LIU: 一上理论, 他们就(笑)

323ZHANG: 对啊(笑), 一进入这个纯符号的状态, 就不行了。

324GAO: 所以呢, 喏, 我在网上看到的是这个(40: 21拿出手机出示短视频)



40: 21

2.3 Transcriptions of third MOKE activity

In 21st March 2017, the last MOKE (Picture 2.3). happened after the open lesson (35 students) of Yao, within all the science TRG, including 21 teachers. The discussion lasts for 20 minutes and 55 seconds, chaired by Zhang. During this discussion, 27 dialogues happened, which was not like the discussion as the second MOKE, but in a form of presenting each other's comments.



Picture 2.3 Third MOKE activity

Texts for transcription in Chinese:

1YAO: 这节课的话是不等式的性质, 这个内容的话本来是有两个课时的, 第一节课是不等式的性质一, 然后第二节课是不等式的性质二和三, 本来一开始我是打算性质一二三一起讲, 但是内容太多了。但是如果下次讲的话, 我是想尝试一下, 就是把定义放一节课, 然后三个性质讲一节课, 试试看效果如何。然后这节课的话, 一开始我设置的是生活化的一些东西, 就是大家身边的事嘛, 接着呢我就是用了一个大家比较熟悉的, 上海雾霾很严重嘛, 所以就用了这样的一个情境, 来引出不等式的定义。接下来的话就是讲了不等式的定义, 然后讲了不等式的性质一, 基本性质一的话我是由等式性质做了一下对比, 但是刚上课的时候可能有点紧张, 我就给忘记提了然后后面才提了一下。接下来的就是一个例题讲解, 还有一个竞答, 希望同学们能够相互 PK, 增加学生的参与性。后面的话, 总结的时候, 其实我今天的时间有点不够, 本来那个总结的视频是要放完的, 下课铃响了, 就只能边放边结束了。就是这些。

2ZHANG: 那么今天呢我就想打破以前常规的, 就是数学老师先讲, 讲到最后呢其他组的老师都该讲的也都讲完了。今天我们就打破一下, 我们就先请每一个组的, 因为时间有限嘛, 我就每一个组请一个代表, 好吧, 那个, 物理, 化学, 物理组, 来一个代表。

3WL: 我来讲吧。姚老师的课因为最开始的时候我没听到, 稍微晚来了几分钟。我是从

不等号判断哪些是不等式开始的，那么我看教案之后发现前面的背景引入啊都很新颖，而且都很贴合实际，跟生活联系的很紧密。然后在中间的过程中，我觉得这个概念讲解都很清楚，学生理解起来也比较好，也很积极的去配合。然后等式和不等式的背景呢，确实很难联系，从教案和讲解上，但是我估计学生呢应该都能明白。然后后面的这个事情，我就觉得学生都能积极的参与，整个教学过程都很完整，从头到尾都相得益彰，挺好的。那我就简单的，我个人觉得有两个小问题，一个就是说我们在那个不等式性质一的时候，不等式的两边同时加上或减去同一个数，那么这个其实这个也没什么问题的，那么从设计意图上来讲呢，因为教案和我们的课堂，如果能匹配的话，那么设计意图从特殊到一般，换句话说，同时加减一个数到同时加减一个字母，表达上能够渐进一些，同时加减一个量，一个相同的形式，那么很多数可以变成一个很抽象的字母，可能，我个人觉得，可能更好。第二个就是说，我个人觉得做题目挺好的，然后小组竞答的环节同学们回答的也都很积极，我刚才在看的时候，我看到闯关 2，我一开始觉得闯关 2 好像跟不等式的关系不是很紧密，然后我感觉学生怎么没去解释啊，后来姚老师说用我们以前的有理数运算的性质啊等等，那么我个人觉得，既然我们是学习的不等式的性质一的话，那么我们，当然闯关 2 是可以挺好的，那么是不是闯关 3 可以放到闯关 2 前面呢。这样这个性质有一个连续性，你前面是针对这个不等号，是跟着老师做，后面这个你自己做，然后这样在顺序上也会挺好的，一开始是数字，然后是字母，然后是闯关 3，能够看出我是怎么样实现加减相同的量，闯关 2 是提醒学生可以用一些别的性质，要注意灵活应用。然后 x 乘以 y ，我当时就在想怎么用不等式的性质 1 啊，如何加减一个相同的量，这不是乘除嘛，然后就在想，是不是在为了下一节的不等式的另外两个性质在做铺垫。那么我就是有这么一个小小的感觉，就是闯关 2 既然跟这个关系不是特别大，那么是不是可以为后一节课的引入啊，包括知识的一个稍微迁移啊综合啊，灵活的去运用不等式啊，做一个准备。这是我个人的一个小小的感受。

4ZHANG: 谢谢啊，那么接着化学组。

5HX: 我讲不了他那么多（笑）。就是一个感触，我第一次听预备年级的课，我就是感觉，我们初三啊真的好难（笑）。对，我感觉嘛，就是讲一节课 40 分钟，说实在的这一点内容我觉得如果要我的话，我可能十几分钟二十分钟就结束了，这个能撑到 40 分钟也不容易，真的特别不容易（笑）。就是觉得，真的挺不容易的，就是从六年级到初三，这个整个过度啊，的确是觉得，真的，我联想到初三真的就是觉得很难了。唯一的一点小意见啊，我是看她在画那个坐标轴的时候，她不是从 0 开始开始嘛，其实这就是物理上的，就是刻度的概念已经出来了。她再到这个 y ， $x+4$ ，就是往那边移动 4 个单位， y 再往右边移动两格，其实这里面呢你没有这个绝对的单位，你没注意，或者说 0 到 1 你索性就小一点，但是小一点学生就看不清楚对吧，就是你移动的 4 其实没有够 4，对吧？

6YAO: 对对对。

7HX: 这是我的一个小意见，总体来说挺不错的，我讲完了。

8ZHANG: 接下去，有没有其他组的一些老师？

9SW: 这个我说吧，我觉得小姚这节课的学生互动特别好，就是说把学生的学习积极性调动起来了，所以孩子在上课的时候也非常愿意上来讲，愿意表达自己的观点。我觉得她确实关注了各个学生的需求，她就把孩子的这个兴趣给调动起来了，这样我就觉得这个课已经成功了一大半了，我就说这些。

10ZHANG: 体育组（笑）

11TY: 我觉得这节课下来, 学生的互动性很强, 而不是很枯燥的上下来, 我们感触蛮深的。我觉得从学生的反应来看, 他们掌握的非常好, 我觉得满成功的。

12ZHANG: 好, 请我们的班主任。

13BZR: 我觉得我们班学生今天表现的蛮好的, 就是我平时上英语课他们也没这么积极。我觉得完成度也蛮高的, 就是小朋友也……姚老师还是花了好多好多心思的。我就说这些, 我觉得挺好的, 真的。

14ZHANG: 好, 那我们数学组, 先请赵老师和高老师, 我们幕后的指导者, 他们帮小姚磨课, 他们几乎每节课都来指导, 请这两位数学老师先来。

15GAO: 小姚的这门课呢, 我们也花了差不多两周哦, 做了 4 稿。整个课程设计的变化还是比较明显, 而且感觉到越来越顺畅, 其实这中间最主要的也是她自己的一个付出, 对吧。那么整个课程体系, 刚才那个沈老师(物理老师)提到的, 就是闯关 2 的一个内容, 我们这节课是新课, 可能是观点不同, 因为新课就是不等式的性质, 但是我们觉得知识还是应该有一个前后的牵连, 不仅要学到一个新的知识, 还要让学生知道, 不等式的运用不仅是它的性质在支撑, 还有一个我们之前学到的很多知识点在支撑, 课后练习对运算也是有要求的。所以我们在这里还是在我们前期听课的时候, 其实也提到闯关 2 要还是不要的问题。我们还是斟酌了一下, 就是不能只是为了学习一个新的知识点, 可能更重要的一个前后新旧知识的一个衔接。所以我们最后商定还是把闯关 2 放进去了。那么可能在语言表达方面, 连接性上略微还是差了一点, 我们以后还是有待提高的。整体上看, 我们这节课还是比较顺利的, 板书各方面, 通过上一次, 前几次我们修改以后, 基本上就走的比较完整。好, 我就说这些。

16ZHAO: 好, 小姚这节课, 实际上我觉得她尤其是在第一部分引入的时候真的花了很多心思, 先联系学生生活实际, 先是比一比瞧一瞧, 小朋友其实这个时候已经跟老师很近了, 她在不等式的引入当中用了生活中的 PM2.5, 这些地方就很顺利的就用了不等号出现, 应该说前面的一部分东西是很顺的。然后实际上我们在讲, 在反复的试讲这门课的时候, 一直觉得那个不等式性质 1 的一个探究的过程, 几句是刚开始的时候小姚可能就是大家一起来填第一题第二题第三题, 那么我们这里还是反复的权衡了一下, 觉得还是, 这部分内容说到底, 就是像刚才张毅(化学老师)所讲的, 真的是很简单, 所以我们一直跟小姚建议, 就说这张学习卡给他们, 让他们自己去做, 他们完全是有这个能力做出来的, 所以今天这个班级的同学的确跟我们预想的一样, 很顺利的就整个探究结果给做出来了, 然后本来是为了生动一点, 让她放一个天平的实验, 那么后来网上找了一个视频, 我觉得也很好, 那么对孩子来说印象可能更深了, 那么实际上最后一块就是, 包括昨天在那里, 我们在那里的时候, 昨天我们最后是在课后的 5 道反馈的题目当中是反复的斟酌了一下, 那么这 5 道题目是在学生手里, 我们老师没有拿到手, 那么在这 5 道题里面, 我们也想了一下, 就跟高老师的观点是一致的。就是数学知识绝对不能说今天上什么, 像前面的东西, 或者说生活当中显而易见的那些东西, 不一定说, 一定要套用数学知识来解释这个问题, 我们希望也能够把它渗透在里面, 所以呢昨天我们三个人, 把这五道题实际上稍微动了一下, 然后小姚最后修改了一下, 所以这五道题我也跟她讲, 因为这个肯定是要考虑时间, 上课的时间进度, 没有时间呢, 那就直接做, 讲掉, 就对着答案, 希望下节课的时候能够再强化一下, 所以说应该说这节课从总体上, 从前到后还是很顺利很成功的。

17ZHANG: 那就按照这个顺序, ZHU!

