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From Teaching Competences to Teaching Praxeologies: The Case of the Problem-Centred Education

Renata Jonina

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Renata JONINA

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**FROM TEACHING COMPETENCES TO
TEACHING PRAXEOLOGIES: THE
CASE OF THE PROBLEM-CENTRED
EDUCATION**

*De la compétence à enseigner aux praxéologies
d'enseignement : le cas de l'éducation centrée sur la
résolution de problèmes*

THÈSE dirigée par :

M. AUDRAN Jacques
Mme KOKE Tatjana

Prof., INSA de Strasbourg / Université de Strasbourg, France
Prof., Université de Stradiņš de Riga, Lettonie

RAPPORTEURS :

Mme LADAGE Caroline
M. DE LIEVRE Bruno

Prof., Université d'Aix-Marseille, France
Prof., Université de Mons, Belgique

AUTRES MEMBRES DU JURY :

M. OGET David

Maitre de conférences, INSA de Strasbourg / Université de
Strasbourg, France

*In dedication to my grandfather who would
have been very proud of me.*

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Foreword

Before the reader can fully immerse himself in reading my thesis, it is important to briefly outline a context within which this research emerged having influenced both its direction and the choice of scientific literature.

While pursuing my Bachelor degree in English Philology at Daugavpils University (Latvia) I got interested in a theory called the Theory of Inventive Problem Solving (TRIZ) and had the chance to get acquainted with educational professionals who developed educational approach based on that theory. When pursuing my Master studies to obtain a qualification of an English language teacher, it was only logical that I would try to integrate at least some elements of that approach in my own practice. Having observed many teachers struggling to change their teaching practice in accordance with the new approach and experiencing significant difficulties myself, I decided to solve my professional problem by doing the research on the topic of teaching competences and TRIZ in education.

Having lived in Latvia at that time and being a native Russian speaker who has no difficulty with reading scientific literature in Russian, there is no surprise that initially I was influenced a lot by the Russian school of Psychology and Pedagogy. Moreover, TRIZ was developed in the former Soviet Union, thus offering many primary sources in Russian for understanding it.

The Anglo-Saxon research literature became my second biggest source of influence. This is due to the fact that being a fluent English speaker I could freely read articles and books in English. Having access to international databases of scientific journals mainly published in English, I could benefit from reading contributions of English-speaking educational professionals and researchers.

This is only at later stages of my research, when I moved to Strasbourg and improved my French, when I started gradually discovering academic writings of the French-speaking world. I was lucky to discover an important theory – the Anthropological Theory of the Didactic (ATD) – that helped me to advance my research. Unfortunately, the lack of time did not allow me to discover French research and thinking tradition even better.

These main facts explain why my research bibliography mainly contains Russian, English and Latvian references with the French ones being in minority. I am sure that had I had more time to discover French research tradition better, I would have been more successful in developing my research problematic and enriching it with research results from the French-speaking countries.

During all these years of pursuing my thesis I was not only trying to understand specific problematics developed by researchers of different countries, but was also trying to marry these ideas with each other, making links between concepts developed in different countries in order to build a broad understanding of my own research problem. In the process of my research I discovered a potential pitfall one may easily fall into. Before any links can be made, one has to make a clear distinction between 'a concept' and 'a term'. One concept can be named with different terms as well as two different concepts may be named with a very similar term in different research traditions. For instance, the well-known term '*problem-based education*' does not denote the same concept as the term '*problem-centred education*' even if both terms refer to a certain 'problem' introduced in 'education'. The opposite example will be with two different terms '*cognitive conflict*' and '*a problem situation*', which in two different traditions (the former mostly Western while the latter Russian) and even domains (one in psychology another one in education) refer to the same concept – difficulty experienced by the mind. Throughout the research I was trying to make distinctions and connections between concepts and terms.

Coming to the research from teaching and having a specific practical problem in mind, I have tried to keep the applied nature of my research throughout its entire development. I hope, however, that it will be useful not only for practitioners but also for researchers who develop mostly theoretical ideas.

The given research was developed at the intersection of different traditions and I hope that despite its shortcomings, it will serve as a basis for further research that will bring deeper understanding of the problem related to the development of teaching competences in general and those relevant for the problem-centred education in particular.

Introduction

The economic and sociological context we live in nowadays is characterised by economists and sociologists as information (or informational) economy and information society respectively (also referred to as knowledge economy and knowledge society) (Lyotard, 1984; Webster & Webster, 2002; Fuchs, 2008). The rapid development of the information and communication technologies has provoked the situation when the main driving force of the economic growth has been shifting from industrialisation to information and knowledge; hence, starting from 1970s the industrial society has been giving its place to information society. The economists David Paul and Dominique Foray (Paul & Foray, 2002) argue that the real issue at stake is not information as such, which has always been driving the economy, but more specifically it is the acceleration of information production, i.e. speed at which this information is created and disseminated. As a result, the society is facing proliferation of high skills jobs which require the production, processing and transfer of information. In other words, its shifting to knowledge-intensive activities (ibid.). Schleicher (Schleicher, 2011 cited in Koke, Murashkovska, & Jonina, 2013) pointed out that in the nearest future the demand for employers with high cognitive skills will increase from 29% to 35% and, on the other hand, the demand for employers with low cognitive skills will drop from 20% to 15%. Moreover, the results of the survey for adult skills highlight that *“with manufacturing and other low-skill tasks in the services sector becoming increasingly automated, the need for routine cognitive and craft skills is declining, while the demand for information-processing skills and other high level cognitive and interpersonal skills is growing. In addition to mastering occupation-specific skills, workers in the 21st century must also have a stock of information-processing skills, including literacy, numeracy and problem solving, and “generic” skills, such as interpersonal communication, self-management, and the ability to learn, to help them weather the uncertainties of a rapidly changing labour market.”* (OECD, 2013, p. 46)

The given circumstances have strong implications for educational systems including school education. Speaking about specific skills and abilities that are required for being successful in knowledge-based economies, Paul and Foray (Paul & Foray, 2002) state that in addition to the apparent need to be proficient in using information technologies and having a number of, what is called, ‘soft skills’, such as ability to work in teams, communication and learning skills, the importance of generic learning

abilities should not be underestimated. According to the scholars (ibid.), the generic learning abilities include the following: learning to learn, knowing what we do not know, and being aware of the main forms of heuristic bias that can distort the power of reasoning. Moreover, it is essential that a person does not only keep up with the constant, accelerating change but is also able to understand and anticipate change. In addition, providing mere access to information is vital but not enough in knowledge societies. The task for educational system is to help people develop “*cognitive capabilities and intellectual frameworks that enable humans to interpret, select and utilise information in ways that augment their capabilities to control and enhance the material circumstances and qualities of their existence*” (Paul & Foray, 2001, p. 10). In the psychological literature, the given cognitive capabilities are referred to as higher-order thinking skills (Gallagher, Hipkins, & Zohar, 2012; Zohar, 1999, 2004; Zohar & Schwartz, 2005). In the educational literature the approaches and programmes which target the development of these skills are referred to as *approaches for teaching higher-order thinking* (Zohar, 1999, 2004, 2008; Zohar & Schwartz, 2005), *approaches for teaching thinking skills* (Adey, 1999; Adey & Shayer, 1993, 1994; Avargil, Herscovitz, & Dori, 2012; Johnson & Siegel, 2010; McGregor, 2007; McGuinness, 1999; Moseley, Elliott, Gregson, & Higgins, 2005), *inquiry-based instruction* (Baumfield, 2006; Baumfield, Butterworth, & Edwards, Gail, 2005; Dostál, 2015; Lehrer, Schauble, & Lucas, 2008; Windschitl, 2003), *problem based educational approaches* (Howard S. Barrows, 1996; Howard S. Barrows & Tamblyn, 1980; Sokol, 2007; Матюшкин, 1972; Махмутов, 1977; Мельникова, 2002; Нестеренко, 2006a), *cognitive-activation instruction* (Echazarra, Salinas, Mendez, Denis, & Rech, 2016, p. 35), and the like. For the ease of comprehension, the umbrella term ‘**teaching for thinking approaches**’ is going to be used further to denote all these approaches and methodologies. Even though the reported success of these programmes and methodologies is varied and a considerable evaluation work still has to be done, there is some clear prove that a number of methodologies for teaching thinking skills are linked with learning outcomes, including improved learners’ thinking (Higgins et al., 2004, p. 44; Loarer, 1998; McGuinness, 1999, p. 29).

Amidst the discussions of the need for changes, international comparative large-scale studies on student achievement, such as PISA, are developed and conducted in order to reveal the current level of students' skills and knowledge and ensure evidence-based policy decisions on the reforms required in educational systems. According to international educational experts of OECD countries (OECD/CERI, 2008), current educational systems are not yet successful in developing skills that constitute the basis for lifelong learning and thus are not successful in preparing students for life in knowledge societies. The given conclusion has been made on the basis of the PISA (Programme for International Student Assessment) results, which is an international research study carried out by OECD every three years since 2000. The study tests the skills and knowledge of 15-year-old students on mathematics, science, and reading literacy in OECD member and non-member nations. Tests administered in some countries also include the assessment of creative problem solving and financial literacy (OECD PISA Website - <http://www.oecd.org/pisa/aboutpisa/>). The strength of the given tests is that they do not measure achievements in terms of specific curricula, i.e. are not purely fact-based or knowledge-based but rather focus on how students can apply their understanding of concepts and processes to function in different situations in the domain (math, reading, science), thus allowing to make conclusions on students' knowledge and skills required for successful adaptation to a changing world (OECD/CERI, 2008, p. 1). The test assesses students' proficiency on the seven-level scale, where Levels 1a and 1b correspond to the low student's proficiency and Levels 5 and 6 the high proficiency. Level 2 is considered a baseline, which every student leaving compulsory education is expected to achieve.

The latest PISA assessment made in 2015 (OECD, 2016a, 2016b) showed that in respect to science proficiency about 20% of students across OECD countries perform below Level 2 and only 8% of students are proficient at Level 5 or 6. What is worrying is that in the majority of countries with comparable data, students' performance in science remained essentially unchanged since 2006. The low achievers of PISA assessment in science have limited scientific knowledge that can be applied only to familiar situations. This limited knowledge is claimed to prevent them from benefiting from further learning opportunities as well as from any involvement in life situations related to science (OECD, 2014b)

What concerns reading, about 20% of students in OECD countries, on average, do not attain the baseline level of proficiency in reading, which means they can merely work with explicitly stated information, with a text about a familiar topic, and only have an ability to make simple connections between the text and common, everyday knowledge. This proportion remained stable since 2009.

What concerns the assessment of skills for dealing with creative problem solving tasks, the results for 2015 test will be published only in 2017, but the data from the results of the PISA test 2012 tells us that only 11,4% of students across OECD countries reached high levels 5 or 6 with 21,4% failing to reach the baseline Level 2 (OECD, 2014a). Poor performance in problem solving means that students are only able to solve very simple problems; these are problems which do not require thinking ahead and that are cast in familiar settings.

These results allow us to claim that too many students still do not have relevant skills in terms of literacies and problem solving abilities for successful functioning in knowledge society.

In addition to international studies, various researchers both in Western and Eastern countries acknowledge that despite the clear need and the available resources for bringing change, the impact on ordinary classrooms has been very small and very few teaching happening in today's classrooms encourage the development of higher-order thinking, problem solving competence and the ability to work with information. The first voices claiming the deficit of impact are heard already in the 80s of the 20th century: „[...] we would argue, relatively little of teaching that goes on in the classroom directly encourages higher order thinking” (Sternberg & Martin, 1988, p. 560). Analysis of the available literature showed that the tendency remains unchanged throughout the years:

- *„Thinking Skills programmes enjoy a periodic popularity and seem to provide an antidote for teachers to the instrumentalism of prescribed curricula as they address more general aims of education. However, along with most other curriculum innovations they usually fail to make a lasting impact or become established within school systems, despite promising evidence of their effects (Leat, 1999, p. 389);*

- “*Very few schools teach students how to create knowledge; instead, students are taught that knowledge is static and complete, and they become experts at consuming knowledge rather than producing knowledge*” (Sawyer, 2006, p. 42).
- The research on the integration of critical thinking approaches in Latvia has revealed that many teachers in Latvia apply critical thinking approaches in a very fragmented way merely using separate methods which characterise the approach and very often have a distorted view on its theoretical basis. The danger of the given situation is that it prevents the development of students’ higher order thinking skills (Izglītības Attīstības Centrs, 2008, p. 17)

The changes in the society driven by information economy as well as research confirming the lack of adequate approaches used in real classrooms created an increased interest in teachers’ competence. One of the driving questions for education systems nowadays is which competences should teachers have in order to meet the demands of education in a modern world and help learners acquire relevant skills and competences in the process of the subject-matter instruction.

According to the OECD report (OECD, 2005, p. 30) almost all countries¹ participating in the international study on teachers **expressed concerns about shortfalls in teachers’ teaching skills**, referred to as *qualitative shortfalls*, and difficulties in updating these skills i.e. a concern whether teachers have the necessary skills and knowledge to meet the needs of the modern school. Moreover, the TALIS survey conducted in 2009 (OECD, 2009, p. 48) pointed out that a significant proportion of teachers think that professional development does not meet their needs and interests neither in terms of quantity, nor in terms of quality and content.

¹ The countries taking part in the project were:

- Analytical Review strand (25 countries, involving 26 background reports): Australia; Austria; Belgium (Flemish Community); Belgium (French Community); Canada (Quebec); Chile; Denmark; Finland; France; Germany; Greece; Hungary; Ireland; Israel; Italy; Japan; Korea; Mexico; the Netherlands; Norway; the Slovak Republic; Spain; Sweden; Switzerland; the United Kingdom and the United States.
- Country Review strand (9 countries involving 10 review visits): Austria; Belgium (Flemish Community); Belgium (French Community); Germany; Hungary; Italy; Korea; Spain; Sweden and Switzerland.

During his presentation at the forum of Education Ministers of OECD (*Organisation for Economic Co-operation and Development*) countries David Hargreaves (Hargreaves, 2000), a professor at School of Education of the University of Cambridge, highlighted that knowledge economies are by definition learning societies and humans have to learn how to learn both in and outside of educational institutions and should be equipped with relevant creative, innovative and entrepreneurial capacities to succeed in “*unstable environments amidst rapidly changing and newly emerging knowledge*” (Hargreaves, 2000, p. 2). Hargreaves (ibid.) has also underlined that knowledge economies require a revolution in education systems; however, the scale of change that has to be introduced is underestimated by educational professionals who, in addition, lack understanding of how to “*generate the new professional knowledge that is needed to manage the transition successfully*” (Hargreaves, 2000, p. 2). If schools and teachers in industrial age served as models of what it is to be a successful member of an industrial society, then schools and teachers in knowledge economies have to prepare young people to life in knowledge economies and, thus, have to be models of what it is to be a successful member of a knowledge based economy (ibid.).

The OECD report “*Preparing Teachers and Developing School Leaders for the 21st Century. Lessons from Around the World*” (OECD, 2012, pp. 11, 35) lists a few changes which have profound implications for teachers, teaching and learning as well as for education systems (see Table 1).

Table 1 Changes which have profound implications for teachers (OECD, 2012, pp. 11, 35)

In the past	Today
Policy focus was on the provision of education;	Policy focus is on outcomes;
Focus was on delivered wisdom	Focus is on fostering user-generated wisdom among teachers in the frontline
Teachers were often left alone in classrooms with significant prescription on what to teach	The most advanced education systems now set ambitious goals for students and are clear about what students should be able to do, and then prepare their teachers and provide them with the tools to establish what content and instruction they need to provide to their individual students.
Different students were taught in similar ways	Teachers are expected to embrace diversity with differentiated pedagogical practices
The goal was standardization and conformity	The goal is about being ingenious, about personalizing educational experiences
Education was curriculum-centred	Education is learner centred; Teachers are being asked to personalize

	learning experiences to ensure that every student has a chance to succeed and to deal with increasing cultural diversity in their classrooms and differences in learning styles, taking learning to the learner in ways that allow individuals to learn in the ways that are most conducive to their progress
Teachers could reasonably expect that what they taught would last for a lifetime, teaching a fixed syllabus of content was at the centre of education in most countries.	Today, where individuals can access content on search engines, where routine rule based knowledge is being digitized or outsourced, and where jobs are changing rapidly, teachers need to enable people to become lifelong learners, to manage non-rule-based complex ways of thinking and complex ways of working that computers cannot take over easily.

In addition to these changes, the report of the European Commission “*Supporting teacher competence development for better learning outcomes*” (The European Commission, 2013, pp. 7–9) outlines the main expectations the society has of teachers’ competence that is required for attaining educational quality. In addition to ‘traditional’ responsibilities, teachers nowadays are expected to be responsible for:

1. teaching in increasingly multicultural classrooms,
2. integrating students with special needs,
3. using ICT for teaching effectively,
4. engaging in evaluation and accountability processes,
5. involving parents in schools,
6. helping students acquire ways of thinking: creativity, critical thinking, problem-solving, decision-making and learning;
7. helping students acquire ways of working: communication and collaboration;
8. helping students acquire tools for working: including information and communications technologies;
9. helping students acquire skills around citizenship, life and career and personal and social responsibility for success in modern democracies;
10. finding, evaluating and deploying learning materials from a wider range of sources, and helping learners acquire these competences;
11. constantly innovating and adapting, including having critical, evidence-based attitudes, enabling teachers to respond to students’ outcomes, to new evidence from inside and outside the classroom;
12. integrating knowledge, handling complexity, and adapting to the needs of individual learners as well as groups.

13. understanding, deploying and assessing key competences; teachers should model these key competences as well as help learners to acquire them.

The report acknowledges (The European Commission, 2013, p. 8) that Ministers of Educations of the European countries have not adopted a complete list of the competences teachers require. However, the agreement has been reached that, as a minimum, teachers should have a specialist knowledge of the subject(s) they teach, the necessary pedagogical skills to teach them, including teaching to heterogeneous classes, making effective use of ICT, and helping pupils to acquire transversal competences. The need to promote certain key professional values and attitudes amongst teachers, such as reflective practice, autonomous learning, engagement in research and innovation, collaboration with colleagues and parents, and an involvement in the development of the whole school, has also been highlighted.

On the other hand, the OECD report “*Teachers Matter: Attracting, Developing and Retaining Effective Teachers*” (OECD, 2005, pp. 97–99) systemizes the change in a teacher’s role as perceived across OECD countries on three levels:

1. At the individual student level:
 - a. Initiating and managing learning processes²;
 - b. Responding effectively to the learning needs of individual learners;
 - c. Integrating formative and summative assessment;
2. At the classroom level:
 - a. Teaching in multicultural classrooms;
 - b. New cross-curricular emphases³;
 - c. Integrating students with special needs
3. At the school level:
 - a. Working and planning in teams;
 - b. Evaluation and systematic improvement planning;
 - c. ICT use in teaching and administration;

² The given point may not be self-explicit, so its explanation is provided here: “As well as providing instruction, teachers are increasingly expected to encourage students to take a more active role in their own learning. In a number of countries providing stimulating settings of learning and helping students to develop problem-solving skills and to monitor and direct their own learning are seen to have become core responsibilities of teachers.” (OECD, 2005, p. 97)

³ The given point may not be self-explicit, so its explanation is provided here: “Some school systems, such as the United Kingdom, have introduced areas such as citizenship education, covering

- d. Projects between schools, and international co-operation;
 - e. Management and shared leadership.
4. At the level of parents and the wider community:
- a. Providing professional advice to parents;
 - b. Building community partnerships for learning;

Latvian researchers (Burceva, Davidova, Kalniņa, Lanka, & Mackēviča, 2010; Čehlovs & Čehlova, 2010, p. 57) describe the change in the teachers' role in terms of the need to become aware of and implement the humanistic approach in education. Humanistic approach in education which was developed on the basis of Abraham Maslow's and Carl Roger's humanistic psychology (Maslow, 1943; Rogers, 1946) is characterised by the acknowledgement of the value of personality and the focus on the development of the pedagogical situations that would be favourable for the development of learners internal potential, personal identity and personal fulfilment (Čehlovs, 2008, p. 17; Špona, 1996).

According to Žogla (Žogla, 2001, p. 28), if the main question of normative didactics was to identify with the help of which content and methods we should teach a learner specific knowledge and skills, then the humanistic-oriented didactics poses another question – how to organise the learning content, how to select relevant methods in order to help a learner to learn. And learning in this new context means acquiring knowledge relevant to a specific subject and acquiring skills to apply this knowledge in a new context, in a new situation; the given acquisition is based on the general learning to learn skill and feeds it back in the teaching-learning process. Hence, didactics in the humanistic culture is viewed as “*a theory of the teaching-learning process oriented towards student's learning*” [uz skolēna mācīšanos orientēta procesa teorija] (Žogla, 2001, p. 28) translation RJ) and the teacher's new role is to organise the teaching-learning process which is oriented on the learner's learning process in contrast to the 'traditional' teacher's teaching process. The role of a modern teacher is to be able to organise a teaching-learning process in a way that would allow the development of learner's cognitive processes through the subject-

community involvement, social and moral responsibility, and political learning, which can be taught separately, or integrated across the whole school curriculum.” (OECD, 2005, p. 98)

matter learning, the development of his emotional and social competence (Burceva et al., 2010)

The above overview shows that the demands placed on teachers are as high as ever and they are expected to constantly evolve and transform their teaching in order to keep up with the pace of the developing world. This raises the problem of transformation of teaching practice of teachers and namely transformations connected to their teaching competences required for organising the teaching-learning process aimed at developing students' cognitive skills and problem solving competence in the framework of the subject-matter teaching. As we can assume from the above discussed reports and research, this transformation has not been very successful yet.

When presented with a new approach, how do teachers transform their current practice? How do they transform the abstract theory into everyday 'living' practice and make that theory part of their teaching repertoire? And why are some teachers more successful in this endeavour than others? These are the guiding questions which led me to conduct the given research.

My research is specifically focused on the competences that are required from a school teacher for organising the teaching-learning process:

- (1) that would allow the development of learners ability to work with the information: find, select and transform it in the process of problem solving;
- (2) would, thus, allow the development of learners' inventive thinking skills and problem solving competence⁴;
- (3) would be organised in the framework of the subject-matter teaching (what has been referred to as infusion): (Burke & Williams, 2008; Li, 2011; Loarer, 1998; McGregor, 2007; McGuinness, 1999), (Kirkwood (2001a) in McGregor, 2007), Mercer, Wegerif & Dawes in Li, 2011).
- (4) and would respect the principles of the humanistic education.

⁴ *Inventive thinking skills* is a term used to denote cognitive abilities developed as a result of working with the Problem-Centred Education (PCE). *Problem solving competence* also has its special definition in the framework of the PCE. The concepts defined by these terms are discussed in more details in Chapter 2.

These are the characteristics of the teaching-learning process which I refer to in my research as the Problem-Centred Education (PCE).

In my research I focus specifically on teachers' teaching competences required for the problem-centred teaching-learning process. The reasons for the selected focus are manifold.

Firstly, this is the researcher's long-standing interest in the problem-centred education and attempts to apply it in her own teaching practice.

Secondly, it is driven by needs and demands from teachers who work on changing their teaching practice and turning their classroom into a thinking classroom. As highlighted by Caena (Caena, 2011b, p. 12) one of the characteristics of the kind of continuing professional development which is most likely to affect teaching positively is the focus on specific knowledge/strategies, in contrast to general one, helping teachers develop the pedagogical skills to teach specific content, with strong positive effects on practice.

One more reason connected to the choice of focusing specifically on the problem-centred education is connected to its relevance to the demands of the knowledge society and research data suggesting its efficiency.

The introduction to this chapter outlined the contextual background of the research which is characterised by uncertainty, rapidly changing and constantly emerging new information. Hence, preparing learners to live in this context and to cope with the new and the unknown is one of the targets of education. Despite various positive features that characterise the existing teaching for thinking approaches and programmes, these were not developed explicitly for this purpose. See (Sokol, Lasevich, Jonina, & Dobrovolska-Stoian, 2013) for the discussion of the issue. The Problem-Centred Education, on the other hand, which relies on the General Theory of Powerful Thinking (OTSM) and the Theory of Inventive Problem Solving (TRIZ)⁵ (Altshuller, 1984, 1986, Хоменко, 1993, 2008; Хоменко & Аштиани, 2007) offers to integrate into the teaching-learning process domain independent tools for managing information in the process of problem solving. It has been explicitly aiming at helping learners develop skills which are necessary for coping with so called non-typical (creative) problems in various domains avoiding a large number of trials and errors (Sokol, Lasevich, Jonina, et al., 2013; Sokol, Oget, Sonntag, & Khomenko, 2008, p.