18ZHU: 我觉得小姚很不错, 刚实习结束, 她能把课上成这样, 态度啊, 形态啊对学生

的互动啊，我觉得都比较成熟了。这节课上的还不是她自己班级对吧，像昨天上的还没有这么顺对吧，是学生的的问题。我觉得与学生的互动之间，已经非常成熟。毕竟花了很多心思，很不错的。

19SHI：我觉得小姚还是花了很大心思，我看的出来的。就是感觉学生很适应小姚的教学哈。非常好，反正，很好。

20GAO：Liu！

21LIU：到时候 PPT 拿来我们直接用一下吧（笑），很好。

22GAO：小金

23JIN：很好（笑）

24ZHANG：大家刚刚说的我就不重复了。她 3 月 7 号对吧，就是课件啊教案啊什么的就发到我邮箱了，可见她作为年轻人，做事情是很用心的。很早就开始着手准备，做这件事情了，而且过程当中是反复修改，之前是上了三节还是四节？

25YAO：4 次。

26ZHAO：一共 5 个班只有一个班没有上到。

27ZHANG：今天等于上第五遍了。以往我们可能最多就上三遍吧，第四遍最多了。可见她对这件事是高度重视的。从这一点上我们所有老师都可以向她学习的。然后呢就是一开始她发给我邮箱的这个教案，我就说我觉得就写得非常好，很吸引我。尤其是前段，是一个高潮，马上把小朋友的注意力和兴趣都吸引了，我说，叫我自己写的话，我是想不到的，由一个问题就是编成了三个题目然后层层递进，把不等式的定义就引出了。后面呢我就是说习题方面怎么编（她在看学生卡）也是经过了几次定稿以后，也是编的相当的好。那么我就再补充一点，就是我感到，因为她这堂课呢本身就是说，渗透了一种就是数学来源于生活，来服务于生活这样一种理念。所以我是觉得如果这节课在某些环节里面，尤其是小沈（物理老师），讲完定义之后，讲不等式性质 1，这个环节如果不那么匆忙，能够再多放一点时间，然后在衔接的过程当中，如果能够设计的再巧妙一点，也能够像第一个问题，怎样像不等式定义一样去引入，为什么我们要学习不等式性质 1 呢，如果这个环节能稍稍设计一下就好了，也许我觉得这节课会更加完美。我自己的设想就是说，在这个不等式 1 引入之前要用类的思想，让大家先回顾等式的思想，这是很好的。因为你的教学设计前半段特别好的反映了数学来源于生活服务于生活，我觉得不妨在不等式性质 1 之前，也能够有一个小小的设计环节。比如说，我这是瞎讲，你刚才的一个视频里面，能够设计成两个小朋友在争论，争论来争论去，不知道自己谁对谁错，那么这个时候请裁判，那么这个时候就引入了我们必须掌握不等式的性质以后才能解决这个问题，那么由问题引入，为了这个问题所以我们才去学新知。这种方式我个人觉得更符合你整个思想的渗透。所以这个环节上如果能设计的更巧妙些，时间上就不会那么匆忙，让学生感觉到，我学习的东西是有目的的，所以我要把这个东西学到手对吧。这个前面学了不等式的定义以后其实他会发现，学完不等式是可以服务于生活的。就是说你到商店里去买一瓶酸奶，同样几个牌子的酸奶你会去看里面的成分，小于等于什么，大于等于什么，这个时候你就会比较了，对吧，其实这就是学了不等式以后的作用，他可以用数学知识去解决问题，如果说这个环节上也能这样去想的话，我觉得可能学生收获会更多一点。其他方面我觉得都很好。

2.4 Transcriptions of first French collective lesson preparation

Les deux enseignantes commencent par chacune se présenter, puis elles présentent les ressources qu'elles sont apportées pour cette préparation collaborative, ensuite elles travaillent, sans interruption du chercheur (D), jusqu'à la fin de l'heure.

Courte présentation de ANNA

0s

Je m'appelle ANNA, et je travaille au collège X.

Nous sommes dans un moment de changement de programme, et on a décidé de réfléchir aujourd'hui à l'introduction de l'algorithmique à partir de l'année prochaine. C'est un chapitre qu'on ne connaît absolument pas. Donc on a décidé d'emmenner en ressource tout ce qui, tout ce qu'on a récolté ces derniers mois au fur et à mesure que ça sortait, c'est-à-dire les programmes, les accompagnements de programme, sur Viaeduc il y avait des groupes notamment qui faisaient passer des informations donc on a récupéré tout ça, au fur en mesure de notre recherche on a créé des padlets dans lesquels on a mis les documents, mais c'est vraiment au fur et à mesure, on les a pas encore étudiés donc on ne sait pas du tout ce qui nous intéresserait dedans. On a mis sur la table devant nous tous les manuels, qui nous ont été envoyés ces derniers temps. Donc pareil on ne sait pas du tout comment ils ont décidé de rechercher cette notion, comment ils veulent la présenter, on ne sait pas si ça va nous plaire ou pas.

Les difficultés, c'est qu'on n'a jamais enseigné cela. La seule fois où on a fait de l'algorithmique et du codage, c'est dans des clubs, sur les temps de midi avec des élèves, uniquement volontaires ; on ne sait pas trop comment on va pouvoir faire avec beaucoup d'élèves. Et on présente à deux, parce que on est habituées à travailler à deux, plutôt que d'aller chercher chacune de notre côté, on préfère regarder les points ensemble et regarder ce qu'il y a d'important dans les différents documents et ce qu'on a envie de mettre en avant. Etant donné que, de toutes façons, les élèves vont passer entre nos mains successives, l'algorithmique, c'est un gros morceau en 5ème, 4ème et 3ème.

1mn54s

Courte présentation de Cindy

Je suis Cindy, je suis aussi enseignante de mathématiques au collège X.

Alors, sur les ressources, je vais pas redire parce que finalement c'est vrai que je pense que ANNA a à peu près tout dit, l'idée aussi c'est que finalement dans un moment où on est obligé de choisir des manuels, on se dit aussi que, face à une nouvelle notion, ça pouvait nous permettre aussi d'appréhender, un

chapitre de manuel qu'on ne connaît pas du tout, et de voir par ce biais là, si ça pouvait nous aider au choix aussi du manuel.

Après, moi, dans les difficultés, c'est vrai qu'il y a l'idée que c'est vrai, on ne l'a jamais enseigné, après, c'est pas seulement qu'on l'a jamais enseigné. C'est même qu'on ne l'a jamais vécu non plus, enfin, vécu non plus... Si, à l'université, enfin, on avait de la programmation, on avait de l'informatique, mais, par contre, c'est vrai que ce n'était pas du tout dans cette optique là. Et en fait, on n'a pas eu de formation, de formation d'enseignant, et disons que la formation qu'on a eue, on a eu la première demi journée, il y a 15 jours, c'était vraiment une formation à l'utilisation du logiciel et pas une formation à l'enseignement de l'algorithmique, donc ça, enfin, je trouve qu'on est, on a un peu démunie de ce côté là. Voilà.

Sachant qu'il faut chercher un petit peu, voilà, comment est-ce qu'on peut faire passer des choses au-delà de la notion quoi. Voilà. Pourquoi deux, j'ajouterais même, qu'on aurait presque pu être trois si notre collègue ne travaillait pas, parce que c'est vrai qu'on est trois collègues dans l'établissement et, face à quelque chose de nouveau comme ça, il va falloir vraiment de toute façon qu'on se mette d'accord à trois sur la progression, sur le cycle, sur les différents éléments, sur les différentes articulations en fonction des niveaux, etc. Donc il y a vraiment quand même la nécessité de partir sur les mêmes bases, et sur la même idée de ce qu'on va enseigner, pour que ce soit cohérent. Et que, à la limite, l'année prochaine quand des collègues vont venir compléter leurs services avec nous, on puisse leur demander aussi quelque chose qui soit cohérent avec ce qu'on fait, pour que, voilà, à l'échelle de l'établissement, on sache où on va.

Donc ça, c'est plus largement, et puis, après, enfin, à deux toutes les deux, parce que voilà, ça fait des années qu'on travaille ensemble, et que, et que, on est, enfin, voilà, je pense que... on n'imagine pas travailler des nouvelles choses, perdre du temps, à bâtir des trucs toutes seules, et après, tout refaire quand on est à deux. Voilà, c'est un peu ça.

(ANNA : oui)

Sachant qu'en effet on a quand même, au gré du... enfin c'est ANNA qui a tout mis dans un padlet. Mais c'est vrai que au gré des différentes réunions, des différentes rencontres, à chaque fois on a eu des informations. Mais qu'on n'a pas eu le temps de prendre en main beaucoup pour l'instant.

4mn51

Préparation de la leçon

CY : Est-ce que vous pouvez présenter les ressources que vous avez portées aujourd'hui pour enseigner l'algorithmique, quelles ressources vous voulez utiliser, et de quelle nouvelle ressource vous avez besoin ?

5m23

Cindy : Tout est nouveau (rires). En fait comme ça n'existait pas avant dans les programme, tout est nouveau ; la ressource de base, c'est quand même le programme.

ANNA : Oui

Cindy : Et l'accompagnement, enfin...

ANNA : Et l'accompagnement...

Cindy : ... c'est vraiment la première chose qu'on regarde parce que c'est ça qui... et après, dans les manuels, il y a une interprétation, l'interprétation des auteurs des manuels, du programme, mais par contre, le programme, c'est quand même la base de ce qu'on regarde en fait. T'as l'accompagnement

[http://cache.media.eduscol.education.fr/file/Algorithmique_et_programmation/67/9/RA16_C4_MATH_algorithmique_et_programmation_N.D_551679.pdf]

ANNA : J'ai l'accompagnement, j'ai tout mis ensemble.

C : voilà. Donc, c'est ça, c'est le programme, et l'accompagnement, mais les deux sont nouveaux, parce que les deux, on n'a pas, enfin, on en a pris connaissance l'année dernière au mois de juin, quand ils ont commencé à faire paraître les projets de programme, mais finalement, c'est pas... Et puis, après, dans les manuels, en fait, pour le moment, on ne sait pas trop ce qu'il y a...

S : On ne sait pas. on n'a pas trop regardé encore

C: Donc je pense qu'on va regarder d'abord ce qu'on a un peu plus l'habitude de regarder, et on va pas regarder ce qu'on n'aime pas regarder...

S : Oui

C : Mais, si , quand même, pour se moquer...

ANNA: Non, non, même pas, plus tard

(rires)

S: mais tout est nouveau, en fait, le... je pense que ce qui est le plus important là, pour défricher parce que en une heure, ça va être juste défricher, ça va être les programmes, les accompagnements de programme, et puis, puis essayer de se mettre d'accord, sur quel point, qu'est-ce qu'on a envie de travailler avec les élèves.

Cindy : Oui, quel type d'activité

Cindy : Sachant qu'on a eu une, une injonction au niveau de l'inspection, et ça a été redit en stage, sur le fait qu'il fallait absolument que les élèves manipulent plus, [Scratch](#), donc le logiciel d'algorithmique....

ANNA : Oui, mais...

Cindy : 10 heures dans l'année, dans chaque année du cycle 4.

ANNA : Oui, mais la difficulté quand même, on va en reparler, mais, moi, j'ai pas envie de faire des cours de Scratch, donc l'algorithmique, pour moi, c'est plus une pensée, c'est pas savoir utiliser un logiciel ; à vrai

dire, un logiciel, les élèves on pourrait leur donner n'importe lequel, ils pourraient...

Cindy : hum hum

ANNA : C'est plus, comme est-ce qu'on va pouvoir leur expliquer ce que c'est qu'un algorithme.

Cindy : oui.

7mn30s

CY : OK, vous pouvez commencer à préparer ?

Cindy : on peut commencer

ANNA : on peut commencer

ANNA: Voilà, j'ai commencé, j'ai copié le petit morceau de programme dans... j'ai écrit un doc [<https://www.dropbox.com/s/b7l749of8pl8fab/Algorithmique.docx?dl=0>]. J'ai écrit un doc, je n'ai pas encore sauvegardé... Je vais sauvegarder tout de suite sur la Dropbox. Comme ça, on n'aura pas de problème. Et... euh... donc algorithmique...

Cindy : euh... On fait l'EPI (Enseignements pratiques interdisciplinaires, liés à la réforme du curriculum [<https://www.dropbox.com/s/7uzq6f692b2ae04/15-EPI.pdf?dl=0>] sur le robot, ou non ?

ANNA : le quoi?

Cindy : L'EPI sur le robot.

ANNA : Ben on a demandé... Je pense qu'on va le faire. Mais, l'EPI, ça sera, du coup ça sera davantage de la programmation, ça va permettre de pouvoir aller en salle utiliser Scratch, pour le coup, si jamais on a l'EPI. Je le range dans quoi, dans les cours ?

08mn14

Cindy : oui

ANNA : je les mets en vrac dans les cours.

Cindy : oui

ANNA: comme c'est pour tout le cycle...

Cindy : Parce que (ANNA : voilà) il n'est pas partagé le vrac des cours.

ANNA : Ah bon je le remettrai alors sur un partagé. Voilà. Donc....

Cindy : Il faut se faire une nouvelle arborescence en fait [<https://www.dropbox.com/s/vurhb9fyzehr34n/16-ArborescDROPOBOX-SR.png?dl=0>]...

ANNA : oui, oui, oui. Donc, (elle lit le programme) « au cycle 4, les élèves s'initient à la programmation, en

développant une démarche de projet quelques programmes simples, sans viser une connaissance experte et exhaustive d'un langage ou d'un logiciel. Décomposer un problème en sous-problèmes, reconnaître des schémas. Écrire, mettre au point (tester, corriger) et exécuter un programme » ...

Cindy : Tu a vu,,,

ANNA : ... écrire un programme...

Cindy : (Elle lit à son tour le programme) « revisiter les notions de variables et de fonctions sous une forme différente, et s'entraînent au raisonnement ».

ANNA : oui, le problème...c'est que ... ils ne peuvent pas le revisiter, vu qu'en 5^{ième} ils ne l'ont pas encore visité...

Cindy : oui, mais, dans...

ANNA : Oui, en 4^{ième}, 3^{ième}, mais... non, je veux dire, ils revisitent le... il faut déjà que... Ils n'ont pas encore découvert l'algèbre... par exemple Ils n'ont pas encore utilisé la variable algébrique... ils ne peuvent pas la revisiter.

Cindy : hum

ANNA : On... On pourrait regarder aussi ce qui ...

Cindy : [incompréhensible]

ANNA : oui, oui, oui... Jeu de labyrinthe, réalisation de figure, initiation au chiffre-mots, moi, dans ce que j'avais vu, ce que j'avais bien aimé dans Pixees, c'est comme ça que ça s'appelle ? Le...

Cindy : l'activité débranchée ?

ANNA : le débranché, oui... Ils ont les crêpes, là... Les fameuses crêpes...

Cindy : oui, les crêpes j'aime bien

9mn53

ANNA: Parce que c'est... c'est compliqué au départ. Tu peux leur faire compter le nombre de fois où ils tournent pour arriver. Une fois que quelqu'un a trouvé un algorithme, c'est super simple, et ça fonctionne, comme tous les jeux à stratégie gagnante, d'ailleurs. Et du coup, on pourrait fabriquer des crêpes pour un certain nombre de groupes et les mettre là-dessus, sur ce problème-là. Par contre il faudrait appeler cela autrement que le crêpier psychorigide [<https://pixees.fr/le-crepier-psycho-rigide-comme-algorithme>], parce que sinon, dès qu'ils sont rentrés à la maison, notre problème, il est mort. Donc, je ne sais pas, enfin, on peut imaginer autre chose, mais on pourrait fabriquer avec des trucs plastifiés...

10mn 30s

Cindy: euh ben oui, de toutes façons, il y a la plastifieuse.

ANNA: Oui... avec des couleurs, et puis leur faire, vraiment leur faire manipuler,

Cindy: oui

ANNA: Et, il y a une autre, une autre activité, toujours sur Pixees, c'est les... c'est [compter en binaire](#) (0, 1, 10, 11, 100, 101, 110, 111...)

Cindy : oui, avec...

ANNA : tu sais, avec les élèves qui se tournent

10mn46s

ANNA: Ça ça peut être bien, parce que le cours se fait. Parce que ce que disent les inspecteurs, c'est pas faire des maths, ça c'est compliqué, on peut pas ne pas faire quand même, on reste quand même sur une réflexion.

Cindy : en binaire ?

ANNA : oui en binaire

Cindy : moi, quand on est en binaire, je trouve quand même cela sympa, il vont travailler sur le sens des opérations, tu vois je vois avec les PE (professeurs d'école) par exemple. Tu vois, tout le travail sur les techniques opératoires, je leur ai fait faire des additions et des soustractions en base 5 (0, 1, 2, 3, 4, 10... ; 412 en base 5 = 107 en base 10) et en fait, c'est vachement intéressant parce que l'idée de retenue, etc., tu comprends bien que c'est lié aux regroupements, c'est vrai que ça peut être sympa de faire ça.

11mn25s

Cindy : moi, j'aimais bien aussi l'idée de danser, c'est l'idée de langage en fait ; les crêpes, c'est vraiment l'idée de décomposer un problème en sous-problèmes...

ANNA : oui, tout à fait

Cindy : compter en binaire aussi, et puis, sinon je marque danse [p. 30 de ce document

http://www.ac-grenoble.fr/savoie/pedagogie/docs_pedas/scratchjr_bl/CreativeComputing20140806_FR.pdf?PHPSESSID=28597fa4423f372e76ef630ddefd7922]

Sohie : attends... La danse, tu l'as trouvée où ? (à demander)

Cindy : on l'a trouvé dans le document, là...

ANNA : le fameux document qu'elles nous ont donné

Cindy : oui, le document de Grenoble

ANNA : c'est lequel ? C'est l'informatique créatrice ?

Cindy : [creative computinghttp://scratched.gse.harvard.edu/guide](http://scratched.gse.harvard.edu/guide)

12mn10s

Cindy : c'est vraiment axé sur Scratch, c'est un peu casse-pieds

ANNA : c'est pas grave que ce soit axé sur Scratch, mais ce qui me gênerait, c'est de faire un cours sur Scratch. Moi, je n'ai pas envie de faire un cours sur Scratch, avec les ordres violets, les ordres bleus, tu vois, parce que c'est un peu ça, après les blocs, c'est pas ça qui est intéressant, c'est...

Cindy : je ne crois pas qu'ils fassent ça...

ANNA : ben, je crois que c'est ce qu'ont fait certains manuels, regarde, prend [le manuel de Sésamath](#) ils ont un cours...

Cindy : Eux (Sésamath), ils leur demandent de faire des trucs, hein, "crée un lutin, ajoute des blocs...",

12mn43

ANNA : on est déjà dans le lutin...

Cindy : ah oui, oui,...

ANNA : je trouve que le faire dans le langage, vraiment le langage naturel...

Cindy : OK

ANNA : Après, quelque soit le langage de programmation sur lequel tu te trouves, tu peux le programmer. On voit bien, en atelier, les élèves ils se retrouvent, je crois que c'est tout à la fin, attends je regarde leur chapitre, je crois qu'ils ont fait un... je crois qu'ils ont utilisé un... vraiment t'as le cours quoi, les boucles, les variables, les...

Cindy : regarde, il y a le crêpier psychorigide, [il est même là](#), ils l'ont piqué, mais ça n'a aucun intérêt qu'il soit placé, enfin qu'il soit dessiné, tu comprends rien...

ANNA : oui, mais celui qui ne sait pas de quoi on parle...

Cindy : oui, mais tu mets un truc avec un film, regarde...

ANNA (elle regarde l'auteur indiqué en fin d'exercice, avec [un lien qui n'est pas cliquable](#), c'est quoi, ça ? c'est bizarre, parce que c'est quand même un truc de l'INRIA, non ? Pourquoi c'est ce lien-là ?