34), where a non-typical problem has been conceptualised as „*the one for which no solution exists or is not known to the problem-solver*” (Sokol et al., 2008, p. 34). Therefore, the choice was made to focus specifically on the Problem-Centred Education. More details and discussion on the Problem-Centred Education as such and its comparison to the wider views are provided in Chapter 2. The aim of this introduction is to merely outline that one of the main distinctive features of the Problem-Centred Education is the domain-independent problem solving tools or the so-called meta-tools coming from OTSM-TRIZ theory that allow a problem solver to organise information in the process of problem solving. These meta-tools are introduced in the teaching-learning process as additional content. The problem-centred teaching-learning process targets fostering learners’ specific cognitive abilities that will ensure learners possess deep knowledge (in contrast to superficial knowledge) of the domain under study, will ensure learners’ conceptual understanding and system view of processes and will allow them to apply the acquired knowledge, skills and understandings in the process of problem solving. In other words, it targets the development of the ability to work with the information in the process of problem solving within the framework of a subject-matter teaching-learning process.

The research on the impact of the Problem-Centred Education on learners has shown some positive results.

Nesterenko Alla (Нестеренко, 2006а, p. 135) ran 10-year longitudinal studies of school children (starting with a group of 7 year olds) who were involved in the problem-centred teaching-learning process. Throughout the 10-year experiment the researcher compared experimental group with a control group according to a set of criteria. The first set of tests was aimed at measuring the quality of students’ creative products in form six, the ability to construct inventive problems in form five and the ability to solve problems in form ten. The quality was measured according to the six main criteria: (1) breadth of description (variety of parameters used), (2) coherence of description (number of developed links between ideas), (3) systemic quality (number of metaphors used for depicting one image), (4) quality of the point of view (when the situation is described from somebody’s point of view, how many parameters of that

⁵ From Russian *Общая теория сильного мышления (ОТСМ), Теория решения изобретательских задач (ТРИЗ)*.

observer are taken into account in order to develop point of view from the perspective of that observer), (5) sensitivity to the problem (number of problems described through the contradiction and number of suggested ways for effective solutions), and (6) efficiency of the solution (number of effectively solved problem tasks)⁶. As reported by Nesterenko (Нестеренко, 2006а, р. 137) the experimental group did better on every measured criteria with the statistically significant difference of <1% (apart from the criteria breadth of description where this difference reached <5%). The second set of tests was aimed at measuring creative abilities of students. In form eight, it was measured according to the criteria offered by Torrance: (1) fluency (number of created stories), (2) flexibility (number of different ways for presenting new stories), (3) originality (number of novel, unexpected, rare answers), and (4) elaboration (quantity and quality of the details used for developing a story/an image). The tests were administered in the beginning of the school year. In order to monitor the dynamics the test was also administered at the end of the school year in the experimental group. According to the reported results (Нестеренко, 2006а, р. 141; Хаяйнен & Нестеренко, 2004), the experimental group performed better on all the criteria⁷. Creativity in form ten was measured according to the criteria on creative potential offered by a German scholar Hort Sievert⁸: (1) ingenuity⁹, (2) combination¹⁰, and (3) divergent thinking. The tests are reported to show (Нестеренко, 2006а, р. 143; Хаяйнен & Нестеренко, 2004) that 87,5% of students in the experimental group had high achievements on the administered tests and only 12,5% had average results. Low results were absent at all. The discovered results allowed the researcher (Нестеренко, 2006а; Хаяйнен & Нестеренко, 2004) to conclude students involved in the problem-centred teaching-learning process have a strong possibility to develop their skills required for effective problem identification, definition and solving and to develop creative skills required for avoiding psychological inertia in the process of problem solving.

⁶ It is worth mentioning that every criteria allows to measure how effectively a student can apply specific problem solving meta-tool for coping with the task. Students acquire these meta-tools in the problem-centred teaching-learning process. The description of the meta-tools is provided in Chapter 2.

⁷ The experimental group had lower results in the beginning of the school year for the criteria of fluency and elaboration. However, the test administered at the end of the school year showed better results than in the control group.

⁸ From Russian, *Хорт Зиверт*.

⁹ From Russian, *находчивость*.

¹⁰ From Russian, *комбинирование*.

In his research, Sokol Alexander (Sokol, 2007; Sokol et al., 2008) has developed and tested the approach to English as a foreign language teaching and learning in the framework of the Problem-Centred Education. The study into the efficiency of the developed approach was conducted in two secondary schools in Latvia with secondary school students in forms 10 and 11. The research used experimental and control groups. The first pre- and post- tests were aimed at assessing the quality of the students' produced products and included the measurement of the quality of the written descriptive essays. The quality of pre-test was measured according to such criteria as (1) number of features mentioned, (2) variety of features, (3) context, (4) motivation, and (5) presentation¹¹. The quality of post-test was measured according to such criteria as (1) classification, (2) number and variety of problems, (3) formulation of problems, (4) motivation and (5) presentation¹². The reported results (Sokol, 2007, p. 211; Sokol et al., 2008) demonstrated that the experimental groups performed significantly better ($t=3.32$, $p=0.001$) on the tests than the control groups. In addition, the researcher (Sokol, 2007, p. 199; Sokol et al., 2008) also measured students' proficiency in English as foreign language. The reported results (Sokol, 2007, p. 199; Sokol et al., 2008) showed that both experimental and control groups improved their language skills and no significant differences was observed between the two groups. The demonstrated results allow to conclude that students involved in the problem-centred teaching-learning process while learning a foreign language can improve both their language skills and have a better possibility than their peers to develop their skills required for effective problem identification, definition and solving.

The results of the positive impact of the problem-centred education on learners made it reasonable to organise professional development of teachers who are interested in developing learners' abilities to solve non-typical problems alongside developing their subject-matter related knowledge and skills.

The problem-centred teaching-learning process requires from a teacher a skill in 'problematizing' the learning content of his subject and organising learners' learning activity in a way that would allow learners to become aware of the problem, to be motivated to solve it, to plan and organise specific actions for coping with the

¹¹ More elaborated description of each criteria can be found in (Sokol, 2007, pp. 187–188)

¹² It is worth mentioning that every criteria for both pre- and post- tests allows to measure how effectively a student can apply specific problem solving meta-tool for coping with the task. Students acquire these meta-tools in the problem-centred teaching-learning process.

problem and to assess one's own performance and the result. In addition, the double challenge is created if a teacher has to introduce learners to the domain independent or meta- problem solving tools coming from OTSM-TRIZ theory for solving the learning problems learners are confronted with. This new content added to the subject-matter teaching-learning process would change how the process of learning is organised, demanding additional understanding and skills from a teacher. In addition to accepting and valuing the general theoretical foundations that stand behind the problem education as such, being a master of his own subject content, having relevant skills in transforming this content into problem tasks for learners and managing the process of learners' solution building, a teacher would need to understand and, probably more important, appreciate the value of a new content (namely, OTSM-TRIZ domain independent tools for problem solving), develop skills of creating a sequence of specific problem tasks that would provide the possibility to introduce learners to these meta-tools for organising information in the process of problem solving and to make learners practice the application of these meta-tools throughout involvement in learning activity. This is quite a lot to demand from a teacher, especially if (s)he in general has been sticking to traditional education without making learners active participants of the learning process.

An attempt to bring the results of the research to the real classrooms was manifested through several educational projects, such as, *Bringing Creativity and Thinking Skills in Educational Process, 2010-2012*; *STEP to Thinking – Summer Schools for Teachers Professional Development, 2012-2014*¹³. During these professional development events a professional development of teachers coming from different European countries was organised. None of the teachers participating in the two projects had any experience with the problem-centred education. Since the teachers did not have this expertise, the team of teacher trainers had to offer a framework that would scaffold the teachers in organising the learning activity of students during which they would develop both their subject matter skills and competence in organising information in the process of problem solving. This framework was called the Thinking Task Framework (see Figure 1). However, the empirical experience of

¹³ Both projects were supported by the Nordic Council of Ministers in the framework of the Nordplus Horizontal programme. Projects' ID numbers: HZ-2010_1a-21089 and HZ-2012_1a-29139 respectively. Moreover, various international teacher professional development courses were also organised throughout the years 2010-2015.

working with different groups of teachers for a while has shown that even though teachers are provided with the ready-made systems of tasks and are interested in the concept of the problem-centred education, many of them fail to bring essential change to the teaching-learning process they organise.

The outlined above negative results of the empirical experience of working with teachers has raised the problem of developing teaching competence of teachers for organising the problem-centred teaching-learning process in their real classrooms. The given situation has called for the research into how teachers put new theory into practice, thus transforming their teaching.

Thinking Task Framework

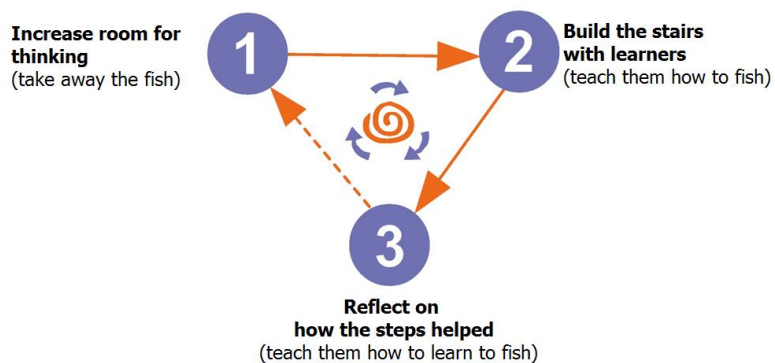


Figure 1 The Thinking Task Framework (Sokol, 2011; Sokol, Lasevich, & Jonina, 2013)

It has revealed the lack of understanding in the question of how teachers build their conception of the problem-centred education; how they transfer its theoretical ideas into their own real-classroom practice and what the difficulties and constraints are which prevent teachers from performing better.

The given situation highlights **the problem of my research**.

Thus, **the aim of my research** is to study teachers' experience of working with the Problem-Centred education in order to shed light into the question of how teachers construct their teaching competence in this domain.

In order to reach my aim I look at my research problem from the angle of the anthropological theory of the didactic (ATD)¹⁴ (Chevallard, 1998, 2007a; Chevallard, Bosch, & Kim, 2015; Chevallard & Sensevy, 2014) and introduce into my research its essential and founding notion of **praxeology (or praxeological organisation)** (see Chapter 3 for more discussion on praxeology). **Praxeology** is a model allowing apprehending, describing, and analysing the elements of knowledge relative to personal or institutional practice (i.e. a human activity). It is, however, not the study of human practice in general but rather the study of a certain practice of a certain person (or institution). Praxeology views knowledge as a practice (the praxis) and discourse on practice (the logos). Modelling a teacher's elements of knowledge related to his teaching in terms of praxeologies allows us to apprehend these elements, study their transformations and compare them to other teachers' praxeologies.

This in return will allow us to find the answers to our **research questions**:

1. How do teachers transform the theory connected to the problem-centred education into their classroom practice?
2. What are the difficulties and constraints that teachers face when trying to acquire components of the teaching competence required for organising the problem-centred teaching-learning process?

Research object: teaching praxeologies for the problem-centred teaching-learning process.

Research objectives:

to define:

- the concept and components of competence, teacher competence and teaching competence;
- the concept of the problem-centred education and position it within teaching for thinking approaches;
- the concept of praxeology;

¹⁴ From French "*Theorie anthropologique de didactique*" (TAD)

to analyse

- theoretical literature and available empirical research results on how teachers transform theory connected to teaching thinking into their own teaching practice;
- teachers' experience who work on the Problem-Centred Education in order to identify teachers' teaching praxeologies;

to build

- teacher's praxeological profiles in order to understand teaching praxeologies of teachers who work on organising the problem-centred teaching-learning process in their classrooms.

Research design and methods:

The given research adopts purely qualitative research design, comprehensive approach (Dayer & Charmillot, 2012) and hence has an exploratory, inductive nature. Since the researcher is adopting the idea that the ability to understand phenomenon and experiences may be inadequate if the researcher merely observes others without being integrated in their environment, the research takes a participatory stance making the researcher an active participant.

Research methods:

- data collection methods:
 - analysis of the available theoretical literature and research results;
 - reflection on one's own pedagogical activity;
 - filming lessons, collecting available videos from lessons and performing direct lesson observation;
 - conduct of semi-structured interviews with teachers who are learning to organise problem-centred education;
 - analysis of teachers' written reflections.
- data analysis methods:
 - analytic approach to modelling the teaching process (Schoenfeld, 1998a, 1998b, 2000, 2011), methodology of competitive argumentation (VanLehn, Brown, & Greeno, 1984);

- qualitative content analysis of interviews and written responses.
- criteria-based analysis of quality of interaction

Research base:

- Teachers participating in the two international projects during which they were learning to organise problem-centred teaching-learning process with their students. Some teachers had a research-proven expertise in organising Problem-Centred Education, others were merely novices in this approach:
 - 2010-2012: Project “*Bringing Creativity and Thinking Skills in Educational Process*” supported by the Nordplus Horizontal Programme;
Constant participants: 2 teachers from Finland, 3 teachers from Latvia, 1 teacher from Norway and 3 teachers from Lithuania
 - 2012-2014: Project “*STEP to Thinking - Summer Schools for Teachers Professional Development*” supported by the Nordplus Horizontal Programme
Constant participants: 7 teachers from Finland, 11 teachers from Latvia, 2 teachers from Norway.

Research stages:

- 2010-2012: The first stage of the research was the integration of the researcher in the team of teachers who were learning to change their practice by adapting Problem-Centred Education. The integration took place through the project specified in the research base (2010-2012). Alongside this integration, the researcher was also learning to change her own pedagogical practice applying the ideas of the problem-centred education in her teaching of English as a foreign language to secondary school students in Riga (Latvia). The given stage took place from 2010 to 2011 and resulted in written reflections on one’s own pedagogical practice (Appendix 1). Both work with teachers and one’s own practice resulted in awareness of some major difficulties that the teachers may have while trying to build their understanding of the Problem-Centred Education and to change their teaching practice.

- 2013-2014: The second stage was connected to doing deeper theoretical analysis of the theoretical literature on competence and teaching competence. This resulted in deeper understanding of components of teaching competence that I have to pay attention to while studying my cases.
- 2012-2013: The third stage of the research consisted in the deeper analysis of the theoretical literature on the principles of the Problem-Centred education and research on teaching for thinking approaches as such. This resulted in positioning the Problem-Centred Education (PCE) among the existing approaches and building a clearer vision of the main principles of the PCE by the researcher. This is also the stage when lesson observation was used to validate some components of teaching competences specific for the PCE.
- 2014-2017: After analysing the notion of competence, the researcher proceeded to the fourth stage of the research which is the study of teachers and their understanding of the problem-centred instruction, as well as the collection (Sep – Oct 2013) and analysis of lessons of teachers-in-action alongside their semi-structured interviews. This is the stage when the researcher identified and compared teaching praxeologies of teachers who transform their teaching practice into the one relative to the Problem-Centred Education. This is also the stage of making the conclusions which would provide some insight into the research questions.

List of Publications

- Sokol A., Lasevich E., **Jonina R.**, Dobrovolska-Stoian M., (2013). “*A thinking based blended learning course in an upper-secondary school in Latvia*” in Tomlinson B., Whittaker C. (eds.) *Blended Learning in English Language Teaching: Course Design and Implementation*. British Council 2013. 189-199. ISBN 978-0-86355-706-4.
- Sokol A., Lasevich E., **Jonina R.**, Dobrovolska-Stoian M., (2013). “*Inventive Thinking Skills, Development*” in Elias G. Carayannis (ed.) *Encyclopedia of Creativity, Invention, Innovation, and Entrepreneurship* (1st edition, pp.1161-1169). Springer-Verlag New York.
- Koke T., Murashkovska I., **Jonina R.** (2013). *Educators' Professional Development: from Policy Guidelines to Collaborative Learning in Action*. In

Rubene Z., Drinck B. (eds.) *The Perspectives of the Pedagogy: Innovative Solutions*. The University of Latvia Press. Riga. 204-214. ISBN 978-9984-45-685-0.

- Sokol A., Lasevich E., **Jonina R.** (2013). *A framework for bringing TRIZ based education for creative thinking to a wider audience*. In Global TRIZ Conference. Conference Proceedings. 2013. Jul 09-11. KATA (Korea Academic TRIZ Association) pp. 108 - 109
- **Jonina R.**, Oget D., Audran J. (2017). *Teaching Competence for Organising Problem-Centred Teaching-Learning Process*. In Cavallucci D. (ed) TRIZ – The Theory of Inventive Problem Solving, Current Research and Trends in French Academic Institutions. Springer Publishing.

List of Reports and Teacher Professional Development Workshops and Seminars

- Report published on the personal page of academic social website Academia.edu: Jonina R, 2012. *Moving Towards Professionalism in Developing Inventive Thinking: Reflecting on Difficulties and Possible Mistakes*. Proceedings from the International Conference “Bringing Creativity and Thinking into the Educational Process”, 14-15 September 2012, Riga, Latvia
- Report published on the personal page of academic social website Academia.edu: Jonina R, 2014. *Developing Competence in Teaching for Thinking: What Do Expert Teachers Do Differently?* Proceedings from the International Conference “Creativity and Thinking Skills in Learning, Teaching and Management”, 19-20 September 2014, Riga, Latvia.
- *October 02, 2015*
Running a workshop for teachers “*Important Components towards Organising a Problem-Centred Lesson*”. Workshop organised in the framework of an international professional development course “Bringing Creativity and Thinking Skills into the Educational Process”. Reinacker, Reutenbourg, France.

List of Presentations

- *September 15, 2012*
Report presentation: Jonina R. (2012) *“Moving Towards Professionalism in Developing Inventive Thinking: Reflecting on Difficulties and Possible Mistakes.”* International TA Teachers Conference “Bringing Creativity and Thinking Skills in the Educational Process”. Riga, Latvia
- *October 30, 2012*
Report presentation: Jonina R. (2012). *“Learning to Develop Students’ Thinking Using the Thinking Approach: Mistakes and Solutions”*. The 12th annual conference of the English Language Teachers of the Latgale region of Latvia “ELT – Traditions, Experience, Reality, Technologies, Innovations”. Educational municipality department of Daugavpils, LATE – Latvian Association of Teachers of English, the British Council. Daugavpils, Latvia
- *July 20, 2013*
Presentation of the research update for the panel of educational experts. An exam presentation required by the Doctoral School MSII at the University of Strasbourg: Jonina R. (2013) *“Infusing Inventive Thinking into Teachers Professional Practice”*. Research Committee evaluating the presentation was composed of Prof. REGE-COLLET Nicole and Prof. POTEAUX Nicole. Obtained a favourable decision of the committee to pursue the development of the research.
- *April 03, 2014*
Poster presentation: Jonina R. (2014) *“Development of Inventive Thinking Skills in the Teaching Learning Process”*. The Research Day at the National Institute of Applied Sciences (INSA). Strasbourg, France
- *June 30 – July 04, 2014*
Poster presentation: Jonina R. (2014) *“Development of Inventive Thinking Skills in the Teaching-Learning Process”*. International **J**Unior **R**Esearchers of **EARLI** (European Association for Research on Learning and Instruction) Conference “Learning and Instruction Inside Out”. Nicosia, Cyprus
- *Sep 19-20, 2014*
Paper presentation: Jonina R. (2014) *“Developing competence in teaching for thinking. What do expert teachers do differently?”* International TA Teachers

Conference “Creativity and Thinking Skills in Learning, Teaching and Management”. Riga, Latvia

- *June 24-25, 2015*

Scientific discussion ‘Assises de la Recherche autour de la TRIZ’ (Research Around TRIZ in France). Paris, France. Presentation “*Développement de compétences en pensée inventive chez les élèves dans le cadre d’enseignements disciplinaires centrées sur la résolution de problèmes*’ (Development of inventive thinking skills of students in the framework of a subject-matter teaching).

- *March 31, 2016*

Poster presentation: Jonina R. (2016) “*Teaching Competence for Organising Problem-Centred Teaching-Learning Process*”. The Research Day at the National Institute of Applied Sciences (INSA). Strasbourg, France

- *May 13, 2016*

Presentation of the research advancement to the LISEC laboratory team: “*Teaching Competence for Organising Problem-Centred Teaching-Learning Process*”. Strasbourg, France

- *June 10, 2016*

Presentation of the research advancement during the PhD student seminar in the National Institute of Applied Sciences (INSA): “*Teaching Competence for Organising Problem-Centred Teaching-Learning Process*”. Strasbourg, France

- *23-24 September 2016*

Paper presentation: Jonina R. (2016) “*Teaching competence for developing learners’ thinking and problem solving: helping in-service teachers grow professionally*”. International conference “Thinking as a Key Competence: Implications for Learning, Teaching and Management”, Riga, Latvia.

Part one

Teaching Competence, Its Structural Components and Its Place among a Wider Notion of Competence and Teacher Competence

Taking into account that the given research deals with the question of how teachers transform certain theory into their classroom practice, my first objective is to clarify what 'theory' means in the context of this research. Developing the idea of 'theory' we can say that there are certain professional expectations the society has from teachers, in other words, certain teacher competence that an educational professional is expected to have. In this respect, expectations of the society from teacher competence and what the real teachers are able of doing would differ, thus allowing us to speak about two different realities, that of expected teacher competence and that of what exists in the real life.

Narrowing down the problem under study even further, my research does not encompass all possible aspects of teacher competence but is rather concerned with the main teacher's professional task, that of teaching - a teacher's performance in the classroom, which requires certain teaching competences. Moreover, I am specifically focused on teaching competences in the domain of teaching for thinking approaches, and particularly in the domain of the Problem-Centred Education.

Having said that I can specify the research question as follows, how do teachers transform teaching competences in the domain of the Problem-Centred Education (PCE) into their classroom practice? Or in other words, how do teachers put into practice teaching competences in the domain of the PCE?

In order to answer this question I first of all have to define the concept of teacher competence and teaching competence and to identify its structural components. This is the objective of this chapter.

1.1. The Concept of Teacher Competence and Teaching Competence

In the light of the current discussions on the competence-based approach in education, the question of teacher competence has come to the frontline of educational concern.

Many EU countries are now reviewing their teacher education and professional development means via formal, informal and non-formal ways to address the challenges faced by the teaching profession in the knowledge society of the 21st

century. The European Union views the role of teachers and their lifelong learning and career development as key priorities¹⁵ (The European Commission, 2005, 2007; The European Commission & Council of the European Union, 2004).

Trying to build a unified policy on teacher competence throughout the EU, the Council and the Commission adopted a joint report “*Education and Training 2010 – The Success of the Lisbon Strategy Hinges on Urgent Reforms*” (The European Commission & Council of the European Union, 2004, p. 28) which recommended the priority-oriented development of the European common references and principles in a number of areas, including the competences and qualifications of teachers.

Common European Principles for Teacher Competences and Qualifications were developed in 2005 (The European Commission, 2005) and define four principles of a teaching profession that are suggested to be applied across Europe. According to these principles the teaching profession should be:

1. a well-qualified profession – hence, the teaching profession should be well qualified;

¹⁵ The issue of teacher quality was first raised under the Lisbon Process (also referred to as Lisbon Agenda or Lisbon Strategy) launched in 2000 by the European Union in order to respond to globalisation and the need to create a new knowledge-driven economy. The primary aim of the Lisbon Process was to make the European Union (EU) the most competitive economy in the world by 2010 and education and training have been described as a major tool for implementing this strategic goal (Lisbon European Council, 2000). One of the methods adopted by the European Commission to follow the development of the Lisbon Process is referred to as the **Open Method of Coordination**. As part of this method Member States cooperate in the form of **Working Groups**: “*The primary focus of the Working Groups is to benefit the Member States in the work of furthering policy development through mutual learning and the identification of good practices, as well as understand what works in education*” http://ec.europa.eu/education/policy/strategic-framework/expert-groups_en.htm. Since 2009, Working Group experts have been exchanging good practices and working on common tools in the field of education. There have been 3 generations of Working Groups:

- 2011 - 2013 eleven Education and Training 2010 Programme Thematic Working Groups;
- 2014 - 2015 six Education and Training 2020 Programme Working Groups.
- A new generation of working groups was launched on 22 February 2016 set to last until June 2018.

The working group on Teacher Professional Development (2011-2013) examined specific aspects of teacher education, in particular the development of teacher competences, teachers’ continuous professional development, and policy on teacher educators. The group produced three guidance for policy makers, two literature reviews, and seven peer learning activity reports. These can be consulted here: http://ec.europa.eu/education/policy/strategic-framework/archive/index_en.htm.