Cindy : tu cherches ?

ANNA : ouais...

Cindy (elle lit le manuel de Sésamath) : Introduction à la programmation. Un algorithme blablabla...

[incompréhensible]

Cindy : (elle continue à lire le chapitre de Sésamath) Un algorithme se compose... Alors là, les règles de l'algorithmique, c'est...

ANNA : c'est pour ça, ce que je te disais, on va pas faire un truc comme ça, c'est pas possible !

Cindy : comment ça s'appelle Asimov, les règles des robots... (trois règles d'un robot d'[un roman de sciences fiction](#)).

(Elle continue à lire la règle 1) "Un algorithme se compose de trois grandes parties" ...

ANNA : en tout cas, ils ont du débranché... Je ne suis pas sûre qu'on en trouve dans tous les manuels...

Cindy : (elle commence à lire la règle 2). "Un algorithme doit éviter de comporter plusieurs fois la même série d'instructions" ...

Ça c'est pareil... En fait, ça doit pas être une règle, ça doit être quelque chose où... Un challenge, où... Dans [Lightbot](#) (qu'on nous a donné en formation), c'est ça, c'est un espèce de petit challenge, où tu n'as plus la place, tu n'as que 12 cases, de toutes façons...

14mn26

ANNA : du coup, j'ai regardé Lightbot quand tu m'en as parlé. Le seul truc, en fait, c'est que tu es obligée de prendre tes challenges dans l'ordre.

Cindy : non ?

ANNA : si, si, t'es obligée, moi c'est ce que j'ai noté

Cindy : non, pas les différents... Je pense que tu dois pouvoir ouvrir chaque truc séparément, regarde...

ANNA : tu vois, ils disaient « code studio », celui d'Angry Bird <http://lightbot.com/hour-of-code.html> ou celui de « reine des neiges », on peut le faire dans l'ordre qu'on veut...

Cindy : Non mais là c'est pareil... Dans un truc, tu as « surcharge »...Par exemple, celui-là, tu peux le commencer, après dedans,

ANNA : dedans, tu es obligée de le faire dans l'ordre.

Cindy : Par contre, tu peux très bien faire... Là, c'est avec des conditions... On peut le commencer tout de suite... Là, t'as des défis... Et là, tu vois, tu montes, tu descends...

15mn

ANNA : Mais moi, je vois bien que, quand on les prend avec les Mindstorms (robots achetés pour le club robotique)[1] ... Je veux dire, les élèves, je veux dire, on leur dit : « vous faites ça », comme c'est que de l'essai-erreur, ils le font sans problème leur truc... Faut dire, c'est pas... La réflexion, c'est vraiment «

comment ca marche ? »...

Cindy : moi j'ai vu Cédric... Cédric [le fils de Cindy, un beta testeur], il écrit son tout petit bout de programme, il le teste, et puis après, il l'inclut dans autre chose....

15mn30

ANNA : il fait vraiment de la décomposition

Cindy : tu vois, par exemple, attends, celui sur « procédure », c'est le 7 [numéro des niveaux, dans Lightbot] je n'ai pas réussi à... Je n'ai pas réussi à faire 12 commandes (rires), mais attends, j'étais hyper fière de moi... et bien c'est vrai que celui-là, typiquement, tout de suite tu vois qu'il y a un truc à répéter... donc avant même d'être dans le truc des boucles, tu fais déjà des boucles, parce que... tu vois, ça... la commande (elle essaie de le faire sur son écran...)

15mn55

ANNA : tu vois, lui aussi, regarde, c'est ça que tu disais, il nous faut une choré (pour chorégraphie), tu vois, on prend la chorégraphie, il y en a un qui la regarde sur son écran et ensuite il la fait faire à la jeune fille... déplacement (ANNA le fait sur son écran)

Cindy : bon après, c'est un peu casse-pied, cette idée d'être toujours dans le déplacement... Enfin, c'est quand même beaucoup ça... Lightbot, c'est que ça, c'est sûr, mais après...

16mn26s

ANNA : ben même, de toutes façons, oui... bon, après, quand l'équipe de l'IREM de Clermont [<http://www.irem.univ-bpclermont.fr/Algo>] est venue à l'APMEP, ils nous ont fait faire des choses mathématiques, additionner des fractions, etc. On n'était pas dans du déplacement, c'était un... Mais, il n'empêche, quand tu es face au programme, et il faut que tu programmes sur Scratch...

Cindy : hum...

16mn47

ANNA : ...une addition de fractions, ben c'est pas évident...

Cindy : Hum, hum

ANNA : Bon très peu de débranché sur celui-là (ANNA indique un manuel). Donc on est d'accord : Crêpier, Binaire, toi tu disais une chorégraphie...

Cindy : Oui

ANNA : les tris non ? Ca ne vaudrait pas le coup de travailler sur les tris ?

Cindy : qu'est-ce que tu veux dire ?

ANNA : comment on trie... Je te donne un...

Cindy : un texte avec...

ANNA : je te donne tout un tas de données, comment tu vas trier, comment tu vas les remettre dans l'ordre croissant par exemple...

Cindy : hum...

17mn27s

ANNA : c'est pas évident, enfin je veux dire, comment est-ce qu'ils vont faire...

Cindy : hum..

ANNA : ils peuvent trier un par un, ou ils peuvent trier séparément deux moitiés, ou tu vois, je..

Cindy : qu'est-ce que ça veut dire... « Certains langages n'utilisent pas la déclaration type » (elle lit Sésamath)

ANNA : je sais pas (rires). Le problème, moi ce qui me gêne, c'est ça, le Python (un langage de programmation), c'est super compliqué, puis ce « égal » (le signe =) qui apparaît de nouveau, avec une autre... C'est de l'affectation, mais ça te fait encore un sens différent pour le « égal »

18mn

Cindy : hum

ANNA : je ne sais pas si cela sert à quelque chose

Cindy : la suite, « ils utiliseront le symbole « flèche dans l'autre sens » pour indiquer une affectation dans le langage algorithmique » (rires)

ANNA : et du coup, c'est un vrai cours, c'est pas possible...

Cindy : mais surtout, il n'y a pas de cours...

ANNA : tu vois, on ne fait pas ça... Je ne sais pas ce qu'on fait, mais moi, je ne fais pas ça...

Cindy : en plus ils ont, des exercices d'algorithmique ?

ANNA : ils en ont un petit peu...

Cindy : ah bon ?

ANNA : ils en ont un petit peu partout, mais enfin il faut le savoir... Ils avaient expliqué...

Cindy : c'est la petite couleur, là ? C'est quoi le code couleur ? Niveau 1, niveau 2..., non le code couleur c'est...

ANNA : niveau 2, niveau 3,

18mn39

Cindy : alors, algorithmique, les thèmes de synthèse

ANNA : ils avaient expliqué que, à chaque fin de chapitre, ils en avaient, mais c'est pas marqué, algorithmique, c'est à eux de réfléchir

Cindy (elle feuillette le livre et lit des extraits, toujours dans Sésamath)... « Je résous des problèmes... en utilisant le numérique ».... Ca veut dire quoi ? Ah si, c'est les logiciels, ça. En utilisant le numérique... C'est quand même vachement malin de mettre « en utilisant le numérique »...

19mn15

ANNA : Mais ça peut être un logiciel de géométrie dynamique...

Cindy : Mais à ce moment-là, tu mets les TICE ? Tu mets le numérique... Et après cela, tu mets « activités numériques » ? (rires...). C'est bizarre... « Ecris un programme »... Si c'est ça, tu vois, écris un programme qui lit deux dates et affiche la durée entre ces deux dates... Ecris un programme qui calcule l'aire d'un triangle à partir de...

ANNA : ça c'est pas mal...

Cindy : ça c'est pas mal...

ANNA : ça c'est bien...

Cindy : ça c'est orange

ANNA : ça demande quand même un peu de réflexion

Cindy : ah ben oui (elle continue la lecture) : « écris un programme qui calcule le volume qui coule après...

ANNA : parce que « écrit un programme qui fait aller ton petit bonhomme jusqu'au bord de l'écran, et revenir, se retourner et partir dans l'autre sens », ça...

19mn59

Cindy : ce qui est rigolo, c'est un jeu, ça permet de montrer...

ANNA : oui, d'accord, mais montrer un peu...

Cindy : tu vois, ça va bien et puis Cédric, il est en 6^e, il est tout content de réfléchir à de petits défis et d'ailleurs ils appellent ça des puzzles, c'est rigolo...

ANNA : hum

Cindy : je trouve que ça te met en route, mais par contre, ce n'est pas une fin en soi... de faire avancer un

robot, ça sert à rien. « Ecris un programme qui te permet de calculer le nombre de secondes dans une année selon qu'elle est bissextile ou pas »...

20mn25

ANNA : c'est compliqué...

Cindy : c'est compliqué, hein... en 4^{ème}...

20mn37

ANNA : tu crois... franchement, il faut déjà le faire

Cindy : hum...

ANNA : c'est, c'est vraiment compliqué, il y a les graphes aussi, tout ce qui est graphe...

Cindy : bon alors ça... C'est 5^{ème} : « complétez le programme suivant pour qu'il convertisse une durée donnée en heures en heures-minutes-secondes », c'est bien parce que les élèves, déjà, ils ne savent pas le faire (rires)

21mn

ANNA : une fois qu'ils ont fait le programme, ils peuvent s'en servir...

Cindy : oui, c'est ça

ANNA : tiens, regarde, il y a un programme de calcul [Important car Sésames développe des programmes de calcul pour l'apprentissage de l'algèbre. Il y a un pont possible avec l'algorithmique]: « Voici un calcul. Première étape, choisir un nombre de départ, ajouter 7, multiplier la somme par 6, soustraire 30, diviser par 3 la différence, soustraire 4 au quotient », ben dis-donc, « et finalement prendre la moitié de cette différence... Quel résultat obtient-on en partant de 12 » (silence) Bon de toutes façons on a un... J'ai pris un... J'ai pris Didier [c'est un manuel scolaire], j'avais regardé Hatier [un autre manuel scolaire], c'est pas... C'est pas trop transcendant...