The working group on School Policy (2014-2015) focused on policies to improve the quality and relevance of Initial Teacher Education and resulted in a ‘*Guide on policies to improve Initial Teacher Education*’, which can be consulted here: http://ec.europa.eu/education/policy/strategic-framework/expert-groups/2014-2015/index_en.htm

A new generation of the working group (2016-2018) will address the question of teacher education under the Working Group on School. The group’s specific mandate detailing the challenges the group needs to address, the outputs to achieve, and the overall roadmap can be consulted here: http://ec.europa.eu/education/policy/strategic-framework/expert-groups_en.htm.

2. a profession placed within the context of lifelong learning – hence, the teaching profession should be seen as a continuum which includes initial teacher education, induction and continuing professional development;
3. a mobile profession – hence, teacher mobility should be encouraged;
4. a profession based on partnerships – hence, the teaching profession should work in partnership with other stakeholders

Moreover, the document defines **three key competences of teachers**, which include:

1. Work with others;
2. Work with knowledge, technology and information;
3. Work with and in society;

The given principles are supposed to serve as a common guide for EU member states for developing specific frameworks of teacher competences that would clearly define what teachers in the 21st century are expected to know and to be able to do; in other words, what it takes to be a high quality teacher in the knowledge society. The **definition of teacher competence applied through the European educational policy documents** is the one adopted in the Recommendation of the European Parliament and of the Council on key competences for lifelong learning: “*Competences are defined here as a combination of knowledge, skills and attitudes appropriate to the context.*”(European Union, 2006b, p. L 394/13)

The definition and content of teacher’s professional competence is normally manifested in relevant professional standards. For instance, in Latvia, standards on teacher’s professional competence (Latvijas Izglītības un Zinātnes Ministrija, 2004) define the content of teacher’s professional competence in terms of skills (domain-general skills, general skills, domain-specific skills for pre-school, basic education and secondary education domains) and knowledge (knowledge of regulating documents, protection of child’s right, pedagogy and psychology, domain-specific knowledge, languages and communication, social sciences, educational management, healthy life style). The knowledge is subdivided into three levels: level of awareness, understanding and application. Moreover, the standards specify teacher’s responsibilities at the stage of planning, action and assessment/evaluation. Each responsibility is further subdivided into relevant objectives (Appendix 2). The

given standards provide no explicit definition of the teacher’s professional competence. **One can only assume the definition** from the discussed content, which would hence be defined as a set of skills and knowledge relevant for the profession of the teacher and the ability to perform a set of professional responsibilities. The table below (Table 2) summarises the set of skills and knowledge expected from the teacher.

Table 2 Teacher’s skills and knowledge required by standards in Latvia¹⁶

Skills	Domain-general skills	General skills	Domain-specific skills ¹⁷
	<ul style="list-style-type: none"> • Ability to plan one’s work and students’ work; • Ability to organise teaching-learning process in accordance with defined aims and objectives; • Ability to assess and foster student’s development and academic results as well as ability to assess the effectiveness of one’s own work 	<ul style="list-style-type: none"> • Ability to set up aims and plan how to achieve them; • Ability to find, analyse and select information and use it; • Ability to develop or select educational programmes; • Ability to select teaching-learning¹⁸ and upbringing¹⁹ resources (content, methods, forms, etc.); • Ability to select or develop teaching-learning materials; • Ability to organise teaching-learning environment; • Ability to identify individual traits of learners; • Communicative skills; • Ability to work in a team; • Ability to organise the teaching-learning and upbringing process in a creative way; • Ability to use a variety of teaching-learning and upbringing resources, including ICT resources; • Ability to identify and solve problem-situations; • Ability to cooperate with parents, colleagues, other specialists and society; • Ability to motivate learners and manage their work; • Ability to study the development of learners’ personality traits; • Ability to foster the development of learners’ sense of responsibility; • Ability to develop learners’ ability to learn; • Ability to analyse one’s own pedagogical activity; 	<p><u>For basic education teachers</u></p> <ul style="list-style-type: none"> • Ability to create opportunities for learners’ self-expression and self-discipline as well as opportunities for the development of learners’ appreciation of values; • Ability to provide information about opportunities of profession and career choice. • Ability to help learners to adapt in a new social environment; • Ability to identify learners’ talents and foster their development. <p><u>For general secondary education teachers</u></p> <ul style="list-style-type: none"> • Ability to create opportunities for learners’ individual work; • Ability to motivate learners for lifelong learning and informed choice of future career; • Ability to manage learners’ research activity; • Ability to develop learners’ skills for independent to analyse and solve problems independently.

¹⁶ Translated from Latvian by RJ

¹⁷ Not reported for pre-school teachers, professional education teachers, and special education teachers since not relevant for the given research.

¹⁸ From Latvian “mācību”. The direct translation of the word “mācību” is “teaching”, however, I translate it as “teaching-learning” since the change in didactic paradigm makes it important to include the learner in the process

¹⁹ From Latvian “audzināšanas”

		<ul style="list-style-type: none"> • Ability to improve one's own professional competence; • Ability to substantiate one's own opinion and respect opinion of others; • Ability to report about the results of one's own work; • Ability to develop creative projects, organise research activity; • Ability to assess the growth of learners' personality traits; • Ability to assess learners' academic achievements; • Ability to develop learners' self-assessment skills. 	
Knowledge	Knowledge of legal document regulating work, documents regarding state educational system and regulatory documents on the teaching profession. Level of knowledge required: level of awareness		
	Protection of children rights [Level of knowledge required: level of application]		
	Pedagogy (educational philosophy) and psychology [Level of knowledge required: level of application]:		
	<ul style="list-style-type: none"> • Theory of teaching and learning, methodology; • Classroom management and child upbringing; • Organisation of the teaching-learning process (teaching methods, lesson, teaching programme); • Assessment of results and organisation of self-assessment; • Organisation of educational environment; • Fostering of communication and cooperation (fostering social relationships); • Methods of educational research; • Psychology (general, developmental, personal development, social); • Special pedagogy; • Domain pedagogy; • Physiology 		
	Knowledge of scientific domain relevant for the taught subject [Level of knowledge required: level of application]		
	<ul style="list-style-type: none"> • Subject; • Didactics of the subject • Basics of integration of the teaching content 		
	Languages and communication [Level of knowledge required: level of application]:		
	<ul style="list-style-type: none"> • ICT; • State language and foreign languages; • Psychology of Communication. 		
Social sciences [Level of knowledge required: level of application]:			
<ul style="list-style-type: none"> • Ethics 			
Educational management [Level of knowledge required: level of awareness]			
<ul style="list-style-type: none"> • Logics; • History of culture; • History; • Philosophy; • Basics of economics; • Environment and health education [Level of knowledge required: level of application] 			
Healthy lifestyle [Level of knowledge required: level of application]:			
<ul style="list-style-type: none"> • Sport; • Healthy nutrition; • Personal hygiene; • Preventive care of addictions. 			

It is worth, noticing, however, that in line with the new demands to the teacher profession and European development of Common competence framework, the standards of teacher professional competence in Latvia are currently being reformed ²⁰ : <http://www.izm.gov.lv/lv/ministrija/192-eiropas-savieniba/latvijas-prezidentura/192-izglitiba-un-zinatnes-ministrija-sak-jauna-skolotaja-profesijas-standarta-izstradi>.

It is also worth mentioning, that the definition of competence often accepted and cited in Latvia is the one elaborated by the scholars Irina Maslo and Inta Tiļļa: “*a unique combination of a set of abilities and experience acquired through personal experiences a person has been confronted with*”²¹ (Maslo & Tiļļa, 2005, p. 7 translated by RJ). I can thus assume that **teacher’s professional competence** may be viewed from the same angle.

On the other hand, French standards on teacher’s professional competence (Le ministère de l’éducation nationale, 2013) are more recent and include both definition of competence implied in the standards and its components. The standards adopt the definition of competence as suggested by the European Parliament and view it as “*as a combination of knowledge, skills and attitudes appropriate to the context. Key competences are those which all individuals need for personal fulfilment and development, active citizenship, social inclusion and employment.*” (European Union, 2006b, p. 394/13) As for the components of professional competence, the French standards define four groups: (1) competences required from any teacher and educational staff, (2) competences which are common for all the teachers, (3) competences which are specific for educational staff responsible for documental resources, and (4) competences specific for educational advisors. All competences are followed by descriptive constituents (Appendix 3). Competences, required from any teacher and educational staff, include the following components:

1. Sharing values of the French Republic;

²⁰ It may also be interesting to notice that some researchers who have been acquainted with the project of new standards (Garjane & Augskalne, 2012) remark that alongside positive aspects of new standards which take into account the role of a teacher in the development of learners’ personality, new standards seem to ignore such important aspect as teachers’ meta-competences and offer a narrowed view of the concept of competence.

²¹ From Latvian “[...] kompetence kā audzināšanas ideāls ir pieredzes gūšanas iespējās pamatota spēju un pieredzes individuālā kombinācija. Procesuālajā izpratnē tā nepārtraukti pilnīgojas, jo spējas attīstās mūžīgi, pilnveidojas pieredze un rodas arvien jaunas pieredzes gūšanas iespējas”

2. Acting in accordance with the fundamental principles of educational system and regulatory framework of the school;
3. Knowing students and the learning process;
4. Taking into account students' diversity;
5. Accompanying students in their training period (from French, *parcours de formation*);
6. Acting responsibly and according to ethical principles;
7. Mastering the French language for the purposes of communication;
8. Using a foreign language in the situations required for performing professional duties;
9. Integrating elements of technological culture which are necessary for performing professional duties;
10. Cooperating within the team;
11. Contributing to the activities of educational community;
12. Cooperating with students' parents;
13. Cooperating with school partners;
14. Taking part in individual and collective professional development activities.

Competences common for all teachers include the following components:

1. Mastering disciplinary and didactic knowledge;
2. Mastering the French language in the framework of one's own teaching;
3. Developing/planning and organising teaching-learning situations taking into account the diversity of students;
4. Organising and putting into action group work which facilitates learning and students' socialisation;
5. Evaluate students' progress and results.

After analysing different approaches to defining teacher competences in Europe, the Thematic Working Group 'Teacher Professional Development' (The European Commission, 2011, 2013, pp. 45–46) concluded that approaches vary a lot and range from general guidelines (for instance in France, Hungary or Luxembourg) to detailed lists of specific competences (for instance, in Estonia, the Netherlands, the UK). Despite the differences, the international review of both policy documents and

research studies²², the Thematic Working Group (The European Commission, 2013, pp. 45–46) identified key aspects of teacher competences (Table 3) that are commonly mentioned in the majority of studies. The group suggested considering these aspects and components as a starting point for dialogue in education and policy arenas.

Table 3 Aspects and components of teacher competences (The European Commission, 2013, p. 45)

Areas of competence	Components of competence
Knowledge and Understanding	Subject matter knowledge
	Pedagogical Content Knowledge (PCK), implying deep knowledge about content and structure of subject matter: <ul style="list-style-type: none"> • knowledge of tasks, learning contexts and objectives • knowledge of students' prior knowledge and recurrent, subject-specific learning difficulties • strategic knowledge of instructional methods and curricular materials
	Pedagogical knowledge (knowledge of teaching and learning processes)
	Curricular knowledge (knowledge of subject curricula – e.g. the planned and guided learning of subject-specific contents)
	Educational sciences foundations (intercultural, historical, philosophical,

²² The review relies in the following perspectives from research and policy that can be consulted for further details:

- a. Darling-Hammond, L. & Bransford, J. (Eds.) (2005). *Preparing teachers for a changing world*. Report of the Committee on Teacher Education of the National Academy of Education. San Francisco: Jossey-Bass.
- b. Feiman-Nemser, S. (2001). From preparation to practice: designing a continuum to strengthen and sustain teaching. *Teachers College Record*, 103 (6), 1013-1055.
- c. Feiman-Nemser, S. (2008). Teacher Learning. How do Teachers learn to teach? In Cochran-Smith, M, Feiman-Nemser, S., McIntyre, D. (Eds.). *Handbook of research on Teacher Education. Enduring Questions in Changing Contexts*. New York/Abingdon: Routledge/ Taylor & Francis.
- d. Geijsel, F., Sleegers, P., Stoel, R. & Krüger, M. (2009). The Effect of Teacher Psychological, School Organizational and Leadership Factors on Teachers' Professional Learning in Dutch Schools. *The Elementary School Journal*, 109(4), 406-427.
- e. Gonzalez, J. & Wagenaar, R. (Eds.) (2005). *Tuning Educational Structures in Europe II. Universities' contribution to the Bologna Process*. University of Deusto & University of Groningen.
- f. Hagger, H. & McIntyre, D. (2006). *Learning teaching from teachers. Realizing the potential of school-based teacher education*. Maidenhead: Open University Press.
- g. Hatano, G. & Oura, Y. (2003) Commentary: reconceptualising school learning using insight from expertise research. *Educational Researcher*, 32(8), 26-29.
- h. Kelly, M. & Grenfell, M. (2004). *European Profile for Language Teacher Education. A Frame of Reference*. University of Southampton, UK.
- i. Krauss, S., Brunner, M., Kunter, M., Baumert, J., Blum, W., Neubrand, M. & Jordan, A. (2008). Pedagogical Content Knowledge and Content Knowledge of Secondary Mathematics Teachers. *Journal of Educational Psychology*, 100(3), 716-725.
- j. Mishra, P. & Koehler, M.J. (2006). Technological Pedagogical Content Knowledge: A new Framework for teacher knowledge. *Teachers College Record*, 108 (6), 1017-1054.
- k. Williamson McDiarmid, G. & Clevenger-Bright, M. (2008). *Rethinking Teacher Capacity*. In Cochran-Smith, M., Feiman-Nemser, S. & McIntyre, D. (Eds). *Handbook of Research on Teacher Education. Enduring questions in changing contexts*. New York/Abingdon: Routledge/Taylor & Francis.

	psychological, sociological knowledge)
	Contextual, institutional, organizational aspects of educational policies
	Issues of inclusion and diversity
	Effective use of technologies in learning
	Developmental psychology
	Group processes and dynamics, learning theories, motivational issues
	Evaluation and assessment processes and methods
Skills	Planning, managing and coordinating teaching
	Using teaching materials and technologies
	Managing students and groups
	Monitoring, adapting and assessing teaching/learning objectives and processes
	Collecting, analysing, interpreting evidence and data (school learning outcomes, external assessments results) for professional decisions and teaching/learning improvement
	Using, developing and creating research knowledge to inform practices
	Collaborating with colleagues, parents and social services
	Negotiation skills (social and political interactions with multiple educational stakeholders, actors and contexts)
	Reflective, metacognitive, interpersonal skills for learning individually and in professional communities
	Adapting to educational contexts characterised by multi-level dynamics with cross-influences (from the macro level of government policies to the meso level of school contexts, and the micro level of classroom and student dynamics)
Dispositions: beliefs, attitudes, values, commitment	Epistemological awareness (issues concerning features and historical development of subject area and its status, as related to other subject areas)
	Teaching skills through content
	Transferable skills
	Dispositions to change, flexibility, ongoing learning and professional improvement, including study and research
	Commitment to promoting the learning of all students
	Dispositions to promote students' democratic attitudes and practices, as European citizens (including appreciation of diversity and multiculturalism)
	Critical attitudes to one's own teaching (examining, discussing, questioning practices)
	Dispositions to team-working, collaboration and networking
Sense of self-efficacy	

As it can be seen from the offered synthesis, the three main structural components of teacher competence (called, areas) are knowledge and understanding, skills, and dispositions (which include beliefs, attitudes, values and commitment).

After undertaking the analysis of the literature alongside project documentation some Latvian scholars (Andersone, 2010, p. 8; Čehlovs & Čehlova, 2010, p. 61) have also come to the conclusion that the three main content components of teacher's professional competence commonly agreed in the literature are knowledge, skills and attitudes (personal characteristics).

Latvian scholars Mihails Čehlovs and Zoja Žehlova (Čehlovs & Čehlova, 2010), offer their own conceptualisation of teacher's professional competence. According to them, definition of the structure of teacher's professional competence should be based on the main idea of humanistic approach, which puts a human being as the highest value in the centre of the teaching-learning process. The basis of a human being is his culture. Hence, teacher's professional competence has three components:

1. teacher's cognitive culture (knowledge, skills, cognitive experience)
2. teacher's psycho-pedagogical culture (system of attitudes, system of values; ability to establish cooperation and engagement)
 - a. Psycho-pedagogical culture does not equal a compilation of certain knowledge. It rather includes four main components which manifest themselves in the attitude towards oneself and ones students:
 - teacher's convictions/beliefs (attitudes, motives, goals)
 - emotions (includes teacher's ability to appreciate, understand and accept students' emotions and adequately express one's own emotions),
 - self-perception/self-image,
 - pedagogical influence (the given influence should have the developmental nature for students and be directed towards the development of environment which makes it possible students' autonomous intellectual and emotional development).
3. didactic culture of teacher's activity (ability to organise and assess activity)

The leading component (the system-building component) is psycho-pedagogical culture, and namely, the system of values. The internal unity of teacher's personality is made up with the interconnection of these three components. Both personal and professional 'I' of the teacher are closely connected to his system of values. Hence, **teacher's professional competence** can be defined as "*a system construct which is manifested in the unity of professional and personal culture based on the system of values and which ensures the effectiveness of pedagogical activity*"²³ (Čehlovs &

²³ from Latvian, "*sistēmisks veidojums, kas izpaužas profesionālās un personiskās kultūras vienotībā uz vērtību sistēmas pamata un nodrošina pedagoģiskās darbības efektivitāti*"

Čehlova, 2010, p. 60 translated RJ). So the development of professional competence should be based on harmonisation of teacher's attitudes.

The National Institute of Education in Singapore (National Institute of Education, 2009) have developed their New Values, Skills and Knowledge (V³SK) Model, which re-groups attributes of the 21st century teaching professionals into skills, knowledge and values, where values perspective is expended in a three-dimensional paradigm: Learner-centred values, Teacher Identity, and Service to the Profession and Community (Figure 2).

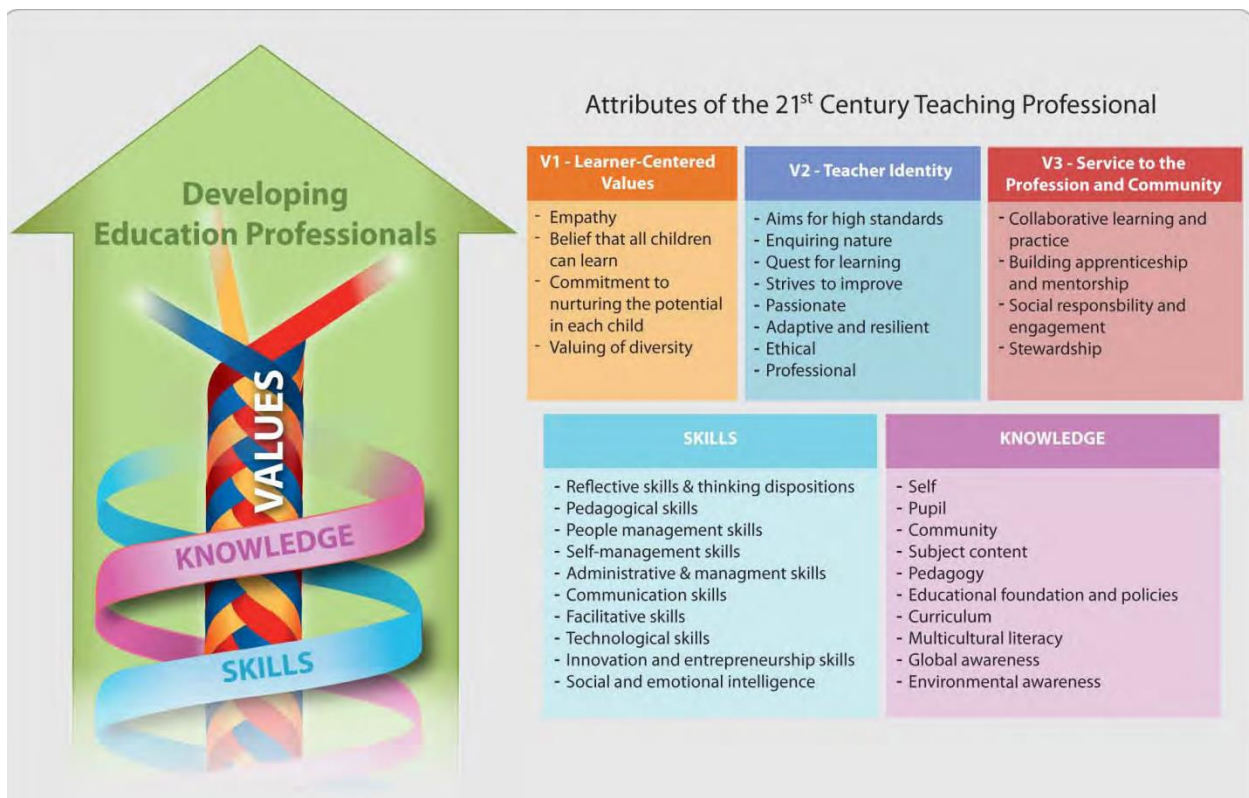


Figure 2 New Values, Skills and Knowledge (V³SK) Model (National Institute of Education, 2009, p. 45)

In addition, the scholars (National Institute of Education, 2009, p. 53) identified teacher's core competencies and grouped them according to the three main teachers performance dimensions (Table 4). Each core competency is accompanied with a detailed definition.

Table 4 Organisation of Teacher's Core Competencies (National Institute of Education, 2009, p. 53)

Performance dimensions	Core competencies
Professional Practice	<ol style="list-style-type: none"> 1. Nurturing the whole child 2. Providing quality learning of child 3. Providing quality learning of child in CCA 4. Cultivating Knowledge: <ol style="list-style-type: none"> i. with subject mastery; ii. with reflective thinking; iii. with analytic thinking; iv. with initiative; v. with creative teaching vi. with a future focus
Leadership & Management	<ol style="list-style-type: none"> 5. Winning Hearts and Minds <ol style="list-style-type: none"> i. Understanding the Environment; ii. Developing Others 6. Working with Others <ol style="list-style-type: none"> i. Partnering Parents; ii. Working in Teams
Personal Effectiveness	<ol style="list-style-type: none"> 7. Knowing Self and Others <ol style="list-style-type: none"> i. Tuning into self ii. Exercising personal Integrity and legal responsibilities iii. Understanding and respecting others iv. Resilience and adaptability

In addition to the three core components of professional competence discussed in the literature, such concepts as a teacher as a **reflective practitioner** (Calderhead, 1989; Schon, 1984) are also widely discussed in the literature. For instance, a Latvian scholar Lūcija Rūtka (Rutka, 2010), views reflection as a mechanism for developing teacher's psychological competence, which includes such components as psychological knowledge, psychological thinking, personal traits essential for professional practice, self-analysis, empathy, decision-making skills, skills of offering psychological support to others, emotional self-regulation, stress management.

As can be seen from the above analysis **teacher competence** is a general term used to denote "*the ability of a teacher to deal adequately with the demands of the teaching profession using an integrated set of knowledge, skills and attitudes as manifested in both the performance of the teacher and reflection on his or her performance*" (Nijveldt, Beijaard, Brekelmans, Verloop, & Wubbels, 2005, p. 90) while **teaching competence** will only be its part. The table 5 below summarises some definitions of teaching competence(s) found in the literature. As it can be seen from the second example, sometimes the researchers confuse the notions and use teacher competence to mean teaching competence.

Table 5 Overview of some definitions of teaching competence found in literature

Authors	Definition	Notes
Tigelaar, Dolmans, Wolfhagen, & Vleuten, 2004, p. 255	<i>In this study, teaching competencies are defined as an integrated set of personal characteristics, knowledge, skills and attitudes that are needed for effective performance in various teaching contexts [...] According to this definition, teaching competencies are integrated and should be viewed as a whole repertoire a teacher has at his or her disposal. The teaching context is important; that is, teaching competencies must be viewed in the light of the various contexts in which teaching takes place.</i>	<ol style="list-style-type: none"> 1. Defining word: <i>integrated set of</i> 2. Structural components: <i>personal characteristics, knowledge, skills, attitudes</i> 3. Context is important for interpreting competence; 4. Competence is connected to 'effective' performance.
Schnick-Vollmer et al., 2015, p. 25	<i>In the current study teachers' competence is defined as sequences of actions functionally related to classroom instruction in accounting that is composed of professional knowledge (CK and PCK), beliefs, motivational orientation, and self-regulatory abilities. With regard to actual behavior or performance, competencies are influenced by situational characteristics and teachers' personal interpretations thereof. [...] different aspects of competence are linked with one another, act in specific situations with one another and thus, lead to observable behavior.</i>	<ol style="list-style-type: none"> 1. Defining word: <i>sequences of actions</i> 2. Structural components: <i>professional knowledge (CK and PCK), beliefs, motivational orientation, self-regulatory abilities</i> 3. Influence of situations on professional competence is emphasised; 4. Competence is manifested in observable behaviour
The European Commission, 2013, p. 8	<i>Teaching competences are thus complex combinations of knowledge, skills, understanding, values and attitudes, leading to effective action in situation. Since teaching is much more than a task, and involves values or assumptions concerning education, learning and society, the concept of teacher competences may resonate differently in different national contexts.</i>	<ol style="list-style-type: none"> 1. Defining word: <i>complex combinations</i> 2. Structural components: <i>knowledge, skills, understanding, values, attitudes, values or assumptions concerning education, learning and society</i> 3. Competence is connected to 'effective action in situation'.