21mn39

Cindy : mais ils n'ont pas refait un... [manuel scolaire]

ANNA : si, si, ils en ont refait un...

Cindy : oui, [un manuel] de 6^{ème}..., je ne vois pas les autres...

ANNA : on ne l'a peut-être pas... Soit on ne l'a pas, soit ils ne l'ont pas encore sorti... Et Kiwi, il n'y a rien dans Kiwi [un manuel scolaire] ?

Cindy : oui, Kiwi, ils avaient d'autres... Tiens, ils ont fait comme ça...

ANNA : il y a aussi, à chaque fois que tu donnes une figure, tu leur demandes de l'étudier...

Cindy : Hum...

ANNA : Parce que, forcément, si tu veux repasser sur l'algorithmique, faut que tu aies vérifié comment c'est fabriqué [elles feuilletent le livre].

22mn15

Cindy : ah oui, elles nous avaient dit qu'il y avait toujours une partie prise d'initiative...

ANNA : où ça, dans Phare [manuel scolaire]

Cindy : Non, dans Kiwi, tu te souviens, il y avait déjà ça (elles feuilletent le livre)

Cindy : oh, regarde, ils ont mis de jolies photos sur Brevet [manuel scolaire], sur l'ombrage, tu te souviens

ANNA : hum

22mn39

Cindy : là, tu vois, il n'y a pas d'algorithme

ANNA : il y a peut-être une couleur ? Il y a peut-être des couleurs en fonction de...[elles feuilletent le livre]

Cindy : Dis-donc, ils ont fait une jolie présentation, regarde le bijou du Brevet et tout, ils ont pas mis juste le truc...

ANNA : bon, là non plus, il n'y a pas grand chose...

23mn07

ANNA : et Kwyk c'est quoi?

Cindy : ben c'est le reste d'Hachette, c'est ça... sommaire [elle lit le sommaire], 5^{ème}

ANNA : Mais il n'y a que 5^{ème}, 6^{ème} et 5^{ème} chez Quick, ça nous intéresse pas...

ANNA: mais fais passer...

Cindy : mais c'est quoi, il y a un cahier, c'est quoi ??? C'est le cahier, ça ?

ANNA : non, c'est un manuel, de cycle

23mn29

Cindy : et, tu vois, livre d'accompagnement pour l'élève [http://www.enseignants.hachette-education.com/college_Mathematiques_Cycle4/pages/collection/kiwi-mathematiques-college-000000020356-4120781.html]... Je comprends rien, parce que là c'est le cahier de l'élève, donc en fait tu as ce manuel là, c'est un quoi... Je sais pas et tu as... Et l'élève, il a un cahier en plus... C'est pas mal, ça, ça résout le problème de l'achat... Tu achètes ça, les élèves, ils achètent eux-mêmes

les cahiers, comme ça, ça coûte moins cher à l'établissement...

23mn59

ANNA : Algorithme et programmation, alors ça commence par l'environnement de Scratch, sur deux pages, et après des activités, programmes de calcul... Comment tu peux comprendre...

Cindy : [elle lit le manuel] les allumettes, les programmes de calcul : « Choisir un nombre, le multiplier par 3 et ajouter 15 au résultat ; choisir un nombre et ajouter 5 et multiplier le résultat par 3 »...

ANNA : des problèmes de calcul, des constructions de figure... La répétition avec un peu de tout et des expériences aléatoires

24mn42

Cindy : Ah oui ?

ANNA : Oui, c'est pas mal, pour l'expérience aléatoire, ça passe en cinquième aussi... Le début des probas...

Cindy : Hum. Là en fait, regarde...

ANNA : Tiens, course de voitures, c'est pas ça qu'il y avait à la préparation (formation continue, deux demi journées, organisées sur Scratch)?

Cindy : ça je ne l'ai pas vu... Alors, eux, regarde, c'est « prise en main de Scratch », c'est ça, et en fait, ils ont une espèce de cahier de l'élève, donc en fait c'est juste les prises en main.

ANNA : D'accord

25mn06 (brouhaha, elles parlent ensemble) (Inaudible)

ANNA : Regarde, c'est plus petit, regarde,

Cindy : c'est le livret

ANNA : le livret, oui... Et donc...

Cindy : Ecrire, mettre au point, exécuter un programme simple

ANNA : attends, comprendre les notions d'algorithme, manipuler la notion de variable, instruction conditionnelle, des boucles, et mettre au point et exécuter un programme correspondant à un problème donné...

25mn33

Cindy : et après, 256,

ANNA : c'est la page où ça se trouve, 154 à 162

Cindy : + 256, alors Partie A, c'est quoi ?

ANNA : exercices d'entraînement et d'approfondissement

Cindy : mémento [<http://fr.zone-secure.net/19572/190266/#page=30>] et exercice d'application

ANNA : d'accord

Cindy : attends...

ANNA : c'est compliqué, hein ?

Cindy : c'est pour ça que je n'avais pas tout pris

ANNA : on a du mal à comprendre...

Cindy : alors en fait, il y a le truc de l'élève avec, tu vois, il y a ça qui est un petit livret pour l'élève avec

ANNA : oui

Cindy : là tu as un mémento, tu n'as pas de cours en fait dans Kiwi

ANNA : oui, le cours en fait, c'est le début, là...

26mn07

Cindy : non, mais en fait tu as 10 pages de cours pour l'ensemble du cycle 4, ça s'appelle pas un cours...

ANNA : il y en a... Il y a un des manuels qui a fait un livret de cours...

Cindy : Ben je ne sais pas, mais on ne l'a pas, là...

ANNA : si, si, on l'a, mais je ne sais pas où c'est... [elles cherchent parmi les manuels], c'est l'un des manuels où il n'y a que du cours...

26mn34

ANNA : notion de variable... On ne peut pas... On ne peut pas imaginer faire un cours d'algorithmique, non, sérieusement. On leur donnera une fiche de...

Cindy : on leur donnera rien du tout, on leur fait faire des trucs..

ANNA : non, mais tu vas (brouhaha)

Cindy : en trois secondes avec une petite icône...

ANNA : ce n'est pas possible

Cindy : le petit programme Lightbot, c'est vraiment... Bon, il y a moins de choses que dans Scratch, parce que tu te déplaces, mais tu peux te lever, tu peux sauter, tu peux faire d'autres trucs, etc., il y a quatre commandes, mais les gamins, ils comprennent tout de suite ce que c'est, donc je vois pas... Enfin, après, tu cherches, c'est pas euh...

27mn14

ANNA : Non, ce qu'il faut voir, vraiment, il faut qu'on reste sur « décomposer », je pense vraiment qu'il faut rester sur ça, de décomposer un problème en sous-problèmes et reconnaître des schémas...

Cindy : c'est déjà fini... Attends, attends...

ANNA : il n'y a pas d'exercice ?

27mn40

Cindy : Ben si, il y en a à chaque fois, mais c'est pas des exercices... [elle lit] « Voici un algorithme qui affiche les nombres de 2 en 2. Mettre A à 1, répéter jusqu'à A = 12 ; mettre A à A+2, dire A pendant une seconde »

ANNA : oui, mais je pense qu'il faut qu'on reste comme ce qu'on faisait quand...

Cindy : j'ai perdu mon programme [elle se remet à lire] « Expliquer pourquoi cet algorithme ne s'arrêtera pas seul une fois lancé »

28mn07

ANNA : Et je rajouterai bien ce qu'on voulait faire avec Alexandra (du groupe Sésame), là, les pixels, tu sais les ordres, pour donner, pour faire faire un dessin, tu vois ce que je veux dire ?

Cindy : oui, oui, je me souviens des pixels, oui..., j'ai pas compris en fait..

ANNA : qu'est-ce que tu n'as pas compris ? « Expliquez pourquoi cet algorithme ne s'arrêtera pas seul une fois lancé » ?...

28mn33

ANNA : « Répétez jusqu'à N = 12 ». Mettre A à 1...

Cindy : non, mais mettre A à 1, il est encore... Et la boucle ?

ANNA : « répétez jusqu'à 12 »

Cindy : « Mettre A à... »

ANNA : il ne passera jamais par 12...

Cindy : à oui, parce qu'il commence à 1...

ANNA : il sera toujours impair...

Cindy : Oui

ANNA : il s'arrêtera pas...

Cindy : tu vois, j'ai mal lu l'énoncé, j'ai juste lu que c'était des nombres pairs, enfin j'imaginai que c'était des nombres pairs

29mn

ANNA : Ce qu'on voudrait leur faire faire : décomposer le problème, reconnaître des schémas,...

Cindy : et là, tu as des exercices

ANNA : tout le reste, ils seront dans l'essai, hein...

Cindy : hum

ANNA : jeu dans un labyrinthe, logiciel pour consolider les notions de longueur et d'angle. On peut reprendre toutes les activités qu'on avait avec la tortue, hein ? Avec les robots ? Tu sais, les robots de Paris-Nord

29mn36

ANNA : D'ailleurs moi j'en ai un qui a voulu le faire tracer. Tu sais, on l'avait fait en classe, en 6^{ème} et il a voulu le tracer au club avec les... Sauf que, comme c'est des robots, des vrais robots, et bien quand ils tournent, les robots, le crayon, il tourne avec, tu sais... Ca fait un truc où tu peux faire écrire ou pas, alors qu'avec Scratch, tu es vraiment dans du modélisé déjà. Alors, les robots pour tracer des figures géométriques [elle saisit du texte sur son clavier]. En fait, il faudrait faire de l'algorithmique pour de l'algorithmique, avec le crépier et le binaire, et la chorégraphie, peut-être...

Cindy : la chorégraphie, c'est vraiment l'objectif de rentrer dans un... Comment ca s'appelle, dans un langage, de dire que finalement...

30mn43

ANNA : et on pourrait imaginer refaire de l'algorithmique quand on est sur les transformations... Leur donner une frise, ou leur donner une photo de... d'un pavage quelconque et leur faire décomposer le pavage en plusieurs éléments qui se répètent ? Tu vois, s'ils ont un pavage, quel est l'élément de base qu'il faut avoir, et qu'est-ce qu'on lui fait faire, si on lui fait faire un retournement...