As stated by Caena (Caena, 2011a, pp. 7–8; The European Commission, 2013, p. 10) **teacher competences**²⁴ implies a wider, systemic view of teacher professionalism, and considers the multi-faceted roles of the teacher on multiple levels – the individual, the school, the local community, professional networks. Whereas **teaching competences** are focused on the role of the teacher in action in

²⁴ The notion of 'teacher competences' seems close in its meaning to the Latvian notion of the 'skolotāja profesionālā kompetence' (i.e. teacher's professional competence), which is also sometimes referred to (see, for instance (Čehlovs & Čehlova, 2010) as 'skolotāja *pedagoģiskā kompetence*' (i.e. teacher's pedagogical competence)

the classroom, directly linked with the 'craft' of teaching - with professional knowledge and skills mobilised for action²⁵.

In order to make a clearer distinction, dimensions of teacher's professional work can be outlined.

Caena (Caena, 2011a, p. 2) states that there is a converging international agreement that a teacher nowadays is viewed in its four main roles:

1. Teacher as instructional manager;
2. Teacher as a caring person;
3. Teacher as an expert learner;
4. Teacher as a cultural and civic person.

I can assume then that if teacher's professional competence is connected to all these dimensions of teacher's profession, then teaching competence is more closely connected to the teacher's role of instructional manager, all other dimensions would merely influence it.

Speaking about the **structure of teacher's pedagogical activity**²⁶, Davidova (Burceva et al., 2010) identifies its 11 components (see Figure 3), with educational activity²⁷ as a core component. Educational activity is viewed as the development and fostering of skills and abilities of learners in a specific domain, which is directed at the development of learner's personality. If teacher's competence may be connected to all of the activities a teacher is involved in, then **teaching competence** can be narrowed down mainly to educational, projecting (ability to envision, plan educational events and their impact on learners, based on learners' specific characteristics and needs), and assessment activities.

²⁵ Caena refers to the following work as a basis for her conclusions: Hagger, H. & McIntyre, D. (2006). Learning teaching from teachers. Realizing the potential of school-based teacher education. Maidenhead: Open University Press.

²⁶ From Latvian, *skolotāja pedagoģiskās darbības struktūra*.

²⁷ From Latvian. *Izglītojošā darbība*.

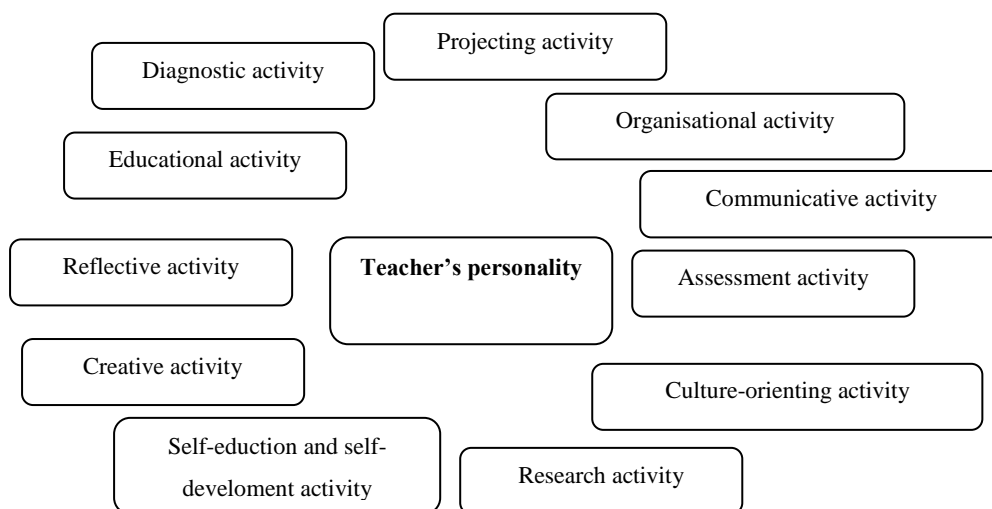


Figure 3 Structure of teacher's activity (Burceva et al., 2010)

Andersone (Andersone, 2010, pp. 12–13) made a review of teacher's professional competence research and development projects developed in Latvia from 2006 to 2008 and concluded that all of them pay attention to the following aspects of teacher's professional competence:

1. effective management of the teaching-learning process;
2. ability to cooperate;
3. ability to build positive and tolerance-based relationships with students, parents and colleagues;
4. ability to be responsible for one's own professional development.

I can assume that teaching competence can be connected specifically to the first aspect of teacher's profession.

Kalniņa (Burceva et al., 2010) is speaking about such component of teacher's pedagogical activity as organisation of the teaching-learning process²⁸. Thus, we can say that a teacher is expected to have '**competence for organising the teaching-learning process**'. The teaching-learning process (from Latvian, *mācību process*) is one of the main concepts of didactics (Žogla, 2001, p. 15). Taking into account that in the humanistic culture the didactics is viewed as a theory of the teaching-learning process oriented towards student's learning (Žogla, 2001, p. 15), we can say that in a

²⁸ From Latvian, *mācību procesa organizatora darbība*.

broader term competence for organising the teaching-learning process is '**didactic competence**'. The French scholar Yves Chevallard defines didactics as "*the science of the diffusion of knowledge in any institution, such as a class of pupils, society at large, etc. More particularly, didactics is the scientific study (and the knowledge resulting thereof) of the innumerable actions taken to provoke (or impede) the diffusion of such and such body of knowledge in such and such institution*" (Chevallard, 2007b). Interpreting this definition in the light of my research I can assume that the ability to put in action those actions which result in the diffusion of knowledge can be referred to as didactic competence. We can conclude that **didactic competence and teaching competence** are synonymous terms which are used in different countries by different researchers. However, I can also highlight that there is a difference between general didactics and didactics of a specific subject (for example, Maths). The term 'didactic competence' would normally refer to the general ability of organising the teaching-learning process, and when one wants to speak about the specific abilities connected to teaching this or that subject, specification of the subject would be required, for example, mathematical didactic competence. The term 'teaching competence' seems to include both general didactic competence and didactic competence of specific subject since it is define as "*complex combinations of knowledge, skills, understanding, values and attitudes, leading to effective action in situation*" (The European Commission, 2013, p. 8). And if we refer back to Table 12 above listing aspects and components of teacher competence we will see that subject-matter knowledge alongside with the pedagogical content knowledge and pedagogical knowledge are listed among 'knowledges' that are expected to be in a teachers' repertoire. Without having knowledge of the didactics of one's own subject it is close to impossible to organise the teaching-learning process itself. Therefore, using the term 'teaching competence' instead of 'didactic competence' seems to be a better approach. So for the purposes of my research I will privilege the term 'teaching competence'.

In order to further analyse teaching competence and speak about its structural components we have to understand a wider debate behind the notion of competence as such. What are the approaches for analysing 'competence'? And why when speaking about teacher competence we use the term 'competence' and when speaking about teaching competence, both the terms 'competence' and

'competences' are employed? The further sub-chapter aims to shed the light to these questions.

1.2. The Concept of Competence

The only definite conclusion that can be made after the review on the literature on the concept of competence is that there is no agreement among the scholars on its definition, and as some researchers claim (Stoof, Martens, Merriënboer, & Bastiaens, 2002, p. 345; Weinert, 2001, p. 6; Winterton, Delamare Le Deist, & Stringfellow, 2006, p. 29) "*there is no theoretical framework for competence*" (Stoof et al., 2002, p. 345). This is due to the historical and contextual background of the development of the concept. Moreover, the conceptual confusion is aggravated by terminological jumble between the term '*competence*' and '*competency*'. In order to understand which concept I can accept for the purposes of my own research, I will make a brief review of the existing conceptual views.

1.2.1. Competence as Superior Performance in Real-World Situations and Competency as an Underlying Characteristic of a Person which Results in Superior Performance

An American psychologist David McClelland is often cited as the founder of the competency movement²⁹ in the field of Human Resource Development in the USA.

²⁹ It should be noticed though, that a psychologist Robert W.White is often accredited with the introduction of the concept of competence in psychological literature. In his article "*Motivation Reconsidered: The Concept of Competence*" (White, 1959) White criticises existing theories of motivation which seek to explain an exploratory behaviour of a human being by primary drives, i.e. basic instincts, or by the urge to reduce anxiety. Instead, he offers to introduce the concept of competence into the discussion that he refers to as "*an organism's capacity to interact effectively with its environment.*"(White, 1959, p. 13 in kindle e-book). Competence is used as a general term which regroups various kinds of behaviour, such as grasping, exploring, crawling, walking, attention and perception, language and thinking, manipulating and changing the surroundings – all of which have to do with effective interaction with the environment. The question the researcher asks is what the nature of motivational aspect of competence is; in other words, what is the nature of the motive for this capacity of a human being to enter into the interaction with the environment from the very birth. So

He was one of the first to argue that one should not test for intelligence but rather for competence (McClelland, 1973), i.e. successful behaviour in real-life situations, since IQ tests are not valid predictors of job success. Hence, in this interpretation, **competence is conceptualised as** performance in real-world situations, “*person’s ability to perform*” (McClelland, 1973, p. 8). For the purposes of measuring competence, McClelland advocated for criterion sampling approach based on job analysis: “*If you want to know how well a person can drive a car (the criterion), sample his ability to do so by giving him a driver’s test [...] there is ample evidence that tests which sample job skills will predict proficiency on the job*” (McClelland, 1973, p. 7). Criterion sampling implies that researchers should get into the field and analyse performance into its components (competencies), which may include both rather traditional cognitive competencies (involving reading, writing, and calculating skills) and what traditionally have been called personality variables (for example, communication skills, patience, moderate goal setting, ego development) (McClelland, 1973). Hence, **competencies** in this context are seen as underlying cognitive and personal characteristics that are involved in performance.

It is worth mentioning, that McClelland and his followers (Boyatzis, 1982; Spencer & Spencer, 1993) further focused specifically on **superior** performance, i.e. successful and effective job performers. Hence, the concept of **competence** includes the trait of not merely acceptable performance but the effective one or the superior one – person’s ability to perform effectively or on the superior level. And a job **competency** in this case is defined as “*an underlying characteristic of an individual that is causally related to criterion-referenced effective and/or superior performance in a job or situation. Underlying characteristic means the competency is a fairly deep and enduring part of a person’s personality. [. . .] Causally related means that a competency causes or predicts behavior and performance. Criterion-referenced means that the competency actually predicts who does something well or poorly, as measured on a specific criterion or standard.*” (Spencer & Spencer, 1993, p. 9) As it

White treats competence as having a motivational aspect, and argues that “*the motivation needed to attain competence cannot be wholly derived from sources of energy currently conceptualized as drives or instincts*” (White, 1959, p. 19 in kindle e-book).

As it can be concluded from the given overview, even though White uses the term ‘competence’ his primary interest is in competence motivation contrasted to competence as achieved capacity. Moreover, his view of competence is very broad and includes all kinds of behaviours involved in interaction with environment.

can be deduced from the given definition, understanding of what it means to be competent does not come from the outside - from a group of experts deciding which functions, tasks and roles a competent professional should be able to perform – hence, this is not a functional job analysis. On the contrary, it comes from analysing a person, i.e. from identifying those abilities or characteristics that professionals possess and that are causally related to effective and/or superior performance in a job. Hence, a characteristic is an independent variable and a job performance is a dependent variable. A competency, which is essential to performing a job but is not causally related to superior performance, Richard Boyatzis (Boyatzis, 1982) called a **threshold competency**. Moreover, it is important to notice that to define a competency means to describe what a person **can** do and not necessarily what he does regardless of the situation and setting. In addition, competencies are connected to effective job performance, where effective performance means that actions are consistent with both job demands and organisational environment (see Figure 4).

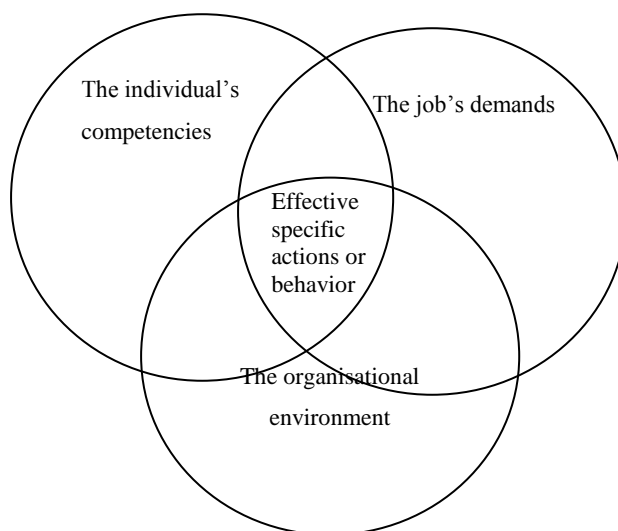


Figure 4 A model of effective job performance (Boyatzis, 1982, p. 13)

Boyatzis (Boyatzis, 1982, p. 40) analysed performance of 2000 managers coming from 12 organisations and representing 41 management jobs. The purpose of the study was to determine which characteristics of managers are related to effective performance in a variety of management jobs in various organisations. As a result

the researcher developed an integrated model of managerial competence that does not merely lists separate competencies but explains the relationship of these characteristics to each other, to the functions of the management job, and to the key aspects of the internal organizational environment.

Even though, the given competency movement in the USA is sometimes referred to as '*the behavioural approach*' (Delamare Le Deist & Winterton, 2005, p. 31), I would argue that it would be a wrong assumption to consider that it focuses only on measuring behaviour since the representatives of these movement clearly state that competencies can include "*motives, traits, self-concepts, attitudes or values, content knowledge, or cognitive or behavioral skills – any individual characteristic that can be measured or counted reliably and that can be shown to differentiate significantly between superior and average performers, or between effective and ineffective performers.*" (Spencer & Spencer, 1993, p. 4) Most probably, the term 'behavioural' is used to denote assessment of a person in action, in his performance, i.e. how certain competencies influence performance. Some German researchers (Klieme, Hartig, & Rauch, 2008, p. 7) refer to the given way of conceptualising competence as '*functional-pragmatic*' approach, meaning that competence relates to situations and demands in specific domains (competent for doing what?) and competencies themselves are context specific dispositions and hence can be acquired by learning³⁰. I assume that the given term better describes the USA competency movement than the misleading term '*behavioural approach*'.

Coming from this conceptualisation of competence, the researchers have developed specific methods for building competence models and measuring competencies (e.g. The Job Competence Assessment method (Boyatzis, 1982, p. 41), behavioural event interview (McClelland, 1998)). What is important to notice for the purposes of the

³⁰ As remarked by Klieme and colleagues (Klieme, Hartig, & Rauch, 2008, p. 8) the given functional-pragmatic concept of competence served as a useful foundation for the empirical assessment of educational outcomes, namely, for the Program for International Student Assessment (PISA). The reasons for this are at least twofold: first, competencies are viewed as context/content-specific dispositions that allow certain achievement and can be acquired through learning; secondly, competencies are connected to situations and demands in specific domains. Based on this functional approach of competencies, Franz Weinert (cited in Klieme et al., 2008, p. 9) suggested a concept of competence which should be used for large-scale assessments of educational outcomes: "*Competencies should be defined by the range of situations and tasks which have to be mastered, and assessment might be done by confronting the student with a sample of such (eventually simulated) situations. This kind of assessment should be of greater practical use because it goes beyond compartmentalized and inert knowledge.*" (Klieme et al., 2008, p. 9)

methodology is that the construction of a competence model does not start with experts defining what a person is supposed to do in order to be effective in a job or the analysis of job activities, but from the analysis of effective performers and identification and further clustering of their competencies (underlying characteristics) which distinguish them from average performers. This can be used if one's definition of competence implies superior performance and if competency is seen as an underlying characteristic of a person, hence, understanding competency requires observing successful and effective job performers with the aim of identifying abilities or characteristics that make them different from poor or less successful performers.

1.2.2. Core Competency as a Key Organisational Resource

If the so called 'functional-pragmatic' approach in Human Resource Development domain focus on individuals and their unique performance then the research in the domain of management theory analyse organisations and their strategies for improving their leadership in a market.

The concept of the **core competency** was introduced by Gary Hamel and C.K. Prahalad (Prahalad & Hamel, 1990) who, speaking about organisations competitiveness, suggest to think of it in terms of core competencies (singular, core competency)³¹, and not in terms of the price/performance of end products. Core competencies are defined as "*the company's collective knowledge about how to coordinate diverse production skills*" (Prahalad & Hamel, 1990, p. 79) and "*integrate multiple streams of technologies*" (Prahalad & Hamel, 1990, p. 83). It is also "*about the organisation of work and the delivery of value*" (Prahalad & Hamel, 1990, p. 84). In other words, these are internal corporate resources, a combination of business specialism and human skills that are required to sustain leadership in a particular class of product (both manufacturing and services) developed by a company. Competencies are unique to an organisation and make it stand out among other less successful organisations. These are specifically core competencies that allow an organisation to build leadership in the design and development of a particular class of

³¹ It is worth noticing that in the cited literature on core competency no clear distinction is made by the researchers between 'core competence' and 'core competency', who seem to use these terms interchangeably.

product. The distinction is made between core competencies, core products (the physical embodiments of one or more core competencies, the components that contribute to the value of an end product), and end products (the final product in the production of which at least one core product is used) (Prahalad & Hamel, 1990). Core competency is in a way linked to the notion of 'strategic intent' (Hamel & Prahalad, 1989) - an ambition to attain seemingly impossible goals, that is supported by strategic fostering and maintaining of the desire to succeed among employees by spreading the vision of global leadership. By focusing on core competencies the companies become what Quinn (Quinn, 1992) dubbed an 'intelligent enterprise'. The research on the methodology for building models of core competencies can be useful for the purposes of the research in educational management.

1.2.3. Competence as Performance to Occupational Standards

The given view on competence has been originally connected to the UK and is based on functional occupational (job-related) standards. Moreover, the discussion on competence as standards has been closely related to the vocational education and training (VET) since VET represents a link between education and the labour market. The given approach to the concept of competence has been sometimes called the '*functional approach*' (Delamare Le Deist & Winterton, 2005, p. 33) and it is said to influence similar developments in other countries of the EU.

As stated by Bob Mansfield (Mansfield, 2004) and Linda Miller (Miller, 1991, p. 11), occupational standards for competent performance in different sectors of industry were introduced in the UK in the 1980s as a response to deficiencies in skills formation and the lack of a clear system of National Vocational Qualifications (NVQs). The methodology adopted for obtaining descriptions of competent performance was Functional Analysis – a top-down approach which allowed to focus on 'outcomes' of successful performance³², i.e. what is required from a successful

³² 'Outcome' approach – as description of competent performance - is contrasted to 'input' approach which includes description of knowledge and skills.

workforce in terms of desirable outcomes that have to be achieved in this or that occupation (Mansfield & Mitchell, 1996; Miller, 1991). Functional Analysis proceeds from identifying *job functions* (or *key roles*) for certain occupational positions (e.g. managers³³); these *job functions* are broken down into a number of *units of competence*, further sub-divided into *elements of competence*. *Performance criteria* with *range indicators* are defined for each element of competence (see Table 6 as an example of managerial competences broken down into units); these form the basis of assessment of performance *in the workplace*. The approach is top-down because this is a group of industry representatives that participate in identifying key roles and breaking them down into individual units. As remarked by Miller (Miller, 1991, p. 12) the performance criteria is descriptive and not prescriptive since they describe the standards of performance that are expected from an employee but do not prescribe the techniques or processes by which an employee has to achieve that expected outcome. Defined occupational standards were translated into National Vocational Qualifications (NVQs) in the UK and allowed to speak about a competence-based approach to occupational standards and hence a competence-based approach to Vocational Education and Training (VET).

Table 6 Example of description of one function of managerial competence. Adapted from (Miller, 1991, p. 13)

Key role	Manage operations
Unit	2.1. Maintain and improve service and product operations
Element	2.1.2. Maintain operations to meet quality standards
Performance criteria	(a) All supplies necessary for operations are available and meet organisational/departmental requirements; (b) Operations within the manager's area of responsibility consistently meet design and delivery specifications; (c) etc.
Range indicators	Operations are all those activities within the manager's line responsibility. <ul style="list-style-type: none"> • Sources of supply (suppliers) are both: <ul style="list-style-type: none"> ○ external organisations ○ internal departments/teams • Supplies are <ul style="list-style-type: none"> ○ Material

³³ For instance, Miller (Miller, 1991, p. 14) states that using the information provided from industry, the Management Charter Initiative (Frank, 1991) derived a list of generic management standards, which included four main generic key roles (functions) a manager is involved in performing: manage operations, manage finance, manage people, manage information. These functions were further subdivided into competence units and elements. These competences are claimed to be generic (core) since irrespective of a specific context, a manager is involved in at least some of the four areas identified by functional analysis and hence has the responsibilities which can be measured through the identified outcomes.

	<ul style="list-style-type: none"> ○ equipment/technology ○ financial ○ subcontractors/consultants/agency staff ○ information <ul style="list-style-type: none"> ● etc.
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Occupational standards (or job-related standards) are defined as the outcomes which people are expected to achieve at work (Mansfield & Mitchell, 1996) and **competence** is then understood as the ability to perform to these standards, so we can refer to it as **functional competence**. As it can be seen, the concept of competence is not viewed from the perspective of a human's dispositions which helps him to achieve a superior performance but rather from the perspective of certain external expectations and is close to the concept of 'qualification'. **Competences**³⁴ are then seen as the outcomes of a competent performance. The structure of functional competence is an empirically supported description of units of competence, its elements, performance criteria and range indicators, and employers, such as trade unions, play an important role in their validation.

As argued by Bob Mansfield and Lindsay Mitchell (Mansfield, 1993; Mansfield & Mitchell, 1996), initially, occupational standards merely described specific occupational skills and the performance of tasks, which depicted a narrow view of competence involving instruction in routine tasks and isolated technical skills. This proved to be inadequate for meeting the new demands and needs of employment. Hence, they developed a new model of occupational competence - the **Job Competence Model** – which added core and key skills to the routine technical skills and thus exited the deficient narrow view of competence.

Le Deist and her colleagues (Delamare Le Deist & Winterton, 2005, p. 36) remark though, that nowadays the concept of competence used by the researchers in the UK is broadened and includes both 'input' dimension (knowledge, skills, understanding) and 'outcome' dimension (functional competences).

Functional job analysis is useful for identifying the main functions within which a professional has to operate, tasks he is expected to perform and roles (a set of activities or responsibilities (Boyatzis, 1982, p. 17)) expected of a person in a particular job. It allows drawing a framework within which a person is operating in a

³⁴ The term '*competency*' or its plural form '*competencies*' is not originally used at all in this case.

job environment and thus answering a question – what are the functions and the domains within which a person is expected to perform.

1.2.4. Competence as a Person's Ability to Use Knowledge, Skills and Behaviour in a Work Context and Competence as Responsibility and Autonomy

As mentioned above, the concept of competence is closely related to vocational education, especially in the current context of a common European space.

EU member states developed a common European credit transfer system for VET (ECVET) that is compatible with the existing European credit transfer system (ECTS) in higher education that allows transparency and recognition of vocational qualifications among the member states (European Union, 2009).

The European Centre for the Development of Vocational Training (CEDEFOP - Centre Européen pour le Développement de la Formation Professionnelle) commissioned several reports to address the issue of developing ECVET. One of these reports (Winterton et al., 2006) focused on a typology of learning outcomes about knowledge, skills and competences (KSCs). As a result, the researchers (Winterton et al., 2006, p. 60) distinguished four dimensions of competence in a unified typology of knowledge, skills and competences (KSCs) (see Figure 5) and offered a holistic model of competence (see Figure 6). According to the offered typology and model, cognitive competence includes knowledge and understanding; functional competence captures skills, whereas social competence includes attitudes and behaviours. As argued by the researchers (Delamare Le Deist & Winterton, 2005, p. 39; Winterton et al., 2006, p. 59) these first three dimensions are rather universal and consistent with the French approach to competence described as *savoir*, *savoir faire*, and *savoir être*³⁵, as well as with the knowledge, skills and attitudes (KSA) derived from Bloom's taxonomy of learning.

³⁵ *Savoir* (knowledge; know-what), *savoir faire* (skills; know-how), *savoir être* (know-how-to-be)

<i>conceptual</i>	<i>occupational</i> cognitive competence (knowledge)	<i>personal</i> meta-competence (facilitating learning)
<i>operational</i>	functional competence (skills)	social competence (attitudes and behaviours)

Figure 5 Unified typology of KSCs (Winterton et al., 2006, p. 60)

Meta-competence, on the other hand, is concerned with facilitating the acquisition of the other competences. According to the authors, the given typology is useful not only for describing a person's underlying knowledge, functional skills and social behaviour that make him effective at work, but also for describing in multi-dimensional terms competences required for an occupation (in case of the functional approach prevalent in the UK).

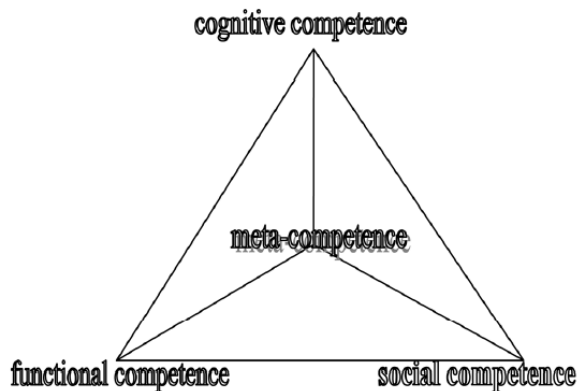


Figure 6 Holistic model of competence (Delamare Le Deist & Winterton, 2005, p. 40)

It is worth mentioning here that the Copenhagen process technical working group (TWG) on credit transfer, which was established in November 2002, developed proposals for the principles of a European credit transfer system for VET (ECVET). These principles were endorsed in December 2004 by the Maastricht communiqué (The European Commission, 2004). For the purposes of ECVET system, the technical working group (TWG) decided to retain the terms 'knowledge, skills and competences' (KSCs) as a unified statement. The term 'competences' in this context would include what Jonathan Winterton and his colleagues (Winterton et al., 2006)

call 'social competence'. However, the researchers (Winterton et al., 2006, p. 60) warned against using the term 'competences' as a short-hand for social competence since it could potentially cause conceptual confusions³⁶. Instead, they suggested ECVET adopts the offered terminology of cognitive competence, functional competence and social competence and includes meta-competence within the social competences category. However, as it can be seen from further developments, namely the development of the European Qualifications Framework (EQF), the terms 'knowledge, skills and competences' (KSCs) were retained as a unified statement³⁷. In the recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning **competence** is defined as "*the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development.*" (European Union, 2008, p. C 111/4) And in the context of EQF, the eight common European reference levels are described in terms of learning outcomes:

- knowledge - described as theoretical and/or factual;
- skills - described as cognitive (involving the use of logical, intuitive and creative thinking), and practical (involving manual dexterity and the use of methods, materials, tools and instruments)
- competence - described in terms of responsibility and autonomy.

I can conclude that the given situation only adds to the confusion of the concept of competence. In the context of the given paper, it is important to be aware of these notions and possible confusions; however, the conceptualisation of competence aimed at finding common reference levels is out of the scope of the given paper.

³⁶ As claimed by Winterton and his colleagues (Winterton, Delamare Le Deist, & Stringfellow, 2006, p. 60), the term competence alone is too broad. It is commonly used as a term for demonstrating knowledge (cognitive competence), skills (functional competence) and appropriate behaviour and attitude (social competences) in a *work context*. And depending on the domain and the country can acquire different meanings.

³⁷ Both ECTS and ECVET comply with the European Qualifications Framework (EQF). The EQF is a tool that helps communication and comparison between qualifications systems in Europe. EQF offers eight common European reference levels which allow interested parties to understand and compare qualifications awarded in different countries and by different education and training systems. These eight levels are described in terms of learning outcomes: knowledge, skills and competences.

The general tendency nowadays is to view competence as a holistic concept (a holistic model of competence represented in Figure 6 above). Some researchers call it an integrated approach (Hager, 1994) and claim that traditional competency standards view is useful since standards provide a clear statement of what is considered to be important for competent performance in a specific domain. However, these have to be complemented by integration of knowledge, abilities, skills and attitudes displayed in the context of realistic professional tasks. The trend of viewing competence as a holistic concept first originated in France and Germany and gradually spread to other countries.

1.2.5. Competences/ies as Context-Independent Generic Skills Underlying Context-Specific Performance

Acknowledging the complexity of the modern world and the need to identify a set of the most relevant competencies that can help individuals to face the complex challenges of today's world, which as a result will have a positive impact on social and economic environment, the OECD member countries launched a Definition and Selection of Competencies (DeSeCo) project (OECD, 2001; Dominique S. Rychen & Salganik, 2000, 2003). In a framework of the given project, **a competency** is viewed as the ability to successfully meet complex demands in a particular context by drawing on and mobilizing knowledge, cognitive and practical skills, as well as psychological resources and social and behaviour components such as attitudes, emotions, values and motivations (Dominique S. Rychen & Salganik, 2003, p. 4) **Key competencies or transversal competencies** are those which meet the following demands:

- Contribute to valued outcomes for societies and individuals;
- Help individuals meet important demands in a wide variety of contexts; and
- Be important not just for specialists but for all individuals.

As a result, a group of experts in consultations with the interested and competent parties build a framework of key competencies that correspond to the defined criteria.

These competencies are classified in three broad categories (Figure 7). However, it is important to point out that at the centre of this framework is reflectiveness, reflective thought and action. Reflectiveness implies “*the use of metacognitive skills (thinking about thinking), creative abilities and taking a critical stance. It is not just about how individuals think, but also about how they construct experience more generally, including their thoughts, feelings and social relations.*” (Dominique S. Rychen & Salganik, 2003, p. 9)

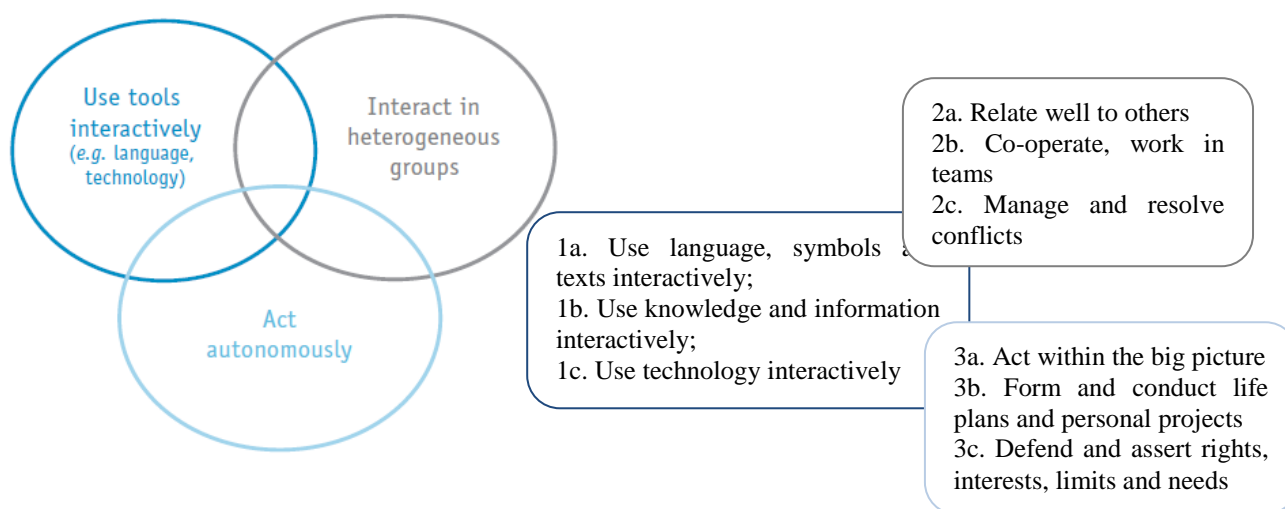


Figure 7 Key Competencies in Three Broad Categories (Dominique S. Rychen & Salganik, 2003, p. 5)

Hence, key competencies in the given context are seen as generic abilities of a person which are context-independent and are indispensable characteristics of a person who wants to be successful in meeting the challenges of the 21st century. They are called transversal or key because they are not directly dependent on any domain but are indispensable for operating qualitatively in specific domains.

Driven by the same need to foster competences that bring benefits to individuals and the society in a wide spectrum of contexts, the European Commission has also been working on strengthening the promotion and development of **key competences** throughout Europe. In contrast to the OECD context where the term ‘key competencies’ is used, the educational initiatives launched and supported by the European Union employ the term ‘key competences’, **Competences** in the given context are defined as “*a combination of knowledge, skills and attitudes appropriate*

to the context. Key competences are those which all individuals need for personal fulfilment and development, active citizenship, social, inclusion and employment.” (European Union, 2006a, p. 3, 2006b, p. L 394/13) The developed European reference framework on key competences defines eight key competences and describes the essential knowledge, skills and attitudes related to each of these:

- communication in the mother tongue;
- communication in foreign languages;
- mathematical competence and basic competences in science and technology;
- digital competence;
- learning to learn;
- social and civic competences;
- sense of initiative and entrepreneurship;
- cultural awareness and expression

The key competences initiative keeps being developed in Europe and is featured in the Education and Training 2010 work programme as well as featured in the development of national educational standards that are developed in European member states. Moreover, a European policy network KeyCoNet – Key Competency Network – has now been focusing on identifying and analyzing initiatives on the implementation of key competences in primary and secondary school education throughout Europe (Grayson, 2014; Pepper, 2013).

1.2.6. Competence as an Analytical Category or as an Ultimate Educational Goal

Latvian researchers (Maslo, 2006; Maslo & Tīļa, 2005; Tīļa, 2005) distinguish between competence as an analytical category of educational quality, a strategic aim, and competence as an ultimate ideal of personal development, or an ultimate upbringing/educational goal.³⁸

³⁸ From Latvian, “audzināšanas ideāls”

As analytical category, competence is used to define the result, the quality level of certain activity. It manifests itself in specific situation and can be characterised as high - low, or basic, independent, and proficient (Maslo, 2006, p. 54; Maslo & Tīļa, 2005, p. 7). Using competence as an analytical category requires educational results to be formulated as actions³⁹ (such as, draws, describes, understands, uses, is able to, analyses, assesses, gets involved, etc.), which means that this is not only knowledge and skills which can be assessed in action but also learners' motivation, responsibility, creativity, etc. (Maslo, 2006, p. 52).

On the other hand, as the ultimate educational goal, competence is defined as “*a unique combination of a set of abilities and experience acquired through personal experiences a person has been confronted with. Competence is constantly evolving since both abilities and experience are in constant development alongside new experiential possibilities*”⁴⁰ (Maslo & Tīļa, 2005, p. 7 translated by RJ). Viewed from this perspective, it is connected to the subject (to the individual) and his individual potential, i.e. abilities acquired through available experience. Competence is hence connected to a set of abilities (individual potential) that can be acquired and improved throughout lifetime through different life situations. Moreover, it is connected to activity for reaching personally meaningful aims. Since every human being has a distinct, unique potential, in order to define the essence of competence it is important to view an individual combination of its components: interplay of subjective (cognitive, emotional, volitional, physical and social skills) and objective (self-experience, experience of others, world experience) structural content components (ibid). The given view of competence is mainly based on the ideas of German scholars, such as pedagogical theorist Klaus Mollenhauer, sociologist and philosopher Jürgen Habermas, as well as contemporary educational professionals such as Frank Michael Orthey, Gerd Mutz, Annegret Eickhorst, etc.

Competence as the ultimate educational ideal is contrasted to the concept of competence as a skill, used in the Anglo-Saxon educational literature in the 70s and competence as qualification, used in the 80s-90s (Maslo, 2006; Maslo & Tīļa, 2005),

³⁹ From Latvian, “darbība”

⁴⁰ From Latvian “[...] kompetence kā audzināšanas ideāls ir pieredzes gūšanas iespējās pamatota spēju un pieredzes individuālā kombinācija. Procesuālajā izpratnē tā nepārtraukti pilnīgojas, jo spējas attīstās mūžīgi, pilnveidojas pieredze un rodas arvien jaunas pieredzes gūšanas iespējas”

which basically corresponds to the view on competence as performance to occupational standards discussed above.

1.2.7. Competence as a Continuum and the Call for a Constructivist Approach

In addition to the holistic view of competence which is trying to break the dichotomy between behavioural assessment in real-life situations or analytical assessment of dispositions that underlies such behaviour, Sigrid Blömeke and her colleagues (Blömeke, Gustafsson, & Shavelson, 2015) highlight that an important question, which is often overlooked in discussions on competence is **how** a person who possesses all the relevant competencies for a competent performance is able to put together competencies to arrive at performance: “*Which processes connect cognition and volition-affect-motivation on the one hand and performance on the other hand?*” (Blömeke et al., 2015, p. 7) The researcher suggests that possible processes may include perception, interpretation of a specific job situation, and decision-making, and encourages to view **competence as a process**, a continuum **with many processes that mediate between disposition and performance** (see Figure 8) and these are these processes that should come to the foreground of research on competence in higher education.

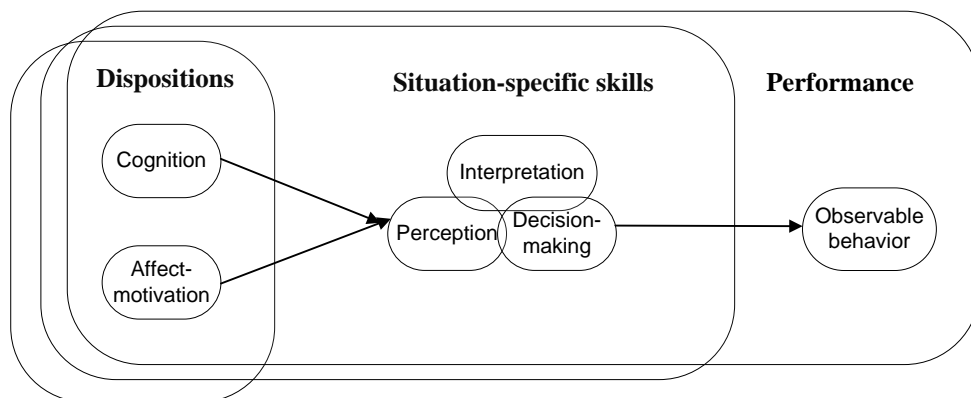


Figure 8 Modelling competence as a continuum (Blömeke et al., 2015, p. 7)

In the light of the debates around the concept of competence, mutual criticism and the quest for its one absolute meaning, some scholars (Stoof et al., 2002) propose a constructivist approach to the definition of competence claiming that in the search for the best definition attention should be redirected to people's own situation and needs instead of search for the absolute meaning. The scholars claim viability to be the most essential criterion in competence definition: "*the criterion for a competence definition is not whether the definition is true but the extent to which the constructed definition has proved to be adequate in the context in which it is used*" (Stoof et al., 2002, p. 347) The authors offer three variables which increase the viability of a competence definition:

1. people – constructing a definition agreed on among the involved stakeholders;
2. goal – constructing a definition specific for the purpose of its application, i.e. what is the definition going to be used for? Too global and abstract definitions that cover a whole range of possible applications decrease the viability of the concept;
3. context – constructing a definition that fits into existing organisational processes and is easy to handle by intended users.

Hence, while shaping the definition of competence it is not necessary to search for fit-for-all model but rather build a definition that would correspond to the research goals and fit its context.

After undertaking the given analysis on the concept of competence, I can make several conclusions on the concepts which I will be using for the purposes of my research. Doing this will allow me to proceed with the analysis of the structural components of teaching competence.

1.3. Preliminary Conclusions

Conclusion 1

The concept of competence (competency, competencies, competences) in educational context is both very popular and highly complex an issue. The reasons for this are at least two-fold. Firstly, the concept originated in different countries simultaneously (*USA, UK, France, Germany and Austria and other EU countries*), thus being influenced by different theoretical views, and secondly, it was developed in different domains (*human resource development, management, vocational education, general education*), each of which having its own focus in how the concept is looked upon.

In the framework of my research I will be using the concept of competence as an analytical category which will require me to describe teaching competences as actions: understands, uses, is able to, analyses, assesses, etc. Since competence will be viewed as a holistic concept, these actions can describe knowledge (cognitive competence), skills (functional competence), attitudes, behaviours and beliefs (social competence), as well as values (values/ethical competence) and even meta-competences.

Competence is connected to real-life situations, specific demands of specific field and activity of an individual. Understanding specific, real job can be done through a list of professional tasks or situations, cognition, affect and motivation involved in effective performance of that job and connected to professional outcomes.

Conclusion 2

Taking into account the fuzzy line between the terms 'competence' and 'competency' (plural form, *competences* or *competencies*), it is convenient to set a clear distinction between the two terms that I apply in this paper.

In the framework of the given research, **competence** will be seen as a broader term, as a large-scale characteristic, capability or attribute (Blömeke et al., 2015, p. 5; Sadler, 2013, p. 13). A **competency**, on the other hand, is a smaller-scale,

identifiable, contributing element or different components of competence (ibid.). *Competence* consists of a large number of *competencies (competences)*, and these *competencies* can be tested by objective means. Having *competence* in performing a particular professional function implies mastering a number of relevant *competencies*⁴¹. For instance, a competent professional is said to have competence in a specific field, and when he puts his competence into practice he orchestrates numerous competencies. Smaller competencies are grouped into components of competence.

At the same time, it is worth noticing that competencies are not used as a synonym of a skill since they comprise not only skills, but also knowledge, beliefs, values and other relevant characteristics, which a person orchestrates when showing competent performance of a professional task.

In respect to **teacher competence**, the term 'competence' is used since it is one unity made up of several components, including teaching competence which is connected to teacher's task of organising the teaching-learning process in the classroom. **Teaching competence** refers to a teacher's ability to organise the teaching-learning process. It is competence directly connected to teacher's basic task that of teaching. Teaching competence is made up of its own components, namely **teaching competences**, which are smaller units, different identifiable components of teaching competence. So 'teaching competence' refers to a teacher's general ability to organise the teaching-learning process, while teaching competences are its small, identifiable constituent elements.

⁴¹ The given distinction raises an important question of whether competence can be decomposed into underlying parts – competencies – or whether it involves something more since the whole does not equate to the sum of its parts. Even though decomposing competence into manageable parts can be useful for certain purposes and is often used for measuring competence, Sadler (Sadler, 2013) advocates for more integrative conceptualisation and measurement of competence. The researcher (Sadler, 2013, p. 21) conceptualises **competence as** an ability to select and orchestrate a set of acquired competencies to serve a particular purpose within a particular context and remarks that these are extra qualities lying at a higher level than the specified set of basic competencies which allow a person to understand a particular context or complex situation within which (s)he operates and to orchestrate the various competencies to respond efficiently to that situation .

Conclusion 3

In the given research '**teacher competence**' is seen as "*a combination of knowledge, skills and attitudes appropriate to the context*" (European Union, 2006b, p. 394/13), namely the profession of a teacher.

And **teaching competence** is defined as "*complex combinations of knowledge, skills, understanding, values and attitudes, leading to effective action in situation*" (The European Commission, 2013, p. 8), namely, action related to classroom instruction.

In a certain way, teaching competence is synonymous to the concept of **didactic competence**.

Teaching competences are seen as small identifiable structural units of teaching competence which can be grouped into larger components.

Having said that, I can now proceed towards the analysis of the components of teaching competence.

1.4. Structural Components of Teaching Competence

Having concluded that teaching competence consists of a set of competences that can be grouped into components the next objective is to identify these structural components and their competencies and to make their comprehensive synthesis.

The analysis of teacher competence and teaching competence undertaken above allows me to define three main areas of teaching competence. The teacher is expected to be able to:

1. plan and prepare the teaching-learning process;
2. organise/manage/coordinate the teaching-learning process, i.e. classroom instruction ;
3. assess/evaluate the teaching-learning process.

Each area has a set of competences, either specific to it or common for several areas. For example, as can be seen from the synthesis of teaching competences

presented in Table 7, the competences connected to setting the teaching-learning aim and objectives are relevant for both planning stage of the teaching-learning process and its execution, at the same time the component connected to adapting the teaching-learning process depending on how it unfolds goes exclusively under the domain of organisation.

Table 7 The first synthesis of the main components of teaching competences

Main components of teaching competences	Main areas of teaching competences		
	Plan and Prepare	Organise	Assess
Formulates and achieves aims of the teaching-learning process			
Formulates and achieves objectives of the teaching-learning process			
Selects and uses materials/resources for the teaching learning process			
Selects and applies the methods of teaching			
Adapts the teaching-learning process depending on the situation			
Creates positive learning environment <ul style="list-style-type: none"> • Motivates learners • Builds positive relationships with learners 			
Uses different methods of assessing students work			
Assesses the results and processes of the organised teaching-learning process (having critical attitudes to one's own teaching)			
Regulates one's own emotional balance including in the cases of problem situations (self-regulatory, self-management abilities)			

The given list is not exhaustive and consists only of those components which were identified in the literature analysed in chapters above and considered functionally more closely related to the process of teaching. One can argue that some important competences were left out, such as for example, teacher's ability to develop learners' ability to learn. On the one hand I can agree that the given competency is important. At the same time, I am more focused on operational and observable competences, those which as a result allow us to assume a teacher has more abstractly defined competence, such as the one which develops learners' ability to learn.

If we try to match relevant knowledge to each component of competence, we can say that subject-matter knowledge (or knowledge of content) as well as pedagogical content knowledge would be required for setting aims and objectives and selecting

appropriate teaching materials. And pedagogical knowledge would be mostly required for selecting teaching methods and putting them into practice.

The defined above components of teaching competences are rather general and do not cover all the essential competences. However, they lay the foundation of the theoretical framework of this research which will be developed further.

In the quest for components of teaching competences I turn to the study of literature on teaching effectiveness, which will add new components to the developed theoretical framework.

1.4.1. Teaching Competences for Teaching Effectiveness

Many international reports and educational policy documents have acknowledged the quality of teaching and teacher education as a key factor in securing the quality of education⁴²:

⁴² The given conclusions were made based on the review of the research. Some research cited in the documents include the following and can be consulted for further details (a non-exhaustive list):

- a. Shulman, L. (1987), "Knowledge and Teaching: Foundations of the New Reform", *Harvard Educational Review*, No. 57 (1), pp. 1-22.
- b. Creemers, B.P.M. (1994) *The effective classroom*. London: Cassell.
- c. Sanders W.L., Rivers J.C. (1996). *Cumulative and residual effects of teachers on future student academic achievement (Research Progress Report)*. Knoxville, TN: University of Tennessee Value-Added Research and Assessment Center.
- d. Scheerens, J. and R.J. Bosker (1997), *The Foundations of Educational Effectiveness*, Pergamon, Oxford.
- e. Darling-Hammond, L. (2000). *Teacher quality and student achievement: A review of state policy evidence*. In *Educational Policy Analysis Archives*, 8(1).
- f. Angrist and Lavy, (2001), *Does Teacher Training Affect Pupil Learning? Evidence from Matched Comparisons in Jerusalem Public Schools* *Journal of Labor Economics*, 19, 2, 343-69
- g. Rivkin, S., E. Hanushek and J. Kain (2001), "Teachers, Schools, and Academic Achievement", Working Paper 6691 (revised), National Bureau of Economic Research, Cambridge, MA.
- h. Santiago, P. (2002), "Teacher Demand and Supply: Improving Teaching Quality and Addressing Teacher Shortages", *OECD Education Working Paper*, No.1, OECD, Paris.
- i. Campbell, A., O. McNamara and P. Gilroy (2004), *Practitioner Research and Professional Development in Education*, Chapman, London.
- j. Eide, E., D. Goldhaber and D. Brewer (2004), "The Teacher Labour Market and Teacher Quality", *Oxford Review of Economic Policy*, 20 (2), pp. 230-44.
- k. Rockoff, J. (2004), "The Impact of Individual Teachers on Student Achievement: Evidence from Panel Data", *American Economic Review*, 94 (2), pp. 247-52.
- l. Schacter, J. and Y. Thum (2004), "Paying for High and Low-quality Teaching", *Economics of Education Review*, 23, pp. 411-430

1. In his review on teacher effectiveness "*Increasing teacher effectiveness*" which publication was supported by UNESCO International Institute for Educational Planning, professor Lorin Anderson of the University of South Carolina, USA, acknowledges that a growing body of the research suggests "*that schools can make a great difference in terms of student achievement, and a substantial portion of that difference is attributable to teachers. [...] differential teacher effectiveness is a strong determinant of differences in student learning, far outweighing the effects of differences in class size and class heterogeneity*" (Anderson, 2004, p. 20).
2. The OECD report "*Teachers Matter: Attracting, Developing and Retaining Effective Teachers*" acknowledges that substantial research indicates that "*factors involving teachers and teaching are the most important influences on student learning. In particular, the broad consensus is that "teacher quality" is the single most important school variable influencing student achievement*" (OECD, 2005, p. 26)⁴³
3. In the communication from the Commission to the Council and the European Parliament "*Improving the Quality of Teacher Education*" has acknowledged that "*research shows that teacher quality is significantly and positively correlated with pupil attainment and that it is the most important within-school aspect explaining student performance (its effects are much larger than the effects of school*

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- m. Darling Hammond et al. (2005), Does teacher preparation matter? Evidence about teacher certification, Teach for America, and teacher effectiveness. Education Policy Analysis Archives, 13(42) 16-17, 20
 - n. Hanushek, Kain and Rivkin (2005), 'Teachers, Schools, and Academic Achievement'.
 - o. Baumert, J. and M. Kunter (2006), "Stichwort: Professionelle Kompetenz von Lehrkräften", Zeitschrift für Erziehungswissenschaft, No.9 (4), pp. 469-520.
 - p. Konstantopoulos, S. (2007) How long do teacher effects persist? Bonn: Institute for the Study of Labor (IZA).
 - q. Creemers, B.P.M. & Kyriakides, L. (2008) The dynamics of educational effectiveness. New York: Routledge.
 - r. Kyriakides, L. & Creemers, B.P. (2008a) 'Using a multidimensional approach to measure the impact of classroom-level factors upon student achievement: a study testing the validity of the dynamic model'. School effectiveness and school improvement, 19(2), 183-205.
 - s. Kyriakides, L. & Creemers, B.P. (2008b) 'A longitudinal study on the stability over time of school and teacher effects on student outcomes'. Oxford review of education, 34(5), 521-545.
 - t. Hattie, J. (2009) Visible learning: a synthesis of over 800 meta-analyses relating to achievement. Abingdon: Routledge.