Cindy : hum

ANNA : et, du coup, une fois qu'ils ont ca, on pourrait le programmer ensuite pour le refaire, s'ils ont tout décomposé... On serait dans la décomposition en sous-problèmes...

31mn28

Cindy : ça serait un pavage, mais un pavage artistique...

ANNA : oui, j'ai vu qu'il y avait des trucs de l'Alhambra [voir par exemple [ici](#)] qui étaient repris dans les livres

Cindy : c'est Transmath [Un manuel scolaire], où ils ont des cahiers à côté...

ANNA : regarde, ils ont des choses comme ça... On pourrait très bien imaginer quel est l'élément simple qu'il faut avoir ici et puis, et puis le décrire pour avoir toute la figure... Et après, s'ils mettent l'image... S'ils prennent l'image comme fond, sur Scratch, ils peuvent la refaire, tu vois, je veux dire, une fois qu'ils ont décomposé leur figure....

Cindy : hum

ANNA : parce qu'on a ça qui va se travailler aussi, qui ne se travaillait plus du tout et qui va se retravailler avec l'algorithmique, c'est le... le repérage dans le plan, parce qu'il y a des coordonnées...

Cindy : Hum

32mn12

ANNA : Et ça, je pense que ça va permettre de travailler le repérage...

Cindy : oui, il y a des coordonnées, et d'un autre côté, ce qu'il nous a montré la dernière fois, ce qu'on a fait... Il a, ils avaient mis ces, des commandes supplémentaires

ANNA : c'est comme quand on va leur faire faire une recherche sur le tableur ou des trucs comme ça, quand on les laisse chercher, là, pour le problème du lapin et de je ne sais plus qui, il s'en sort très bien tout seul

Cindy : oui, oui, justement, on n'est pas obligé de tout leur donner, d'ailleurs moi, tu vois, la fonction « tourne à gauche, avance... », je ne sais plus ce qu'ils avaient fait comme machin, moi, en fait, j'avais compté comme machin, ils nous avaient dit que, j'ai regardé en fait, quand tu... quand tu mets ton curseur n'importe où sur l'écran, comme c'était quadrillé, j'ai compté que ça faisait 15 pixels le carreau, donc après, j'ai demandé d'avancer de 15, en fait, tu vois...

ANNA : oui...

33mn10

Cindy : et ça allait...

ANNA : Et bien moi, je vais te dire, quand on fait avec mes [Mindstorms](http://www.lego.com/fr-fr/mindstorms) (<http://www.lego.com/fr-fr/mindstorms>) ils réfléchissent, ils font un essai, ils comptent... Parce que tu sais, c'est en tour de roues, donc ils comptent la longueur qu'il avance en tant de secondes et puis ils font leurs calculs, les gamins, il y a de la proportionnalité, là-dessous...

Cindy : hum

ANNA : moi, je ne suis pas... J'ai vu, dans les, dans ce qu'ont donné les inspecteurs, là, donc ils ont filé les, tu sais, les, c'est sur ViaÉduc [<http://www.viaeduc.fr/group/2533>] réseau social d'enseignants développé

par le ministère français) j'ai récupéré, ils ont filé des trucs où c'est déjà préparé en fait...

33mn46

ANNA : heu, évidemment, je vais avoir du mal à le retrouver... Ils ont préparé, et, en fait, tu vois, là, par exemple, ils ont des cartes binaires je ne sais pas ce que c'est [Silence, elles cherchent] C'est rien [On entend pianoter sur le clavier] non, je ne sais pas où c'est. Je vais en ouvrir un autre. Ah, c'est ça, c'est les cartes en fait. C'est pour que tu puisses les imprimer sans avoir à les dessiner toi-même, sauf que [rires] ce sont des cartes avec des points [Rires], si, si, je t'assure, il y a des cartes, enfin bref, c'est pour... pour si jamais tu sais pas les dessiner..

34mn30

Cindy : tu sais la différence entre le lutin et son costume, qui peut être souvent source de confusion pour les scratcheurs [utilisateurs du logiciel Scratch]...

ANNA : ben oui, parce que le lutin, c'est le petit bonhomme, son costume, c'est dans quel état il est... Tu peux le faire avec sans jambe en l'air, ou... sans truc...

Cindy : « la métaphore des acteurs portant différents costumes peut aider à clarifier la différence » Ca, ça sert pas à grand chose, enfin...

ANNA : par contre il faudra qu'on réfléchisse à ce qu'on met en Mise en train...

35mn03

ANNA : ... Parce que, ça, je pense, ça peut-être des trucs bien, leur donner un bloc, comme ça, et proposer ou leur demander ce qui se passe, que fait le lutin, ça peut permettre de travailler Scratch autrement, mais pas, tu vois... De toutes façons, il va y avoir deux choses, soit on a l'EPI [Enseignement pratique interdisciplinaire], soit on ne l'a pas. Si on a l'EPI, on va pouvoir travailler en demi-classes et ils vont pouvoir apprendre à utiliser Scratch, mais en le testant. Si on n'a pas l'EPI, on va devoir le faire dans les classes, mais là ça va être plus compliqué, parce qu'on va être obligé d'être à 2 par poste [2 élèves par ordinateur] et on sera pas s'ils savent l'utiliser ou non

35mn36

Cindy : Hum

ANNA : Et après, il faudra qu'on le fasse vivre sans que ce soit...

Cindy : oui, on le saura pas, mais d'un autre côté, je trouve que c'est enrichissant de travailler...

ANNA : oui, mais on va pas passer... Combien ils ont dit que cela faisait de séances, tu te rappelles ?

Cindy : 10h de Scratch

ANNA : Non, combien ils on dit que cela faisait d'heures, à peu près... le morceau algorithmique sur l'année ?

Cindy : j'ai juste retenu 10h de Scratch...

ANNA : juste 10h ?

Cindy : 10h de Scratch

ANNA : d'accord

36mn15

ANNA : Non, mais ce qu'il faut, c'est dans les autres morceaux de programme, trouver des moments où on les fait réfléchir en... autour de l'algorithme : quel algorithme peut traduire... Faut que ca rentre dans leurs façons de réfléchir [Silence].

Cindy : Hum

ANNA : il y avait un texte qu'il faudra lire, moi je ne l'ai pas du tout lu, c'est euh... [elle cherche dans son ordinateur] c'est là-dedans, c'est un truc qui s'appelle « Pensée informatique à l'école », tu vois, de Grenoble encore, en fait c'est Grenoble qui a fait ça

ANNA et Cindy : [Elles rient, passage difficile à comprendre] ... rencontrer quelqu'un de Grenoble

37mn

ANNA : « [Initier les élèves à la pensée informatique et à la programmation avec Scratch](#) », je pense que...

Cindy : Qui l'a fait ?

ANNA : Pierre...

Cindy : Pensée informatique à l'école...

ANNA : Pierre Tchounikine, je ne sais pas, je ne le connais pas [Silence correspondant à la lecture du document]

37mn26

ANNA : Et encore il parle encore d'informatique créative, c'était déjà, c'était ça, le texte... ?

Cindy : Le texte, c'est [Informatique créative](#)

ANNA : je pense que c'est ça, comment être initiés à la pensée informatique sans être mangés par le type de programmes, de programmation qu'on va utiliser...

Cindy : manger, comment

ANNA : Non, mais là, que ce soit Scratch ou un autre, c'est une histoire de blocs... Je veux dire que ce soit

Scratch ou que ce soit Mindstorm, pour les gamins c'est des blocs, c'est...

Cindy : Hum, hum

ANNA : Une fois qu'ils ont compris comment ça fonctionne... Bon, sur Mindstorm, c'est plus dans la mécanique parce qu'il faut calculer... Là, on va pas faire que ça, on va pas faire 10h d'algorithmique, et puis *point barre* [Ce qui veut dire : point final]. Il faut que, à chaque fois, dans nos chapitres, on pense des exercices...

38mn23

Cindy : moi, ce que je ne comprends pas, c'est que, là, tu vois, dans les activités qu'ils proposent : « Créer des conversations entre des personnages », tu es super content...

ANNA : non, ça fait partie de... C'est ludique... Ils vont faire un jeu, ils vont... et puis... Ca va te permettre de différencier, aussi, je veux dire tu as celui qui va faire juste ce que tu as demandé, et tu as celui qui, quand il a terminé, il va mettre un fond, il va essayer de faire un... [silence]

38mn51

Cindy : oui, mais bon, enfin, tu vois, ça c'est pareil, ça n'a pas d'intérêt tout seul en math... Je ne sais pas comment dire... Créer une histoire, modifier l'histoire, etc., c'est de la narration, tu pourrais imaginer ça en sixième, en français...

ANNA : Tu pourrais imaginer que, en français, ils créent un texte et en math, ils l'animent ou en techno, ils l'animent sur le...

Cindy : oui, mais là, je ne sais pas comment te dire, mais par exemple là, le fait de mettre un fond, etc. C'est vraiment j'apprends à utiliser les blocs Scratch, là, c'est pas de l'algorithmique, ça...

ANNA : mais on s'en fiche... Enfin, je veux dire que c'est comme quand tu es sur euh, sur Cabri ou sur Geogebra et que les gamins, ils mettent un fond...

Cindy : Oui...

ANNA : ils peuvent bien mettre un fond s'ils en ont envie

Cindy : oui, mais ce n'est pas une partie intégrante de l'activité

ANNA : on ne va pas le mettre dans les activités non plus, ça ne nous intéresse pas, quoi

39mn40

Cindy : Oui c'est pour te dire mais regarde, il décrit le déroulement suggéré, bon, il y a déjà 5 séances, donc tu crées des personnages, tu coordonnes les interactions des lutins, tu leur fais faire des conversations, tu crées des scènes, différentes scènes avec un diaporama qui [incompréhensible]... Après tu as toujours une

séance de débogage dans leur truc et ensuite tu enrichis les histoires des autres. Mais, tu vois ça, c'est vraiment, je ne sais pas comment te dire... Ca peut être un travail en effet intéressant de dire « je mets en image ce qui a été fait dans une autre... », tu vois je ne sais pas, on peut imaginer que, en Français, ils aient des rédactions, des trucs comme cela, et que ils illustrent leurs images avec un petit truc Scratch, mais c'est de l'utilisation de Scratch, je ne vois pas où est la réflexion algorithmique là-dedans...