⁴³ The report also acknowledges that "*the largest source of variation in student learning is attributable to differences in what students bring to school – their abilities and attitudes, and family and community background.*" (OECD, 2005, p. 26) However, these factors are difficult for policy makers to influence, at least in the short-run.

organisation, leadership or financial conditions).” (The European Commission, 2007, p. 3)

4. The OECD report “*Creating effective teaching and learning environments. First results from TALIS*” acknowledges the research findings proving that “*professional competence is believed to be a crucial factor in classroom and school practices*” (OECD, 2009, p. 89) and the quality of instruction is fundamental to students learning, having even a greater effect on student achievement than characteristics of the school environment (Scheerens and Bosker, 1997 cited in OECD, 2009, p. 97)
5. Finally, in their exhaustive review of research on effective teaching, James Ko and Pamela Sammons sum up that “*much of the research evidence to date on educational effectiveness suggests that: while schools can make a difference to student achievement, the most substantial portion of that difference may be attributed to teachers*” (Ko, Sammons, & Bakkum, 2013, p. 25).

It should, however, be noticed that some empirical reviews (Coe, Aloisi, Higgins, & Major, 2014, p. 9) point at the research which invites to exercise some caution in interpreting claims about effect of the teacher⁴⁴. As mentioned elsewhere, students’ achievement can be influenced by many factors, including characteristics of students themselves, a school and a context. Nevertheless, it is unreasonable to neglect the results of the growing research, which allows us to make a tentative assumption of effect of teacher quality on students’ learning, since the data often shows that

⁴⁴ Some research cited in the review include the following and can be consulted for further details:

- a) Raudenbush, S.W. (2004), ‘What Are Value-added Models Estimating and What Does This Imply for Statistical Practice?’, *Journal of Educational and Behavioral Statistics* 29(1):121–129.
- b) Hamre, B.K., Goffin, S.G. & Kraft-Sayre, M. (2009) *Classroom Assessment Scoring System Implementation Guide: Measuring and Improving Classroom Interactions in Early Classroom Settings*.
- c) Newton, X. A., Darling-Hammond, L., Haertel, E., & Thomas, E. (2010). *Value-Added Modeling of Teacher Effectiveness: An Exploration of Stability across Models and Contexts*. *Education Policy Analysis Archives*, 18(23), n23.
- d) Hill, H. C., Kapitula, L., & Umland, K. (2011). A validity argument approach to evaluating teacher value-added scores. *American Educational Research Journal*, 48(3), 794-831.
- e) Strong, M., Gargani, J., & Hacifazlioglu, O. (2011). Do we know a successful teacher when we see one? Experiments in the identification of effective teachers. *Journal of Teacher Education*, 62(4), 367–382.
- f) Dumay, X., Coe, R., and Anumendem, D. (2013) ‘Stability over time of different methods of estimating school performance’. *School Effectiveness and School Improvement*, vol 25, no 1, pp 65-82.

“differences in student performance are often greater within schools than between schools” (OECD, 2005, p. 12).

Assuming these are teachers who bring the essential difference into the teaching-learning process, it is important to understand which teaching competences are put into the foreground that are considered to play a more important role in helping a teacher to lead students to successful learning. The research on teacher effectiveness should help me to find the answer to this question. Three international reviews and reports (Anderson, 2004; Coe et al., 2014; McBer, 2000) were studied in order to reach this objective.

First of all, the research on effective teaching defines teaching effectiveness as teacher behaviours and classroom processes *“which lead(s) to improved student achievement using outcomes that matter to their future success”* (Coe et al., 2014, p. 2). The possession of knowledge and skills is referred to as ‘teacher competence’, their use as ‘teacher performance’, and ‘teacher effectiveness’ links *“teacher competence and teacher performance with the accomplishment of teacher goals (that is, ‘teacher effectiveness’)”* (Anderson, 2004, pp. 22–23). Ko and his colleagues (Ko et al., 2013, p. 6) remark, that the term ‘teacher effectiveness’ have been often used interchangeably with such terms as ‘instructional effectiveness’ and ‘teaching effectiveness’. This is due to the fact that the primary nature of a teacher’s work is instructional and that teaching and instruction is generally carried in the classroom.

It is worth noticing that the reports acknowledge all the complexities connected to linking identifiable teacher classroom behaviours to improved students’ outcomes. First of all, it is acknowledged (Coe et al., 2014, p. 9) that in addition to teacher effect a number of other factors may influence the result, such as characteristics of students, school and context. Moreover, since the whole is always greater than the sum of its parts, dividing teacher’s behaviour into small constituent components may be too limited a view, which does not really say anything on how teachers make choices on which competences to orchestrate and why. Nevertheless, it is important not to neglect that certain behaviours lead to more effective student learning than others.

Anderson (Anderson, 2004, p. 24) also remarks that teachers cannot be effective in every aspect of their work and that their effectiveness can depend both on the goals that teachers pursue or the characteristics of the students being taught. For example, a teacher may be successful in teaching a certain topic to his students and fail with another topic. Likewise, a teacher can deal perfectly well with less able students and experience difficulties with providing challenge to more able students. Nevertheless, it is reasonable to assume that ‘effective teachers’ are more consistent in achieving successful results in terms of students learning, despite classroom conditions, time and goals they pursue.

In the report for the Department of Education and Employment (UK), McBer (McBer, 2000) provides the analysis and conclusion on the research on teacher effectiveness undertaken in the UK. The scholars collected data (both on teachers’ practices and students’ progress) from around 80 schools and analysed it in order to create a description of teacher effectiveness based on evidence. The scholars identified three main factors within teachers’ control that significantly influence pupil progress. Each factor includes a set of behaviours grouped in several clusters:

- **Factor 1. Teaching skills** – teacher’s classroom ‘micro-behaviours’, that the teacher constantly exhibits when teaching a class i.e. teaching strategies and techniques that can be observed when teachers are at work in the classroom. Teaching skills are clustered under seven headings and some key questions can be asked in order to identify whether a certain skill manifests itself in teacher’s practice or not (Table 8).

Table 8 Teaching skills (McBer, 2000)

Name of group of teaching skills	Key questions to identify if the skill is present
High expectations	Does the teacher encourage high standards of effort?, accuracy?, presentation? Does the teacher use differentiation appropriately to challenge all pupils in the class? Does the teacher vary motivational strategies for different individuals? Does the teacher provide opportunities for students to take responsibility for their own learning? Does the teacher draw on pupil experiences or ideas relevant to the lesson?
Planning	Does the teacher communicate a clear plan and objectives for the lesson at the start of the lesson? Does the teacher have the necessary materials and resources ready for the class?

	Does the teacher link lesson objectives to the National Curriculum? Does the teacher review what pupils have learned at the end of the lesson?
Methods and strategies	Does the teacher involve all pupils in the lesson? Does the teacher use a variety of activities/learning methods? Does the teacher apply teaching methods appropriate to the National Curriculum objectives? Does the teacher use a variety of questioning techniques to probe pupils' knowledge and understanding? Does the teacher encourage pupils to use a variety of problem solving techniques? Does the teacher give clear instructions and explanations? Does practical activity have a clear purpose in improving pupils' understanding or achievement? Does the teacher listen and respond to pupils?
Pupil management/Discipline	Does the teacher keep the pupils on task throughout the lesson? Does the teacher correct bad behaviour immediately? Does the teacher praise good achievement and effort? Does the teacher treat different children fairly? Does the teacher manage non-pupils (support teachers/staff) well?
Time and Resource Management	Does the teacher structure the lesson to use the time available well? Does the lesson last for the planned time? Are appropriate learning resources used to enhance pupils' opportunities? Does the teacher use an appropriate pace? Does the teacher allocate his/her time fairly amongst pupils?
Assessment	Does the teacher focus on understanding and meaning?, factual memory?, skills mastery?, applications in real-life settings? Does the teacher use tests, competitions, etc. to assess understanding? Does the teacher recognise misconceptions and clear them up? Is there evidence of pupils' written work having been marked or otherwise assessed? Does the teacher encourage pupils to do better next time?
Homework	Is homework set either to consolidate or extend the coverage of the lesson? Is homework which had been set previously followed up in the lesson? Does the teacher explain what learning objectives pupils will gain from homework?
Time on task and lesson flow	Is there an appropriate balance between different lesson stages: whole time interactive, whole class lecture, individual work, collaborative group work, classroom management, testing/assessment? Are the majority of students (over 90%) on task throughout the lesson?

- **Factor 2. Professional characteristics** – ongoing and deep-seated patterns of behaviour, the way the teacher habitually approaches situations. These characteristics have to do with self-image, values and at the deepest level the motivation that drives performance. These characteristics fall into five clusters (Table 9)

Anderson (Anderson, 2004, p. 22) remarks that there is no direct influence of these teacher characteristics on teacher effectiveness. Rather, teacher characteristics (what teachers are) have effect on the way in which teachers organise their classroom and operate within them (what teachers do). And this is the latter which has direct effect on how much students learn.

Table 9 Description of teacher's professional characteristics (McBer, 2000)

Title of cluster	Title of professional characteristics and key question	Description of characteristics depending on the level
Professionalism	<p><u>Respect for others:</u> Does the teacher show respect and consideration for others?</p>	<p><u>Level 1. Listens</u> Actively listens to pupils and others. Does not interrupt. Shows interest in, and acknowledges, what others say.</p> <p><u>Level 2. Values others</u> Behaves in a way which shows pupils or others that they are valued as individuals, and for what they contribute. Gives repeated messages about this.</p> <p><u>Level 3. Values others despite provocation</u> Acts in a way which shows pupils or others that they are still valued, even when they have done something unacceptable. Maintains positive expectations against the odds.</p> <p><u>Level 4. Creates a community where there is mutual respect</u> Takes a number of steps over time to create a feeling of community in the class or in the school. Encourages pupils and others to value each other when there are differences of view and background. Consistently and publicly praises achievements of pupils who have succeeded against the odds.</p>
	<p><u>Challenge and support:</u> Are the teacher's actions based on the desire for each pupil to attain high levels of achievement?</p>	<p><u>Level 1. Cares for the pupil</u> Ensures the day-to-day practical wellbeing and safety of pupils. Does not tolerate bullying and tackles it immediately.</p> <p><u>Level 2. Expresses positive expectations</u> Says to pupils 'You can do it'. Builds self-esteem in pupils by, for example, setting tasks which will allow them to succeed, giving rewards which are valued, and praising them when they have done well.</p> <p><u>Level 3. Strives for the best possible provision</u> Acts relentlessly in the interests of all pupils. Strives to secure the best possible provision. Persists in working for the best possible educational outcomes for all pupils, even when the going gets tough.</p> <p><u>Level 4. Challenges others in the pupil's best interests</u> Challenges others to bring about the best educational outcome for all pupils, persisting in overcoming barriers. Is prepared to be appropriately stern in the best interests of the pupil.</p>
	<p><u>Confidence:</u> Does the teacher believe in his or her own ability to succeed, and does he or she rise to challenges?</p>	<p><u>Level 1. Shows confidence</u> Demonstrates self confidence in most situations. Expresses optimism and confidence in own ability to do things.</p> <p><u>Level 2. Actively contributes</u> Contributes positively, giving personal views in staff meetings and in meetings with parents. Gives an objective and independent opinion.</p> <p><u>Level 3. Expresses a professional view</u> States confidence in him or herself as a professional. Refers to and draws on own experience when doing something new or handling a difficult situation.</p>

		<p><u>Level 4 Rises to challenges</u> Takes on new or difficult challenges willingly and positively. Expresses confidence in own ability to succeed against the odds. Challenges or expresses a different perspective from that of others, including senior colleagues, on a professional issue, when appropriate.</p>
	<p><u>Creating trust:</u> Can you depend on the teacher to accomplish what he or she has agreed to do? Is he or she consistent and fair?</p>	<p><u>Level 1. Acts reliably</u> Delivers what he or she promises. Makes clear commitments and honours these.</p> <p><u>Level 2. Acts fairly and consistently</u> Acts fairly and consistently over time. Applies rewards and sanctions consistently.</p> <p><u>Level 3. Lives up to what he or she professes to believe.</u> Lives up to his or her stated values and beliefs. Avoids giving 'mixed messages' by saying one thing and doing another.</p> <p><u>Level 4. Lives up to his or her professed beliefs even when it is difficult to do so</u> Even when it is difficult to do so, or there is a significant personal cost, acts consistently in accordance with own stated values and beliefs.</p>
Thinking	<p><u>Analytical thinking:</u> Does the teacher analyse situations and data in a logical and systematic way?</p>	<p><u>Level 1. Breaks down problems</u> Breaks down tasks or problems into key parts. Makes lists of actions required and resources needed before a lesson.</p> <p><u>Level 2. Recognises cause and effect</u> Shows that he or she can analyse the reasons for actions and behaviour. Analyses the reason for something. Demonstrates an ability to think through an implication. Prioritises. Makes clear, logical lesson plans, and structures coherent programmes of work.</p> <p><u>Level 3. Analyses variables</u> Considers several possible causes for any given situation. Demonstrates consideration of multiple implications.</p>
	<p><u>Conceptual thinking:</u> Does the teacher have the ability to recognise patterns and concepts, apply models of best practice to school situations and create new ideas and approaches?</p>	<p><u>Level 1. Uses common sense</u> Uses common sense to cut through detail, resolve problems and get things done.</p> <p><u>Level 2. Sees patterns</u> Recognises patterns in behaviour, situations and performance data. Makes comparisons and links.</p> <p><u>Level 3. Uses concepts</u> Creatively adapts and applies concepts, ideas and best practice from other schools or other situations. Refers to theories of how people learn when planning lessons and programmes of work.</p> <p><u>Level 4. Makes the complex simple</u> Helps pupils and others to understand something complex by finding a new and creative way to explain it in simple terms.</p>
Planning & Setting expectations	<p><u>Drive for improvement:</u> Does the teacher constantly strive to raise pupil achievement and to surpass challenging targets?</p>	<p><u>Level 1. Wants to do a good job</u> Strives to do a good job. Thoroughly plans, delivers and evaluates lessons. Keeps required records. Is dissatisfied when he or she is prevented from doing a good job. Seeks to learn.</p> <p><u>Level 2. Sets own standards</u> Sets own standards and measures lessons against these in order to improve learning outcomes. Reflects on what should be done better next time.</p> <p><u>Level 3. Creates improvements</u></p>

		<p>Acts positively to improve the quality of teaching and learning, and achieves a measurable improvement. Improves own classroom practice or brings about a specific improvement for the school by accomplishing something better, more quickly, or more effectively.</p> <p><u>Level 4. Sets and tackles challenging targets</u> Sets and works relentlessly to achieve ambitious targets for all pupils, appropriate to their level, whatever their capabilities; and for him or herself, including those relating to personal Continuous Professional Development. Communicates the importance and urgency for all pupils to maximise their full potential. Continuously focuses on tracking and measuring personal and pupils' performance against objectives.</p>
	<p><u>Information seeking:</u> Does the teacher seek out information from a range of sources?</p>	<p><u>Level 1. Finds out</u> Asks direct questions to get a first-hand understanding of what is going on.</p> <p><u>Level 2. Digs deeper</u> Gets to the root of things by asking incisive questions. Goes beyond the obvious questions</p> <p><u>Level 3. Gathers information</u> Gathers information or resources from a range of sources, for a specific purpose. Does in-depth research to find out about a particular topic or issue.</p> <p><u>Level 4. Uses own systems</u> Systematically gathers and stores information, day by day, that will be relevant to teaching or learning, or to the school.</p>
	<p><u>Initiative:</u> Does the teacher have a bias for action, and does he or she think ahead to anticipate and act on future needs and opportunities?</p>	<p><u>Level 1. Seizes opportunities and sorts out problems</u> Acts immediately to seize opportunities as they occur and to tackle problems.</p> <p><u>Level 2. Acts decisively</u> Is decisive in a crisis situation. Defuses potential conflicts before they escalate.</p> <p><u>Level 3. Thinks and acts ahead</u> Thinks and acts ahead of time, to seize an opportunity or to sort out a problem.</p> <p><u>Level 4. Prepares for future opportunities</u> Anticipates and prepares for possible problems or opportunities that are not obvious to others. Takes action to create an opportunity or to avoid a future problem.</p>
Leading	<p><u>Managing students:</u> Does the teacher manage pupils to work together effectively and achieve high levels of performance?</p>	<p><u>Level 1. Gets pupils on task</u> Quickly gets pupils on task, beginning lessons by stating learning objectives. Recaps and summarises points covered. Provides clear instructions about tasks and focuses pupils' attention.</p> <p><u>Level 2. Keeps pupils informed</u> Makes sure pupils understand why they are doing something. Describes how the activity fits into a programme of work. Keeps pupils up to date by providing information and feedback on progress.</p> <p><u>Level 3. Makes every class effective</u> Consistently makes any class or group effective by getting the right pupils working together on appropriate things. Removes barriers which are preventing the class or groups working effectively together.</p> <p><u>Level 4. Takes actions on behalf of the class</u></p>

	<p>Speaks positively about the class to others and builds up its image. Goes out of his or her way to obtain the extra materials and resources the class, group or team needs: for example, by engaging the support of parents, the community or commercial organisations.</p> <p><u>Level 5. Takes the role of leader</u> Ensures the class and groups fully achieve their objectives at all times. Fully motivates every pupil and gets everyone wholly involved in achieving what needs doing. Always establishes a positive, upbeat atmosphere and takes pupils forward together.</p>
<p><u>Passion for learning:</u> Does the teacher demonstrate a passion for helping pupils to learn, and act to facilitate this?</p>	<p><u>Level 1. Creates a learning environment</u> Makes effective use of a range of learning stimuli and experiences which appeal to the different ways pupils learn. Makes the classroom attractive, comfortable, and stimulating as a space.</p> <p><u>Level 2. Shows how</u> Gives a clear teaching input about a subject. Demonstrates how something is done. Shows what success looks like. Asks questions to encourage pupils to participate and to check understanding.</p> <p><u>Level 3. Supports practice</u> Provides all pupils with relevant and stimulating opportunities to practise, take on and internalise new knowledge and skills, at a level appropriate to them as individuals and recognising learning style preferences. Gives individual encouragement and support, especially when pupils have difficulties. Uses a repertoire of questions to engage pupils and extend their learning.</p> <p><u>Level 4. Drives for understanding</u> Gets pupils to work out answers for themselves by asking challenging and appropriate questions. Gives individualised formative feedback, to get pupils thinking and making breakthroughs in their understanding. Uses approaches which lead pupils to have their own insights, and which allow pupils to understand for themselves.</p> <p><u>Level 5. Motivates pupils to learn independently</u> Continuously provides pupils with opportunities to experience learning as enjoyable and satisfying, to increase their self-motivation. Consistently provides a range of opportunities for pupils to direct their own learning; provides independent learning options, and enables pupils to access these. Encourages self and peer evaluation. Builds pupils' capacity to question themselves.</p>
<p><u>Flexibility:</u> Can the teacher be flexible and adapt to meet changing circumstances?</p>	<p><u>Level 1. Keeps an open mind</u> Expresses willingness to try out new ideas and approaches. Accepts that others have a point of view.</p> <p><u>Level 2. Adapts procedures</u> Makes sensible alterations to normal classroom procedures when the situation demands it, to achieve an objective.</p> <p><u>Level 3. Changes tack</u> Reacts to pupil responses, and changes what they are doing if an approach is not working, drawing fluently on a range of approaches and teaching techniques to do so. Takes advantage of unexpected events and weaves them into the lesson. Deviates from a lesson plan to pursue a warmth of interest that arises in a learning situation.</p>
<p><u>Holding people accountable:</u> Does the teacher set out clear expectations for others and hold people accountable</p>	<p><u>Level 1. Makes expectations clear</u> Says clearly what behaviour and what standards of work are expected from pupils and colleagues. Contracts with pupils what they can expect from him or her as a teacher. Is crystal clear about what is to be achieved.</p> <p><u>Level 2. Sets boundaries</u> Sets clear limits and boundaries for behaviour and what can and cannot be done, in order to support learning.</p>

	for performance?	<p><u>Level 3. Demands performance</u> Holds pupils and others accountable for what they have undertaken to do. Challenges them to meet agreed standards, and tells them when work is not good enough.</p> <p><u>Level 4. Confronts poor performance</u> Acts when pupils or colleagues do not work to the required standard, and takes steps accordingly. Having confronted poor performance, takes timely and decisive action to ensure performance recovery.</p>
Relating to others	<u>Understanding others</u> : Is the teacher aware of what others are feeling and thinking? Does he or she understand the meaning of, and reasons for, other people's behaviour?	<p><u>Level 1. Is sensitive to body language</u> Observes pupils and others and works out how they are feeling from their non-verbal behaviour.</p> <p><u>Level 2. Understands meanings</u> Understands the significance of the behaviour of pupils and others, even when this is not overtly expressed. Deduces the meaning of what others are doing when they are giving 'mixed messages' – saying one thing but doing another.</p> <p><u>Level 3. Understands ongoing behaviour</u> Demonstrates objectivity in assessing others' strengths and weaknesses and is able to assess these accurately. Makes sense of the reasons for someone's ongoing patterns of behaviour.</p>
	<u>Impact and influence</u> : Does the teacher use vivid actions and deliberate influencing strategies to persuade pupils and other adults to produce desired outcomes?	<p><u>Level 1. Uses logic to persuade</u> Persuades using facts and figures. Uses a logical argument, for example, to get agreement or to support a view.</p> <p><u>Level 2. Takes actions to persuade</u> Takes a number of different steps to persuade others, using several different lines of argument.</p> <p><u>Level 3. Calculates an impact</u> Sets out to make a lesson work for pupils, planning to deliver it in a way which will appeal to them. Does something that will make learning vivid or memorable. Consciously manages pace in a lesson to maximise learning outcomes. Uses rewards to influence behaviour and performance positively. Plans to make a particular impression to influence a parent or a colleague</p> <p><u>Level 4. Influences indirectly</u> Influences with and through others – including parents and other pupils - to support learning.</p>
	<u>Team working</u> : Does the teacher work effectively with others to achieve shared goals for pupils and the school?	<p><u>Level 1. Helps and supports others</u> Willingly helps others out. Co-operates with, and supports, colleagues and parents when asked.</p> <p><u>Level 2. Shares information</u> Keeps colleagues informed and shares good ideas. Communicates effectively with parents about their children's progress.</p> <p><u>Level 3. Gets inputs from others</u> Asks colleagues, parents and others for their opinions and their ideas. Asks for feedback on their own work.</p> <p><u>Level 4. Builds team spirit</u> Makes people feel proud of being part of the team. Speaks positively about the team and its achievements to others. Brings issues which hamper effectiveness of the team into the open, and supports the team in overcoming these.</p>

- **Factor 3. Classroom climate** - defined as a measure of the collective perception of pupils regarding those dimensions of the classroom environment that have a direct impact on their capacity and motivation to learn. These nine dimensions include:
 - Clarity around the purpose of each lesson. How each lesson relates to the broader subject, as well as clarity regarding the aims and objectives of the school.
 - Order within the classroom, where discipline, order and civilised behaviour are maintained.
 - A clear set of Standards as to how pupils should behave and what each pupil should do and try to achieve, with a clear focus on higher rather than minimum standards.
 - Fairness: the degree to which there is an absence of favouritism, and a consistent link between rewards in the classroom and actual performance.
 - Participation: the opportunity for pupils to participate actively in the class by discussion, questioning, giving out materials, and other similar activities.
 - Support: feeling emotionally supported in the classroom, so that pupils are willing to try new things and learn from mistakes.
 - Safety: the degree to which the classroom is a safe place, where pupils are not at risk from emotional or physical bullying, or other fear-arousing factors.
 - Interest: the feeling that the classroom is an interesting and exciting place to be, where pupils feel stimulated to learn.

Environment: the feeling that the classroom is a comfortable, well organised, clean and attractive physical environment.

Such teacher attributes as knowledge of the subject, of the teaching methods for the subject, curriculum areas and the way pupils learn stand aside and are not included among the main factors.

The conclusions of the study reveal that teaching skills, professional characteristics and classroom climate will predict well over 30% of the variance in pupil progress. The display of both professional characteristics and good teaching skills by a teacher lead to the creation of a good classroom climate and as a result to improved students' progress. At the same time, the scholars point out that biometric data, such as teachers'

age, experience, qualification etc., did not have any correlation with the positive impact on students' learning.

Anderson (Anderson, 2004) developed a conceptual framework for understanding and improving teacher effectiveness. The framework contains six components, two of which – *teacher characteristics*⁴⁵ and *student characteristics* – are not easy to be influenced, if possible at all, especially in a short period of time. However, three other components – *curriculum*, *classroom* and *teaching* - are alterable and should be considered in the first place if one wants to improve *student learning*, which is the final concept used in the framework. The three alterable components are discussed in more details below.

1. **Curriculum** includes the standards which describe objectives – i.e. intended student learning outcomes – as well as learning units.

Speaking about **objectives**, it is recommended to formulate them following the structure of subject-verb-object, where 'subject' is a student, 'object' is the content a student is intended to learn and 'verb' should connect students to content. For example, "The student (subject) will be able to identify (verb) nouns in sentences (object)".

The scholars recommend using the taxonomy table in order to understand objectives in terms of cognitive processes and type of knowledge involved (Table 10). In the taxonomy table subject-matter content is replaced by types of knowledge: factual, conceptual, procedural and meta-cognitive. And the horizontal dimension includes modified categories of Bloom's taxonomy: remember, understand, apply, analyse, evaluate, and create (see Table 11 for more cognitive verbs classified according to Bloom's taxonomy and revised Bloom's taxonomy). The given table allow describing the content of the study through the cognitive demand by type of knowledge, as well as shifting the focus from topics or content areas to be taught to student learning. As remarked by Anderson, there is ample evidence that many teachers start their planning with classroom activities (what students will do) rather than with standards (what students will learn). Using the taxonomy table may be used to help teachers change this habit.

⁴⁵ Anderson refers to McBer's (McBer, 2000) list of teacher charactersitics that I discussed above, adding that other researchers have also identified several of these characterstics in their works, sometimes having a different term to name them.

Table 10 The Taxonomy Table (Anderson, 2004, p. 36)

The knowledge dimension	The cognitive process dimension					
	1	2	3	4	5	6
A. Factual knowledge	Remember	Understand	Apply	Analyse	Evaluate	Create
B. Conceptual knowledge						
C. Procedural knowledge						
D. Meta-cognitive knowledge						

In order to understand which cognitive processes and type of knowledge the formulated objective would involve, the teacher has to focus on the object. For example, in the example above we had the objective “The student (subject) will be able to identify (verb) nouns in sentences (object)”. ‘Nouns in sentences’ is an object. ‘Nouns’ are concepts, rather than fact or procedure. Next, the teacher has to focus on the verb – ‘identify’. If the objective is to make students identify nouns that they have already seen, then the cognitive process involved would be ‘remember’. If, however, students are expected to identify nouns in sentences that they have not encountered based on their understanding of the concept of a noun, then the cognitive process involved in this process will be ‘understand’. So the objective can be classified either as remember conceptual knowledge or understand conceptual knowledge respectively.

Table 11 Cognitive verbs from simple to complex. Based on Bloom’s Taxonomy (Bloom, 1984) and Revised Bloom’s Taxonomy (Anderson, 2004, p. 139; Krathwohl, 2002).

Knowledge (remember)	Comprehension (understand)	Application (apply)	Analysis (analyse)	Evaluation (evaluate)	Synthesis (create)
<ul style="list-style-type: none"> Recognise (Identify) Recall (Retrieve) Define Name Describe Outline Label Recite List Select Match State Repeat Record Underline	<ul style="list-style-type: none"> Interpret (paraphrase, translate) Exemplify (illustrate) Classify (categorise) Summarize (abstract, generalise) Infer (conclude, extrapolate, predict) Compare (contrast, map, match) Explain (construct causal models) Convert Extend Defend Discriminate Distinguish Estimate	<ul style="list-style-type: none"> Execute (carry out) Implement (use) Change Organize Compute Prepare Demonstrate Relate Develop Solve Modify Transfer Operate	<ul style="list-style-type: none"> Differentiate (discriminate, distinguish) Organise (integrate, outline) Attribute (deconstruct) Break down Infer Deduce Diagram Point out Relate Separate out Illustrate Subdivide	<ul style="list-style-type: none"> Check (detect, monitor) Criticize (judge) Appraise Compare Justify Contrast Support Validate Defend	<ul style="list-style-type: none"> Generate (hypothesize) Plan (design) Produce (construct) Categorize Devise Compile Formulate Compose Predict Create Design

As claimed by Anderson (Anderson, 2004, p. 37) knowing how to teach and assess student learning using the taxonomy table can help teachers become more effective.

Once objectives are understood, the task of the teacher has to plan **learning units**. A learning unit is defined as “*an interrelated set of objectives, assessments, and activities and materials that require several weeks to teach (generally three or more)*” (Anderson, 2004, p. 37). The task of the teacher is to align activities and materials with required standards or objectives. Focusing on planning learning units rather than daily lessons allow among other gains to have time needed to teach important connections between ideas, activities and topics.

As a result, three recommendations are formulated for improving teacher effectiveness:

- Teachers must have a sound understanding of the standards that define intended or expected student learning;
- Teachers must use their understanding of standards to design appropriate and effective learning units;
- Teachers must be aware of the need for curriculum alignment – that is, the critical connection between the standards/objectives, the assessments, and the instructional activities and materials.

2.1. Classroom: environment, climate and culture

The scholar differentiates between physical and psychological classroom environment.

- **Physical environment** exists independently of people and includes furniture, tools and equipment, materials, number of students and adults present in a classroom. This can be manipulated easily.
- **Psychological environment**, on the other hand, exists in the mind of those who live in this physical environment. This is individual student’s perception of the **classroom climate**. In comparison with the physical environment which has indirect influence on students’ learning, classroom climate is claimed to have a direct influence.

Anderson (ibid) speaks about three components of classroom climate that have been found to be consistently related to student learning: **affect**, **task** and **organisation**. Effective teachers are perceived by students to create classrooms which **are inviting**, **task-oriented** and **well organised**.

Inviting classrooms are said to be those where students feel mutual respect between teachers and students and where there are positive and cooperative relationships.

Task-oriented classrooms are characterised by the awareness of students of definite goal they have to pursue and belief that they are held accountable for achieving this goal. Large proportion of classroom time is spent on pursuing this goal.

Well organised classrooms are those where, according to students, expectations for behaviour and learning are made explicit and an appropriate structure is provided by the teacher to guide behaviour and learning.

- If **classroom climate** deals with the psychological environment as it is perceived by individual students, then **classroom culture** deal with the psychological environment as it should be perceived by all of the students in the classroom. It is *“the system of beliefs, values, and modes of construing reality that is shared by the teachers and the students”* (Anderson, 2004, p. 50)

Classroom culture can be defined by looking at the roles and responsibilities of students and teachers, the relationships between teachers and students and among students themselves, and importance and nature of learning.

Three recommendations are formulated for improving teacher effectiveness in respect to the component of classroom environment and culture:

- Teachers should create attractive and functional classrooms. Part of the functionality of classrooms concerns the availability of the necessary equipment and material;
- Teachers should create a classroom environment that is warm, yet business-like. This requires equal emphasis be placed on the academic and socio-emotional needs of the students;

- Teachers should work diligently to establish a classroom culture based on explicit values and beliefs. These values and beliefs should provide the basis for the way in which teachers and students relate to one another, as well as the expectations for behaviour, effort and learning.

2.2. Classroom: organisation and management

The distinction is made between classroom organisation and classroom management. As claimed by scholars, the influence of classroom organisation and management on student learning result in indirect.

- **Classroom organisation** is defined as academic and social arrangement of students within classroom.

Classrooms may be homogeneous and heterogeneous. The research suggests that less academically able students improve their results when studying together in one class with more academically able students.

Another aspect connected to types of classroom organisation in ways of instructional purposes: whole class, small group or individual student. As claimed by Anderson (ibid.) effective teachers tend to provide a balanced combination of all three classroom arrangements.

- **Classroom management** refers to the ways in which teachers promote positive, co-operative and task-oriented behaviour and deal with misbehaviour and disruptive behaviour. Two key aspects of classroom management are (1) preventing behavioural problems from occurring (**preventive classroom management**), and (2) reacting to behavioural problems once they have occurred (**reactive classroom management**).

The research suggests that more effective classroom teachers are more efficient in preventive classroom management; they do not wait till the conflict appears but rather establish clear **rules** and **routines** which minimise the possibility of problem appearance.

Rules are defined as prohibitions on student behaviour and, as a consequence, are often stated negatively, for instance, in the form of “do not...”.

Routines are defined as sequences of steps which students have to follow as they perform classroom activities that occur with some degree of regularity, for instance, the way they are expected to participate in class discussions or the way home tasks are checked.

Effective rules and routines have some common characteristics:

- They are planned in advance;
- They are relatively few in number;
- They are communicated clearly to students and their necessity is justified;
- There are specific consequences applied if rules and routines are not respected.

The goal of rules and routines is to finally develop students' inner self-control rather than having teacher exercising external control all the time. So they must be put into practice from the beginning of the teaching-learning process and followed consistently.

Anderson (ibid.) offers a list of teacher behaviours validated by the research⁴⁶ that are associated with preventive classroom management:

- 'With-it-ness': constant awareness of everything that is happening in the classroom at all times;
- 'Group alerting': using a standard and predictable signal to get students' attention;
- 'Overlappingness': the ability to deal effectively with more than one matter at the same time;
- 'Momentum': keeping events and activities moving at a fairly brisk pace;
- 'Accountability': letting the students know that they themselves are responsible for their learning and the quality of their work;
- 'Providing variety and challenge in seatwork': setting assignments that provide a sufficient element of challenge and variety to maintain the students' interest and attention.

⁴⁶ Anderson (Anderson, 2004, p. 67) makes reference to the works of Evertson and Randolph (1999) "*Perspectives on classroom management in learning-centered classroom*" and Wang et al. (1999) "*Toward a knowledge base for school learning*". In: H.C. Waxman, H.J. Walberg (Eds.) *New directions for teaching practice and research*. Berkeley, CA: McCutchan.

As a result, for improving teacher effectiveness it is recommended that teachers are aware of and apply the above formulated teaching practices connected classroom organisation and management.

3. Teaching

The last component of the framework for improving teacher effectiveness developed by Anderson is teaching. It is composed of two parts: **the structure of lessons** and **teacher-student communication**.

- If the primary building block of the curriculum is the learning unit, then the primary unit of delivery of the curriculum is **the lesson**. Lessons are embedded in learning units and are influenced by it, as well as by classroom environment and climate, classroom organisation and management.

Each lesson has an **internal structure composed** of several components: (a) the purpose of the lesson, (b) the activities in which students engage during the lesson as well as the sequence of these activities, (c) the time allocated to the lesson and the pace at which students move through the lesson, (d) the ways in which progressed is assessed and evaluated, and (e) the roles and responsibilities of teachers and students.

Speaking about **purpose or goals** and objectives, three levels of objectives are distinguished: global (course), educational (learning unit) and instructional (lesson).

Instructional objectives can be academic (focus on students' knowledge or skills), social (focus on social skills and relationships), and recreational (focus on enjoyment of participating in the activities). Academic purpose of the lesson must be consistent with the educational objectives of the learning unit. Anderson (ibid.) claim that the vast majority of an effective teacher's lessons focus on academic purposes.

Lesson can also be of different **roles** in terms of facilitating student learning: understanding new content, expanding on new content for the purposes of its mastery, reviewing previously taught content to help students remember it or for the purposes of correcting misunderstandings.

- **Lesson activities**, sometimes also called **instructional formats**, refer to the events of the lesson.

There are many possible events that can happen on the lesson; the most frequent of them include the following: one-way presentation (lecture or monologue), two-way presentation (discussion or dialogue), mediated presentation (computers, videotapes and slides), seatwork, group work, silent reading, reading circles, construction, games and housekeeping, recitations (rapid-fire questions and answers), student reports, tutorials, and tests. Normally several activities are employed during the lesson, however, some lessons can also be single-activity lessons.

- The next aspect relevant the lessons is **lesson structure** which can differ not only from country to country but also from teacher to teacher.

Anderson (ibid.) mentions that a four-phase lesson structure in mathematics classrooms was found to be common in Germany. The lesson begins with review of previous material, then follows the presentation of the topic and the problem to study, after that there goes the development of a procedure to solve the problem, usually in a whole class activity guided by the teacher and the last phase is practice, usually by assigning a set of problems similar to those in the previous phase that are solved by the students as seatwork. In Japan, however, the structure would differ and would include five phases: review of previous material, then presentation of the problem of the day, after that students work individually or in groups to solve the problem, followed by discussion of solution methods and highlight and summary of the main points by the teacher.

Anderson concludes that the major research findings show the type of activity has less significance than the way in which the activity is presented to students (structure and clarity), how students engage in the activity (involvement) and how the activity and the students' participation are interpreted by the students themselves (meaning).

Five main recommendations for improving teacher effectiveness are derived from the analysis of the component of teaching:

- Teachers and their students should view lessons as parts of larger units of instruction;
- Teachers should prepare students for learning by providing an initial structure to clarify intended outcomes and cue the desired learning strategies;

- To facilitate meaningful learning and retention, teachers should clearly explain and develop the content, putting emphasis on its structure and connections;
- Students need sufficient opportunities to practice and apply what they are learning and to receive improvement-oriented feedback;
- The teacher should provide whatever assistance students need to enable them to engage in learning activities productively.

One more part of teaching component is **teacher-student communication**. One can make a distinction between student-directed patterns of verbal interaction and teacher-directed patterns, the latter being more frequent in classrooms around the world. Teachers' most frequent patterns include: tell something, ask questions, allow/encourage students to answer the questions, react to the answer or lack of answer.

In addition to talking teachers can also show something tangible or show students what is expected to learn/know. Showing and telling must go hand-in-hand if teachers want to be effective communicators. Combination of showing and telling is called **demonstrating** or **modelling**, and it is particularly important when the teacher wants to help students develop learning strategies. One form of strategy teaching is called 'cognitive modelling' which occurs when the teachers talk through the strategy as they demonstrate it to students.

In addition to verbal communication, there is also non-verbal communication, for instance, when a teacher reacts to an answer by a simple nod.

Another aspect important in teacher-student communication is classroom **dialogue**. Dialogue is distinguished from monologue because dialogue involves teacher talking *with* students rather than talking *at* them. Through the dialogue, students are expected to justify their answer, explain or elaborate on it or comment on classmates' comments or answers.

Several recommendations for including teacher effectiveness have been made:

- As mentioned elsewhere, showing and telling in combination are likely to be superior to either one in isolation.

- Teacher should balance lower-order questions and higher-order questions. **Lower-order questions** are asked with the purpose of finding out whether the students understand what is being presented. When asking these questions teachers should (a) ask clear, un-ambiguous questions, (b) ensure that the questions focus the students' attention on the key content and objectives; (c) try to understand the reasons for anything that may have been misunderstood (d) avoid too many choral responses and better focus on one student at a time. **Higher-order questions** are asked with the aim to stimulate the students' thinking. When asking these questions teachers should (a) allow sufficient time for a student to think about and formulate their answer and (b) remind students that this is not a rhetorical question hence the answer is expected.
- Teachers should provide immediate feedback to students concerning the correctness of adequacy of their responses. In cases where the initial feedback is negative corrective feedback, which gives students insight into how to correct the identified problem, should be provided.
- Teachers should praise students to reinforce correct, adequate and appropriate responses, as well as their thought and effort. This should be done in moderation and it should be clear to students why they are being praised.
- When incorrect, incomplete or no responses are given by the students, the teacher should react in one of several potentially useful ways: (a) staying with the student, probing his understanding and helping him to formulate a more accurate answer, (b) giving clues to the student to help him formulate a more appropriate answer, (c) redirect the question to another student in the class or if everything fails (d) provide themselves the appropriate response.

To sum up the main ideas presented in the research review done by Anderson (Anderson, 2004), it can be said that if the teachers work on improving his competence in three main domains discussed above – curriculum, classroom and teaching – they will increase the chances of creating conditions that will maximize student learning. Some of the reasons mentioned by Anderson (ibid.) which prevent teachers from changing their teaching practice include (1) a lack of awareness the change is needed, (2) a lack of knowledge, particularly procedural knowledge, concerning how to change, and (3) the belief that changes will not make any difference to them or their students.

Coe and his colleagues (Coe et al., 2014) reviewed research on teacher effectiveness and identified six common components which should be considered if one wants to improve teaching quality. The first two of them have strong evidence of impact on student outcomes, the second two have moderate evidence and the last two only some evidence:

1. (Pedagogical) content knowledge (*strong evidence*)
 - a. Deep knowledge of the taught subject;
 - b. Understanding the ways students think about the content, being able to evaluate thinking behind students' own methods, and identifying students' common misconceptions.
2. Quality of instruction (*strong evidence*);
 - a. Effective questioning;
 - b. Use of assessment;
 - c. Reviewing previous learning;
 - d. Providing model responses for students;
 - e. Giving adequate time for practice to embed skills.
3. Classroom climate (*moderate evidence*);
 - a. Quality of interaction between teachers and students;
 - b. Teacher expectations: creating constantly demanding classroom and recognising students' self-worth;
 - c. Attributing student success to effort rather than ability;
 - d. Valuing resilience to failure (grit).
4. Classroom management (*moderate evidence*);
 - a. Make efficient use of lesson time;
 - b. Coordinate classroom resources and space;
 - c. Manage students' behaviour with clear rules that are consistently enforced and are all relevant to maximising the learning that can take place.
5. Teacher beliefs (*some evidence*);
 - a. Why particular practice(s) were adopted⁴⁷;
 - b. The purpose teachers aim to achieve;

⁴⁷ It is claimed that if one wants to characterise teachers as more or less effective, it is not enough to simply describe or define observable teacher's practices or approaches, it is also important to understand why teachers adopt them.

- c. Teachers beliefs about the nature of the subject they teach and what it means to understand it;
 - d. Teachers' theories on what learning is and how it happens;
 - e. Teachers' conceptual models of the nature and role of teaching in the learning process.
6. Professional behaviours (*some evidence*)
- a. Reflecting on and developing professional practice;
 - b. Participation in professional development;
 - c. Supporting colleagues;
 - d. Liaising and communicating with parents.

Moreover, the scholars identified four examples of practice described in educational research literature, which fit their criteria of effective practice (Coe et al., 2014, p. 11):

- Well-defined, well-specified and implementable intervention;
- Intervention which defines something (operationalisable behaviours, skills or knowledge) that can be changed;
- Some evidence which link the approach with improved student outcomes (outcomes do not have to be limited to academic attainment).

These four include *Danielson's Framework for Teaching*, *The Classroom Assessment Scoring System (CLASS)*, *Rosenshine's Principles of Instruction* and *Creemers and Kyriakides' Dynamic Model of Educational Effectiveness*. Among these four, the last one is claimed to be the only one which provides a well specified theory that has been tested with some success (Table 12). As can be seen, the model both adds and specifies many components of teaching competences which can be considered for theoretical framework of this research.

Table 12 The dynamic model of educational effectiveness (Creemers & Kyriakides, 2006 in Coe et al., 2014, p. 16)

(1) Orientation	(a) Providing the objectives for which a specific task/lesson/series of lessons take(s) place (b) Challenging students to identify the reason why an activity is taking place in the lesson.
(2) Structuring	(a) Beginning with overviews and/or review of objectives (b) Outlining the content to be covered and signalling transitions between lesson parts (c) Drawing attention to and reviewing main ideas.
(3) Questioning	(a) Raising different types of questions (i.e., process and product) at

	<p>appropriate difficulty level</p> <p>(b) Giving time for students to respond</p> <p>(c) Dealing with student responses.</p>
(4) Teaching modelling	<p>(a) Encouraging students to use problem-solving strategies presented by the teacher or other classmates</p> <p>(b) Inviting students to develop strategies</p> <p>(c) Promoting the idea of modelling</p>
(5) Application	<p>(a) Using seatwork or small-group tasks in order to provide needed practice and application opportunities</p> <p>(b) Using application tasks as starting points for the next step of teaching and learning.</p>
(6) The classroom as a learning environment	<p>(a) Establishing on-task behaviour through the interactions they promote (i.e., teacher–student and student–student interactions)</p> <p>(b) Dealing with classroom disorder and student competition through establishing rules, persuading students to respect them and using the rules.</p>
(7) Management of time	<p>(a) Organizing the classroom environment</p> <p>(b) Maximizing engagement rates.</p>
(8) Assessment	<p>(a) Using appropriate techniques to collect data on student knowledge and skills</p> <p>(b) Analysing data in order to identify student needs and report the results to students and parents.</p> <p>(c) Teachers evaluating their own practices.</p>

In addition to effective practice, Coe and his colleagues (Coe et al., 2014, p. 22) also discuss examples of ineffective practice, which sometimes is wrongly popularised as ‘best practice’ but has, however, no research-based evidence behind its claimed positive effects. These practices include:

- Using praise lavishly;
 - Wrong kind of praise can be harmful to learning. Praise which is encouraging and protective of low attaining students may be interpreted as evidence that a teacher has a low perception of a student’s ability.
- Allowing learners to discover key ideas for themselves;
 - Research evidence favours direct instruction to a ‘discovery learning’ if a teacher wants students to learn new ideas, knowledge, or methods.
- Group learners by ability
 - Some research suggests that grouping students by ability makes very little difference to learning outcomes. In addition, it is claimed that allowing ability grouping can create an exaggerated sense of within-group homogeneity in the teacher’s mind.
- Encourage re-reading and highlighting to memorise key ideas;
 - Even if this approach may seem effective, the research findings in cognitive psychology suggest that other approaches are much more effective in helping students to revise and memorise materials. These

include, for example, testing yourself, trying to generate answers, deliberately creating intervals between study to allow forgetting.

- Address issues of confidence and low aspirations before you try to teach content;
 - Even though it may be logical to address motivation of low achieving students before attempting to teach them something, the research results are more likely to suggest that low motivation is often result of constant failure. So it is recommended to teach students and to start making them succeed first and their motivation will increase as a result.

- Present information to learners in their preferred learning style (visual, auditory, kinaesthetic);
 - Psychological evidence shows there are no benefits for learning.

- Ensure learners are always active, rather than listening passively, if you want them to remember.
 - This is probably one of the examples when the importance of the form of work is exaggerated over the content. The real need behind making students remember something is making them think about it. It can be achieved when students are either actively doing something or passively listening to something and the art is to find the right combination depending on the aim of the tasks offered to students. Probably, here we can also mention the discussion behind the type of instruction: individual, small group teaching or large group instruction. As claimed by some researchers (Good & Biddle, 1988 p.116 in Coe et al., 2014, p. 12), “*The issue is not individualised instruction or small-group instruction, but rather the quality of thought and effort that can occur within these structures*”.