40mn34

ANNA : oui, je suis d'accord avec toi, je ne peux pas faire ça...

Cindy : non, mais tu vois..

ANNA : oui, c'est inintéressant... Autant le fait de leur demander...

Cindy : oui, mais c'est autre chose, c'est pas...

ANNA : non, mais ce qu'il faut faire...

Caire : c'est pas de l'algorithmique...

ANNA : leur faire faire un programme, trouver une problématique, leur faire faire le programme, et ensuite leur demander de le faire avec le moins de commandes possible...

Cindy : hum...

41mn03

ANNA : si on part du crêpier, on va leur demander de trouver une façon de ranger les crêpes...

Cindy : Hum

ANNA : avec le moins de commandes possibles...

Cindy : Hum

ANNA : le groupe qui aura gagné, c'est le groupe qui l'aura fait avec le moins de commandes possibles...

Cindy : oui, oui, oui. Ben ça, c'est ce que tu retrouves dans le...euh

ANNA : dans l'heure de code, dans l'heure de code [J'ai trouvé l' « heure de code » sur [Khan Academy](#); l'organisation code.org propose aussi aux enseignants de prendre une heure pour apprendre à programmer, Canopé, qui est l'institution dédiée à la documentation des enseignants, en parle [ici](#)], tu n'as qu'un certain nombre de blocs, au fur et à mesure, tu as de moins en moins de blocs, donc de toutes façons, tu ne peux pas faire avec...

Cindy : Ben là, en fait, ce qu'ils font, c'est que... tu as... bon au début, tu n'as presque rien à faire faire au robot, donc tu... Tu as 12 places, dans un petit écran, tes 12 places, tu peux les occuper comme tu veux, et

après, tu as trois trucs de 12 places, mais tu en as 2 qui te servent à élaborer des procédures, soit que tu peux boucler, soit que tu peux ré-utiliser l'une dans l'autre, pour économiser de la place dans la troisième. Et souvent, en fait, dans le programme de base, tu as 2 cases, par exemple, tu vois, donc tu peux...

ANNA : Hum

42mn09

Cindy : tu es très très contraint dans le programme de base, ce qui fait que tu es vraiment obligée, dans tes procédures ou dans tes boucles, de, comment ça s'appelle, d'être réduit, et ça, je pense que ça doit aussi exister...

ANNA : Sachant que il faut réussir à faire une programmation minimale pour les 3^{ème}, hein, parce qu'ils vont l'avoir au brevet [Examen final à la fin de la classe de 3^{ème}, donc du collège],

Cindy : Oui [silence] tu vois, ils disent les blogs, non les blocs avec lesquels tu as [Incompréhensible, puis rires]

ANNA : non mais ce qui est intéressant, c'est qu'ils apprennent à faire un bloc à côté, à se servir du bloc dans leur programme, des choses comme ça, tu vois, c'est intéressant...

42mn50

Cindy : [Elle continue à lire un texte] « Encourager les élèves à se faire une idée de ce que sont les variables en se penchant sur le code de quelques uns des projets du studio dédié à la gestion du score »...

ANNA : moi, je ne comprends pas pourquoi ça s'appelle une variable... Ça s'appelle vraiment une variable, en informatique ?

Cindy : Je crois, oui...

ANNA : Et bien, je n'en suis pas sûre...

Cindy : si, si, je crois...

ANNA : je pense que, dans ce cas-là, il faudrait changer le nom... On ne peut pas appeler tout pas le même nom...

Cindy : oui, oui...

ANNA : ça... ça va créer un bazar... Surtout si la première variable qu'ils rencontrent, c'est la variable informatique, pour le coup, parce que, si on parle de variable en 5^{ème}, en algorithmique, alors qu'on ne parle jamais pratiquement de variable en algèbre, on ne leur donne pratiquement jamais le mot...

Cindy : hum...

ANNA : on ne parle pas de variable, de constante, là on va en parler...

Cindy : hum...

ANNA : Moi, je pense qu'il y a un vrai problème au niveau du vocabulaire, on va avoir un vrai problème au niveau du vocabulaire...

Cindy : Hum...[On entend taper sur le clavier de l'ordinateur]

43mn44

Cindy : tu vois, il y a quand même, chapitre 4, non, tu as quand même les trois premiers chapitres qui ne sont que sur l'habillage, quoi, faire un truc joli, mettre de la musique...

ANNA : Non, parce que ça amuse, c'est...

Cindy : moi, je ne vois pas pourquoi ça amuse, pourquoi...

ANNA : de toute façon, au brevet, ils vont avoir un truc sur papier, donc...

Cindy : le genre de truc...

ANNA : qu'est-ce qu'on ira...

Cindy : par contre, leurs fiches, elles ne sont pas mal faites, hein... tu vois, on pourrait... s'en inspirer [rires]

44mn26

Cindy : tu vois, tu as toujours les mêmes blocs...

ANNA : hum

Cindy : et tu as un petit espace de notes, enfin... tu vois

ANNA : hum

Cindy : tu vois, la présentation, c'est...

ANNA : on a dit que c'était lequel, celui-là, je l'ai ouvert, c'est ça ?

Cindy : je crois que c'est celui-là

ANNA : mais celui-là, je ne sais pas pourquoi, je n'arrive pas à le voir comme... parce qu'il y a une part sur Pixees en fait

Cindy : ah, c'est pas...

ANNA : Il faut que je le trouve, ça doit être dedans, mais... [elles cherchent]

Cindy : heu... Celui-là [Elles lisent]

45mn17

ANNA : parce que là, on a, pour les activités débranchées, on a des mises en œuvre, hein...

Cindy : Hum...

ANNA : on va regarder...

Cindy : dans Pixees...

ANNA : Oui [Elles regardent]

45mn55

ANNA : bon, de toutes façons, si on leur parle de Classcode <https://studio.code.org>, et qu'on leur donne les liens, ils vont aller les faire, les trucs, hein [Silence], pas la peine de garder du temps en cours pour faire... On en fait, on commence, et, soit ils trouveront au CDI [Centre de documentation et d'information] ... soit chez eux, ils vont le finir, hein...

Cindy : hum [Silence]

ANNA : On va voir, si on prend un peu de hauteur... ben moi ce qui me gêne... C'est que le contenu qu'on nous donne, c'est juste de l'utilisation de Scratch

Cindy : ben ce contenu là, c'est Cindymont ça...

46mn37

ANNA : Alors... [Un grand moment de silence, activité de lecture de l'écran] qu'est-ce que j'ai fait...

Cindy : tu as cliqué sur [incompréhensible...], c'est revenu à l'image...

ANNA : c'est pas vrai, ça, je tourne en rond... [continuation de la recherche], voilà, alors...[rires] ah ben, super, c'est quoi ?...

Cindy : oui, ça, je l'ai laissé, et puis moi, il est bien ouvert

ANNA : c'est pas le bon...

Cindy : Attends, mais c'est quoi ?

ANNA : C'est pas le même, tu veux dire, ce serait autre chose, ça ?

47mn34

Cindy : vas-y, descend, ils disent que c'est, oui, regarde, descend, descend !

ANNA : mais non, il y a un truc qui est ouvert, là...

Cindy : descend !...

ANNA : ah, voilà... [Silence] On n'a que les slides, on n'a pas [rires], je ne sais pas, ça ne m'aide pas beaucoup... « En savoir plus » ? Ah oui, c'est là, tient... « Formation numérique »...

Cindy : [Incompréhensible] non ne le mets pas, ne le mets pas, mets-le avec les notes...

ANNA : mais il n'y a pas de notes...

Cindy : si, si, il y en a...

ANNA : d'accord [Silence] bon, OK, et bien voilà, c'est pas, euh... il y a 4 slides...

Cindy : non, mais c'est le premier truc

ANNA : oui... Chapitre 1, « présentation »

Cindy : retourne en arrière d'une...

ANNA : chapitre 2, « Dans le bain avec le jeu de Nim »... « Trouver... »... Ah, tiens, il y a des tris, là...

48mn51

Cindy : hum

ANNA : « Trouvez votre prénom »,

Cindy : mais tu vois...

ANNA : après il y a le crêpier... Attends qu'est-ce qu'ils disent là ? [silence]

Cindy : non, tu te souviens, tu fais...

ANNA : Comment tu sais comment ?...

Cindy : tu bascules tout à l'heure, tu as fait comme ça, là

ANNA : mais où, qu'est-ce que j'ai fait tout à l'heure ? non...

Cindy : attend, attend...

Cindy : non, attends...

ANNA : ça marchait, tout à l'heure... et là, ça n'a pas marché...

Cindy : regarde, tu as là, dessous, bon, on s'en fout.... Et Cindy, car je m'appelle...[évocation des surnoms donnés à ANNA et Cindy pour la recherche : Anna et Cindy, rires]

ANNA : si tu préfères avec certitude qu'il y ait ton prénom

Cindy : oui

ANNA : heu... d'accord

Cindy : hum

ANNA : donc par ordre alphabétique, c'est sûr que c'est plus simple... Si, j'y étais, mais je ne m'étais pas vue... « C'est plus facile quand c'est trié »

Cindy : oui, ça va être super...

ANNA : encore

ANNA : prends-moi un prénom... Tu vois, ça, je pense que c'est vraiment faire un tri et choisir les tris...

Cindy : ça, c'est la même chose que la crêpe ?

ANNA : non... Parce que la crêpe, il faut réfléchir pour que la plus grande se retrouve tout en haut à l'envers si après on veut qu'elle soit... Tu vois ? Ce n'est pas le même ordre alphabétique, par ce que là, c'est l'ordre alphabétique, comment est-ce que je le mets en œuvre, quoi... Un truc que tu fais depuis que tu es petit, je ne sais pas. Je me demande si les tris, cela ne peut pas être une idée, aussi... pour les faire réfléchir...

Cindy : sur l'algorithmique, si si, parce que tu as les idées de test, tu as les idées de boucle

ANNA : oui, oui...

50mn48

ANNA : parce que, si chaque table part sur une méthode, on va avoir quand même 5 ou 6 méthodes

Cindy : Hum

ANNA : Et puis sûrement des méthodes plus rapides que d'autres, plus efficaces, donc on va pouvoir parler d'efficacité, comment je sais que mon programme il est efficace par rapport à celui du voisin, tu vois, des choses comme ça...

Cindy : Ouais

ANNA : qu'on aura aussi avec le crêpier, disons que cela ne se marche pas dessus

Cindy : non...

ANNA : c'est tout le même type de...

Cindy : heu... Si on fait le point...

ANNA : aller, si on fait le point...

51mn22

ANNA : donc... donc on a pas mal de boulot... [Rires]

ANNA : donc j'ai mis les deux objectifs les plus importants, qui seraient : décomposer le problème en sous-problèmes, y compris en géométrie, donc on a les deux, et puis reconnaître des schémas, donc penser à faire en Mise en train, des... présenter des programmes et puis leur demander ce qu'ils font, et puis après, du coup, on a la validation tout de suite si on fait fonctionner Scratch...

Cindy : Hum

ANNA : Les difficultés qu'il ne faut pas qu'on oublie, c'est que, il va y avoir un gros problème à mon avis sur les variables, les fonctions, enfin tout le vocabulaire qui est identique à...

Cindy : oui...

ANNA : Et puis, j'ai, j'ai pas marqué, mais l'affectation, le signe égal qui va...

Cindy : [Incompréhensible : il me semble qu'elle évoque les difficultés d'un élève, Emmanuel]

ANNA : Il va falloir faire super attention, parce que, du coup...

Cindy : oui

ANNA : Voilà, et puis les activités, plutôt commencer par du débranché...

Cindy : Hum...

ANNA : bon, on n'a pas beaucoup avancé, mais...

Cindy : par contre, les critères de progressivité, là je ne comprends pas...

Cindy : « en 5^{ème}, les élèves s'initient à la programmation événementielle »...

ANNA : Oui ?

Cindy : qu'ils doivent faire quelque chose ?

ANNA : c'est quelque chose, quand t'a envie de le faire [brouhaha], quand on fait « feu vert »

Cindy : « progressivement », non, en plus c'est vrai il y a un autre texte... « Progressivement, ils développent de nouvelles compétences, en programmant des actions en parallèle, en utilisant la notion de variable informatique, en découvrant les boucles et les instructions conditionnelles qui complètent les structures de contrôle liées aux événements ». Le seul problème, c'est qu'il n'y a pas de repères de progressivité, dans les repères de progressivité...

ANNA : non... parce que elle prend... Non, voilà, ils commencent en 5^{ème}, quoi...

Cindy : De toutes façons, on doit tout faire ! En fait, c'est juste la complexité des problèmes... Une boucle, tu peux avoir... Dès que tu répètes quelque chose...

ANNA : mais ça, ça vient immédiatement...

Cindy : ... tu peux faire une boucle...

ANNA : ... Je veux dire, si tu leur fais tracer un carré, ils vont l'écrire quatre fois, mais si tu leur fais construire un décagone, ils ne vont jamais l'écrire 10 fois, enfin je veux dire, ça vient tout de suite. Les gamins, tu les mets devant le truc, ils ne vont pas écrire 25 fois, même si tu peux dupliquer, ils ne vont pas

dupliquer 10 ou 15 fois quelque chose...

Cindy : donc en fait, quand même, on part quand même sur l'idée que la progressivité, elle vient de la complexité du programme...

ANNA : Oui...

Cindy : complexité du problème, du programme, enfin, je mets un slash entre les deux, heu, mais heu, pratiquement tout le langage, faut, en cinquième, en fait, il faut qu'on ait vu tout le langage...

ANNA : ça serait, c'était l'idée, c'est l'idée si jamais on nous donne l'EPI, ça serait l'idée qu'ils aient vu tout le langage en 5^{ème}, et qu'on ait plus qu'à le faire vivre après

Cindy : Oui...

54mn13

Cindy : et c'est quand même l'idée que, à la fois ils voient tout le langage, à la fois on travaille d'abord sur du débranché pour... Ah, c'est peut-être pour ça, en fait, qu'ils font tant de blabla « décorer ton fond d'écran blabla », c'est peut-être aussi pour dire que, finalement, tu travailles en parallèle... C'est-à-dire que, d'un côté, tu travailles en débranché pour avoir l'idée d'algorithmie, de l'autre côté tu fais des trucs pseudo-ludiques sur Scratch...

ANNA : Oui...

Cindy : et après, tu mixe les deux, en fait, c'est peut-être ça ?

ANNA : Oui... Mais en même temps, si tu as réfléchi à quelque chose, tant qu'à faire, autant le mettre en œuvre...

Cindy : oui, parce que, moi...

ANNA : avec Scratch, quoi

Cindy : mon problème de gauchère-droitière, c'est horrible

ANNA : oui... parce qu'en plus, il faut que tu le fasses... euh

Cindy : et c'est vrai que moi, si je ne teste pas le problème – le programme, je me trompe une fois sur deux

ANNA : oui, oui...

Cindy : donc le langage, là dessus... On peut partir là-dessus. Après il y a des choses... compter en binaire, la danse, le tri, c'est tout des choses qu'il faut faire sur des grosses, en fait... Il faut le faire en une heure...

ANNA : c'est des activités d'une heure, oui...

Cindy : Et puis par contre, il faudrait de toutes façons, mais si on n'a pas l'EPI... il va falloir...

ANNA : Il va falloir demander des temps en dédoublement, hein ?

Cindy : Oui... en dédoublement, ou...

ANNA : quand les ordinateurs ne font que ça, ils ne marcheront plus...

Cindy : oui...

ANNA : on va passer... Ils ne vont plus marcher, donc

D (c'est la fin de l'heure) : could you explain us what you will do in the following steps for your lesson preparation on this topic ? How will you cooperate, and distribute your work ?

Cindy : pour l'instant, on n'a pas prévu, encore...

ANNA : eh bien déjà il y a jeudi après-midi...

Cindy : je crois qu'on va surtout coopérer [rires]

ANNA : on va se mettre d'accord sur des activités phares qu'on veut faire...

Cindy : hum, hum

ANNA : ... à tous les élèves, peut-être pas beaucoup parce qu'on a beaucoup de personnes qui... Et puis, euh, essayer de le décrire plus précisément... et qu'elles soient euh... Par exemple, il y a des choses qui existent déjà...

Cindy : hum...

ANNA : donc, par exemple, si on veut les faire travailler en binaire et le crêpier, c'est des trucs, on va les écrire comme il faut et faire une fiche, et puis, celle-là, dire qu'on veut que tous les élèves la fasse...

Cindy : oui...

ANNA : quel que soit le niveau, d'ailleurs... L'année prochaine, il faudra travailler sur tous les niveaux en même temps, parce qu'on commence, donc si on veut pouvoir, il va falloir que... 5^{ème}, 4^{ème}, 3^{ème}... on fasse la même chose...

Cindy : je crois que je n'ai pas lancé l'enregistrement... [Camtasia]

ANNA : c'est pas grave, j'ai fait la même chose... Tu veux rajouter quelque chose ?

Cindy : non après, jeudi prochain, ce jeudi ?

ANNA : ce jeudi

Cindy : on a une formation sur Scratch. Et en fait, la formation sur Scratch, comme elle consiste à utiliser Scratch, ça nous a moyennement intéressées, donc euh... Et le formateur, il nous a dit qu'on pouvait amener des documents et des trucs de travail pour préparer nos séquences, donc en fait, je pense, la

prochaine étape, c'est qu'on va se voir avec notre troisième collègue, euh, lui dire un peu où on en est de nos idées, euh, et puis repartir de là-dessus pour euh, je pense, euh, en effet, peut-être se partager... réfléchir en commun sur le but de chaque activité, et puis après, peut-être se partager l'écriture des fiches...

ANNA : oui, oui

D : avec le troisième enseignant de mathématiques...

Cindy et ANNA : oui, avec Fabien...

D : et avec les enseignants de technologie ?

ANNA : ah l'enseignant de technologie... L'enseignant de technologie, ce n'est pas tout à fait la même chose, parce que l'enseignant de technologie est vraiment sûr de la programmation, d'ailleurs ça on n'a pas regardé... Il faut qu'on mette en parallèle le programme de technologie dans notre document, on l'a pas mis... Il faut qu'on le mette pour qu'on voit qu'est-ce qui se recoupe, et qu'est-ce qui ne se recoupe pas... Et en fait on a proposé pour l'année prochaine de faire un EPI avec la technologie : technologie math, on a demandé de faire une heure, on ne sait pas si ça sera accepté, on a demandé de faire une heure à l'année, où on pourrait avoir soit du co-enseignement, soit chacun une moitié de classe, pour pouvoir avancer nous sur l'utilisation du logiciel, de Scratch, et puis lui, sur l'utilisation d'un logiciel de programmation. Et l'idée ce serait de faire un projet où nous on programme sur Scratch et on envoie... On pensait acheter des cartes Arduino. On envoie sur la carte le programme qui a été fait par les élèves dans l'objectif... Je ne sais pas, on se disait avec Sébastien (le professeur de technologie), on se disait qu'on pourrait programmer des feux, tu sais des feux tricolores, bon, on sait pas, mais l'idée c'est ça, peut-être des feux tricolores, avec pour certains groupes juste le feu voiture, pour d'autres groupes qui seraient plus avancés, qui auraient bien compris, faire aussi des feux piétons, oui, voilà. On a des robots Mainstorms, donc on pourrait aussi peut-être utiliser cela. Mais là, pour l'instant, on attend de savoir si c'est accepté ou non [l'EPI]... Si ce n'est pas accepté, il faudra qu'on le fasse sur notre temps, c'est pour ça qu'on marquait qu'il faudrait demander des heures de dédoublement si jamais... [Finalement les professeurs ont obtenu l'EPI, consistant en une heure de classe hebdomadaire pour deux professeurs : soit une heure en co-animation, soit deux fois une demi-heure en demi-classes]

D : merci...

ANNA et Cindy : de rien