Amongst various conclusions offered in the review, one suggests that even though it is impossible to reduce entirely effective teaching into a set of components, there are, however, practices which provide certain evidence of leading to improved students' learning. Teaching competences which lie behind these practices should not be neglected. As mentioned above, the review specifically stresses the credibility and utility of the Dynamic Model of Educational Effectiveness.

The review of the research on teacher effectiveness gives us several new components which we have to consider while speaking about teaching competences. However, teacher effectiveness is not the only domain which we can study in order to identify the sought for components. Since my specific interest lies in the domain of problem education, the research which deals specifically with teaching for thinking approaches

has to be examined. Which teaching competences are considered to be essential if the teacher wants to introduce a teaching for thinking approach into her everyday practice? This is the question which leads me to the next chapter of this research.

1.4.2. Teaching Competences for Teaching for Thinking Approaches

In order to find the answer to the question about teaching competences required for teaching thinking, the research review was made. The focus of the review was on the research which studied teachers who implemented one of the teaching for thinking approaches in their real classrooms.

The guiding research question for the reviews was what exactly was measured in this research to make a qualitative distinction between a teacher who is successful in implementing a teaching for thinking approach and a teacher who is less successful or is not implementing the approach at all. Specific focus was paid to the research dealing with classroom studies, namely, teachers in action. This was essential in order to identify competences which are relevant for the direct teacher's task, that of teaching.

The literature was identified from the multiple sources I studied when working on the theoretical foundations of teaching for thinking approaches discussed in details in Chapter 2. Identified research was summarised in a form of a table (see Appendix 4) under eight columns:

1. Source (if the research was identified in a review);
2. Research authors;
3. Title of teaching for thinking approach (if research belonged to a specific approach);
4. Research aim;
5. Research participants;
6. Research method (what was measured and how);
7. Results and conclusions

8. Implications for my research.

The order of the studies presented in the table was based on the date of publication starting from the earliest and ending with the most recent one.

The undertaken analysis allowed identifying the following categories within which teaching competences can be drawn:

1. **Classroom dialogue, classroom discussion or teacher-student interaction and its quality** (Adey, Hewitt, Hewitt, & Landau, 2004a; Emery & Wilks, 1998; Li, 2011; Naisbett, 1997; Topping & Trickey, 2007; Zohar & Schwartz, 2005; Мельникова, 2002)

As claimed by some researchers (Topping & Trickey, 2007) dialogue and its quality in the classroom proves to be one of the major indicators of how much thinking is happening in the classroom. Therefore, it is important to understand existing quality criteria for classroom dialogue.

- a. Proportion of students talking vs teacher talking;

Teachers who are more effective in teaching thinking will have relatively higher proportion of students talking since they engage their students in a meaningful dialogue.

- b. Asking students to elaborate on the answer, clarify it vs not asking students to elaborate or to reason their judgement;
 - i. Probing questions directed at individual student's response;
 - ii. Frequency of probing questions;

A dialogue in a thinking classroom is characterised by teachers asking their students to explain their reasoning, clarify their answer and elaborate on it. Therefore, more effective teachers' classrooms would be characterised by the presence of these questions on the lessons.

- c. Pursuing students understanding why something is wrong or right.

Since in a thinking classroom a teacher is genuinely interested in students reasoning, their reaction to students' wrong answer is an important factor to consider. What is the best way to react to students' erroneous answer in order to help them become aware of the faults in the reasoning and at the same time not to destroy student's motivation and self-esteem? The researchers invite to consider several techniques, which are claimed to improve the quality of the teacher-student dialogue.

- i. Teachers are encouraged to change the habit of immediate rejection of student's wrong answer ("no", "nearly but not quite") or its neglect and start pursuing the reason of the fault ("why is it then?");
 - ii. It is equally important to control the tone of the response. Some researchers (Мельникова, 2002) recommend accepting the erroneous reply with a neutral tone;
 - iii. Those teachers who started implementing one of the teaching for thinking approaches realised the importance of understanding the source of the student's mistake (Zohar & Schwartz, 2005). From "the teacher does not understand the source of the student's mistake and therefore cannot treat it successfully" to "understanding possible source and using techniques that would help a student get out of difficulty". Possible techniques may include:
 1. Using the erroneous answer to generate a whole class discussion;
 2. Generating a simpler, similar problem, that may enable the student to solve the original problem through analogy;
 3. Asking questions in order to track the source of the student's mistake.
 4. Providing scaffolding so that the student could find the correct answer by herself;
- d. Combined explanations and elaborations

Since a thinking classroom is also a collaborative classroom, students do not only build their understanding on their own but should also be involved in combined elaborations. More effective teachers in teaching for thinking classrooms tend to do it using different techniques, one of them being the following:

- i. After getting students response, check for agreement or disagreement with other students. Students' discussion followed by "Do you agree with that? Anyone got any other idea?"

- e. Involvement of all students vs focusing on only active/strong students

One mistake which teachers often make is working with a small number of active students and judging about the understanding of all students on the basis of the activity of this small group. Teachers who are interested in teaching for thinking change their practice in a way that they try to involve as many students as possible in the classroom discussions. The following techniques have been found useful for this purpose:

- i. Proceeding with asking opinion of several students even if the first one gave the 'correct' direction;
- ii. Not rushing into asking the first student who raises a hand but giving time to others to think.

- f. Importance of wait-time: giving students longer time to think before offering a helping question, asking another student to respond or providing a correct answer (Li, 2011; Naisbett, 1997; Zohar & Schwartz, 2005)

Since students are involved in deep reasoning, effective thinking teachers are aware of the important of the wait-time and give enough time to students to think on their answer before intervening with any sort of help.

- a. Reformulating and summarising learners' contribution and clarification, reducing interruptions.

Some studies (Li, 2011) emphasize the key role of the teacher in creating, developing, managing and navigating the space for thinking by several ways, some of which being reformulating learners' contribution and clarification, summarising it as well as reducing interrupting students.

2. Teacher's questioning techniques: types of questions asked and their quality (Adey et al., 2004a; Ferretti, MacArthur, & Okolo, 2001; Koufetta-Menicou & Scaife, 2000; Naisbett, 1997)

As important as the quality of the dialogue, the research highlights the importance of the quality of teachers' questions for the development of students' thinking. As research on teachers working on thinking approaches suggests, effective thinking teachers are characterised by improved questioning techniques.

- a. Teachers who start working with teaching thinking approaches shift from simple questions and simple answers to more complex questions (questions which require higher-order mental operations) and answers showing evidence of thought;
- b. Teaching for thinking teachers shift from closed questions (what/when) to open questions (how/where)
 - i. 'how-questions' (procedures) and 'why-questions' (underlying reasons) are linked to students use of metacognitive skills;
 - ii. Variety of open questions from more straightforward "why is...?" to "why do we...?", "why not...?", "what if...?".
- c. More effective teaching for thinking teachers use more focused questions and examples from students' daily lives;

3. Importance of 'language of thinking' (terminology) used on the lessons (Adey et al., 2004a; Koufetta-Menicou & Scaife, 2000; Zohar & Schwartz, 2005).

Many teaching for thinking approaches advocate for the explicit use of the 'language of thinking' on the lessons by teachers and students. The language of thinking includes words that refer to mental processes and products, or to words that describe thinking (i.e. thinking, drawing conclusions, making assumption, assuming, justifying, establishing causal relationships, making contradictions, etc.). By using the terminology students learn to associate a mental operation with a specific term and become aware

of their own mental processes. In their research Zohar and her colleagues (Zohar & Schwartz, 2005) counted the number of thinking words (how many 'words') and variety of thinking words (how many different words irrespective of the number of times they were pronounced) used by the teacher on the lesson.

4. Types of tasks given to students.

According to some scholars (Zohar & Schwartz, 2005), tasks can be classified by cognitive levels: recall of information, comprehension, lower-level application, and higher-order thinking (analysis, creation, evaluation). This classification resonates with the cognitive processes discussed by Anderson (Anderson, 2004) (see Tables 10 and 11 above). Teaching for thinking teachers should on a regular basis involve students in doing higher-order tasks on their lessons.

5. Thinking strategies students are engaged in and their variety (Zohar & Schwartz, 2005)

In teaching for thinking classrooms students should be involved in developing thinking strategies. Therefore, the number of thinking strategies teacher manages to involve students in is important and can be considered as an indicator of effective teaching. Some of the thinking strategies include the following:

- a. Inquiry skills: Defining a research question, Planning an experiment, Describing experimental results, Drawing conclusions, Controlling variables, Thinking about interactions between variables
- b. Processing skills: Entering data into a table, Making graphs, Reading data from a table, Analyzing data
- c. Critical thinking skills: Problem solving, Making comparisons, Forming definitions, Identifying relevant information for solving problems, Identifying tautologies, Identifying assumptions, Sampling, Hypothetical-deductive reasoning, Constructing arguments and counter-arguments, Searching for various factors that should be taken into consideration while discussing a problem, Asking questions.

6. Importance of asking students to reflect on the process (Adey, Hewitt, Hewitt, & Landau, 2004b; Zohar, 1999; Zohar & Schwartz, 2005)

Several scholars highlighted the importance of involving students into reflection on their teaching process and results. This reflection can happen at several levels:

- a. Students are asked to identify the thinking strategies they had used during the lesson, to reflect upon their mistakes, to explain their mistakes, and to suggest ways for avoiding similar mistakes in the future;
- b. Students are asked about how to generalize a thinking strategy;
- c. Students are asked to reflect on the gains from the lesson;
- d. Students are asked to analyse what thinking skills are applied in the process of problem solving

7. Bridging thinking developed during the activity to different contexts or to the world outside school (Adey, Hewitt, Hewitt, & Landau, 2004c).

Many teaching for thinking approaches highlight the need to connect classroom activity to the world outside school. Teachers who work with these approaches make more links between the content under study and other contexts.

8. Setting explicit lesson/task aims (what students do and why they do it) (Мельникова, 2002)

One of the essential conditions that would make the teaching-learning process successful is that students should be aware of the aim behind a lesson as a whole and every task in particular. 'Which subject-matter problem are we solving?' 'What is that we do not know?' 'Why do we do it?', 'What will it help us to make better?' These are some of the questions which should be explicit for every learner. The easiest way to do it is merely inform students about the lesson aim. This, however, is not the most effective technique since it will hardly ensure students accept this aim as their own. Melnikova (ibid.), for instance, has developed a technology of the problem-dialogical teaching-learning process. In her technology the awareness of the lesson aim comes after students face a problem situation (see Chapter 2 for more discussion on problem situation). Either following her technology or developing one's own way, teachers should

make students aware of the lesson aim in a way that makes them accept it as a goal worth pursuing. In this case, working on further tasks will be meaningful activity for students which will lead them towards finding the answer to the question they are concerned with.

Many conclusions connected to teaching for thinking approaches are drawn from evidence coming from research in cognitive psychology. Therefore, this academic discipline can also be studied to reveal understanding about the nature of learning, the conditions more favourable for it as well as the role of memory. Coe and his colleagues (Coe et al., 2014) reviewed some of the available research and found the concept of “desirable difficulties” (Bjork & Bjork, 2011 in Coe et al., 2014, p. 17), meaning that some approaches which seem to make learning harder and less satisfying for learners in a short-term, actually result in better long-term retention. For examples of ‘desirable difficulties’ include (ibid.):

- Varying the learning context and types of task rather than keeping them constant and predictable, improves later retention, even though it makes learning harder in the short term.
- The same amount of time spent reviewing or practising leads to much greater long-term retention if it is spread out, with gaps in between to allow forgetting.
- Learning in a single block can create better immediate performance and higher confidence, but interleaving with other tasks or topics leads to better long-term retention and transfer of skills.
- Having to generate an answer or procedure, or having to retrieve information – even if no feedback is given – leads to better long term recall than simply studying information. Testing can also support self-monitoring and focus subsequent study more effectively. *“Basically, any time that you, as a learner, look up an answer or have somebody tell or show you something that you could, drawing on current cues and your past knowledge, generate instead, you rob yourself of a powerful learning opportunity”* (Bjork and Bjork, 2011, p61 in Coe et al., 2014, p. 17)

In addition Dunlosky and his colleagues (Dunlosky et al., 2013 in Coe et al., 2014, p. 18) made a summary of the research on the impact of learning techniques and discovered that some techniques have high utility, while others only moderate or even low utility:

- (high utility) Self-testing or taking practice tests on material to be learned;
- (high utility) Implementing a schedule of practice that spreads out study activities over time;
- (moderate utility) Generating an explanation for why an explicitly stated fact or concept is true;
- (moderate utility) Explaining how new information is related to known information, or explaining steps taken during problem solving;
- (moderate utility) Implementing a schedule of practice that mixes different kinds of problems, or a schedule of study that mixes different kinds of material, within a single study session;
- (moderate utility) Writing summaries (of various lengths) of to-be-learned texts;
- (low utility) Marking potentially important portions of to-be-learned materials while reading;
- (low utility) Using keywords and mental imagery to associate verbal materials;
- (low utility) Attempting to form mental images of text materials while reading or listening;
- (low utility) Restudying text material again after an initial reading.

The given conclusions have clear implication on teaching, giving teachers directions on how to increase the effectiveness of the teaching-learning process they organise.

Having revised the literature relative to different aspects of the teaching competences which are essential for organising effective teaching-learning process as well as the process which has a high potential for the development of students thinking, I can now make certain conclusions which will allow me to shape the theoretical framework of my research.

1.5. Preliminary Conclusions

Conclusion 1

Different researchers identified important domains of good teaching (be it effective teaching or teaching which results in improved cognitive achievements of students or the like). Though being named differently by different researchers or being included in different classifications, these domains very often are identical in nature. For instance, when defining task-oriented classroom climate Anderson (Anderson, 2004) says that students have to be aware of the goal of the teaching-learning process, while Melnikova (Мельникова, 2002) is explicitly speaking about making students aware of the aim. One of the characteristics of methods and strategies for McBer (McBer, 2000) is the use of variety of questioning techniques, while many researchers involved in the study on teaching for thinking approaches also highlight the important of questioning. If McBer (McBer, 2000) includes pupil management (namely, the correction of bad behaviour) under the category of teaching skills, then Anderson (Anderson, 2004) is speaking about it under the category of classroom culture (namely, expectations for certain behaviour) as well as under classroom management (dealing with misbehaviour) and not under the category of teaching.

The conclusion I can make is that these domains can be combined together to have a better picture of all the components important to consider when speaking about organising the teaching-learning process. Some domains are clearly distinct from each other and some of them are overlapping.

Conclusion 2

Speaking about teaching, we can make the distinction between those domains which are related directly to the teaching-learning process and those which are said to influence it indirectly. In other words, the review gives some ideas of possible relationships between various components.

For instance, Anderson (Anderson, 2004) speaks about teacher characteristics claiming that their influence on teacher effectiveness (and consequently on student learning result) is not direct. What influences it directly is the student characteristics (knowledge

and skills, aptitudes, attitudes and values), the curriculum, the teaching and the classroom. Though both teacher and student characteristics are difficult to influence especially in the short term.

McBer (McBer, 2000), on the other hand, is claiming that teaching skills and teacher's professional characteristics lead to effective classroom climate. So we can assume they have a direct influence on student learning.

Coe (Coe et al., 2014) suggests that some teacher characteristics that cannot be directly observable in the classroom were found to be related to students gains. These include content knowledge and pedagogical content knowledge, beliefs about the nature of the subject they teach and what it means to understand it, as well as beliefs about how children learn and about the teacher's role in promoting learning.

Anderson (Anderson, 2004) found out that the major research findings show the type of activity has less significance and impact on student learning than the way in which the activity is presented to students (structure and clarity), how students engage in the activity (involvement) and how the activity and the students' participation are interpreted by the students themselves (meaning).

As I can conclude, there is no unanimous opinion on which components are more important than others; however, some tentative assumptions can be made from the available research.

Conclusion 3

The undertaken analysis allows me to extend on and re-synthesize the main components of teaching competences (see Table 13 and Figure 9). Those components which were kept from the previous summary are typed in *italics*. As it can be seen from, the 10 main dimensions which were identified include Aims of learning, Instruction (or Teaching or Methods for reaching instructional aim), Interaction (or Communication), Classroom management, Classroom climate (or Classroom psychological environment), Classroom physical environment, Classroom culture, Assessment, Homework, Teacher beliefs and values

Table 13 The second synthesis of the main components of teaching competences

Dimensions	Main components	Teaching competences
Aims of learning	Formulation of aims	<i>Formulates and achieves aims and objectives of the teaching-learning process</i>
		Plans the lesson as a part of the learning unit
		Links lesson aims and objectives to curriculum
		Formulates aims and objectives of the lesson through student learning outcomes following the structure of subject-verb-object
		Identifies types of knowledge and cognitive processes that stand behind formulated objectives
		Formulates three levels of aims: <ul style="list-style-type: none"> • global (course); • educational (learning unit); • instructional (lesson) Instructional aims can include: <ul style="list-style-type: none"> • academic (focus on students' knowledge or skills), • social (focus on social skills and relationships), • recreational (focus on enjoyment of participating in the activities)
Involvement of students in aim formulation	Knowledge for reaching formulated aims	Formulates the role of the lesson: <ul style="list-style-type: none"> • understanding new content, • expanding on new content for the purposes of its mastery; • reviewing previously taught content to help students remember it; • reviewing previously taught content for the purposes of correcting misunderstandings.
		Builds a logical link between formulated objectives, instructional activities, materials and assessment: alignment
Instruction (Teaching or Methods for reaching instructional aim)	General lesson structure	Makes students aware of learning aims and objectives <ul style="list-style-type: none"> • Communicates a clear plan and objectives for the lesson at the start of the lesson; • Challenges students to identify the reason why an activity is taking place in the lesson; • Makes students formulate lesson aim
		Shows relevant content knowledge for the domain selected for study Shows relevant pedagogical content knowledge for the domain selected for study (can name the ways students think about the content, can evaluate thinking behind students' own methods, and identify students' common misconceptions)
		Builds a lesson according to a specific lesson structure <ul style="list-style-type: none"> • E.g. a four-phase lesson structure (Germany): <ol style="list-style-type: none"> 1. review of previous material 2. presentation of the topic and the problem to study, 3. development of a procedure to solve the problem (usually in a whole class activity guided by the teacher) 4. practice, (usually by assigning a set of problems similar to those in the previous phase that are solved by the students as

	seatwork).
Elements of the lesson	Outlines the content to be covered and signals transitions between lesson parts
	Reviews previous learning;
	Draws attention to and reviews main ideas.
	Encourages students to use a variety of problem solving techniques: <ul style="list-style-type: none"> • Encourages students to use problem-solving strategies presented by the teacher or other classmates; • Invites students to develop strategies
	Provides model responses for students;
	Gives sufficient opportunities to practice and apply what students are learning;
	Provides improvement-oriented feedback
	Reviews what pupils have learned at the end of the lesson
	Asks students to reflect. Reflection can happen at several levels: <ul style="list-style-type: none"> • Students are asked to identify the thinking strategies they had used during the lesson, to reflect upon their mistakes, to explain their mistakes, and to suggest ways for avoiding similar mistakes in the future; • Students are asked about how to generalize a thinking strategy; • Students are asked to reflect on the gains from the lesson; • Students are asked to analyse what thinking skills are applied in the process of problem solving
	Bridges thinking developed during the activity to different contexts or to the world outside school
General characteristics of instruction	Draws on students experiences or ideas relevant to the lesson
	<i>Selects and applies the methods of teaching</i> <ul style="list-style-type: none"> • Uses a variety of activities/learning methods
	Gives clear instructions and explanations
	<i>Adapts the teaching-learning process depending on the situation</i>
Types of tasks	Involves students in tasks of different cognitive level and regularly involves them in doing higher-order tasks. <ul style="list-style-type: none"> • recall of information, • comprehension, • lower-level application, • higher-order thinking (analysis, creation, evaluation).
Classroom instructional organisation	Use variety of instructional formats (activities, events), such as <ul style="list-style-type: none"> • one-way presentation (lecture or monologue), two-way presentation (discussion or dialogue), mediated presentation (computers, videotapes and slides) • seatwork, group work • silent reading, reading circles • games • recitations (rapid-fire questions and answers), • student reports • tutorials • tests

		<p>Ensures appropriate balance between different lesson stages:</p> <ul style="list-style-type: none"> • whole time interactive, • whole class lecture, • individual work, • collaborative group work, • classroom management, • testing/assessment
		Provides a balanced combination of three classroom arrangements: whole class, small group and individual student.
	'Thinking language' of the lesson	Uses different 'thinking words' (words that refer to mental processes and products) on the lesson (i.e. thinking, drawing conclusions, making assumption, assuming, justifying, establishing causal relationships, making contradictions, etc.).
	Thinking strategies students are engaged in and their variety	<p>Involves students in using a variety of thinking strategies:</p> <ul style="list-style-type: none"> • Inquiry skills: Defining a research question, Planning an experiment, Describing experimental results, Drawing conclusions, Controlling variables, Thinking about interactions between variables • Processing skills: Entering data into a table, Making graphs, Reading data from a table, Analyzing data • Critical thinking skills: Problem solving, Making comparisons, Forming definitions, Identifying relevant, information for solving problems, Identifying tautologies, Identifying assumptions, Sampling, Hypothetical-deductive reasoning, Constructing arguments and counter-arguments, Searching for various factors that should be taken into consideration while discussing a problem, Asking questions
	Materials & Resources	<i>Selects and uses materials/resources for the teaching learning process</i>
Interaction (Communication)	Dialogue	Is talking <i>with</i> students, rather than talking <i>at</i> them: asks, listens, responds, reduces unnecessary interruptions
		Pursues students understanding why something is right; Asks students to elaborate on the answer, clarify it and reason their judgement;
		Deals adequately with students incorrect, incomplete or wrong answers: <ul style="list-style-type: none"> • provides immediate feedback to students concerning the correctness of adequacy of their responses; • avoids immediate rejection of student's wrong answer ("no", "nearly but not quite") and starts pursuing the reason of the fault ("why is it then?") helping student to formulate a more accurate answer; • controls the tone of the response, accepting the erroneous reply with a neutral tone; • understands possible source of students' mistakes and uses techniques that would help a student get out of difficulty: <ul style="list-style-type: none"> ○ generates a simpler, similar problem, that may enable the student to solve the original problem through analogy; ○ asks questions in order to track the source of the student's mistake. ○ provides scaffolding, gives clues, so that the student could find the correct answer by herself; ○ uses combined explanations and elaborations: uses the erroneous answer to generate a whole class discussion: "Do you agree with that? Anyone got any other idea?" ○ (if the above fails) redirects the question to another student in the class ○ (if the above fails) provides the appropriate response
		Praises students to reinforce correct, adequate and appropriate responses, as well as their thought and effort and makes it clear to students why they are being praised.

		Gives longer time for students to think and respond before offering a helping question, asking another student to respond or providing a correct answer
		Maintains a balanced proportion of students talking vs teacher talking
		Reformulates and summarises learners' contribution and clarification
	Questioning	Uses a variety of questioning techniques to probe pupils' knowledge and understanding
		Raises different types of questions (i.e., process and product) at appropriate difficulty level: <ul style="list-style-type: none"> • lower-order questions are asked with the purpose of finding out whether the students understand what is being presented. • higher-order questions are asked with the aim to stimulate the students' thinking (they require higher-order mental operations); • shifts from closed questions (what/when) to open questions (how/where), 'how-questions' (procedures) and 'why-questions' (underlying reasons); • variety of open questions from more straightforward "why is...?" to "why do we...?", "why not...?", "what if...?".
		Uses more focused questions and examples from students' daily lives;
	Student engagement	Involves all students in the lesson rather than focuses on only active/strong students. Some techniques which may be used include: <ul style="list-style-type: none"> • Proceeds with asking opinion of several students even if the first one gave the 'correct' direction; • Not rushes into asking the first student who raises a hand but giving time to others to think.
	Patterns of verbal interaction	Uses different patterns of verbal interaction: tell something, ask questions, allow/encourage students to answer the questions, react to the answer or lack of answer.
	Patterns of action	Combines showing and telling (demonstrating or modelling) in his teaching
		Uses 'cognitive modelling' - talk through the strategy while demonstrating it to students.
Classroom management	Student management/ Discipline	Keeps the majority of students (over 90%) on task throughout the lesson
		Applies preventive classroom management effectively. <p>Through establishing rules and routines, persuading students to respect them and using them. Rule and routines:</p> <ul style="list-style-type: none"> • are planned in advance; • are relatively few in number; • are communicated clearly to students and their necessity is justified; • have specific consequences applied if not respected. <p>Through certain behaviours for preventive classroom management:</p> <ul style="list-style-type: none"> • 'With-it-ness': constant awareness of everything that is happening in the classroom at all times; • 'Group alerting': using a standard and predictable signal to get students' attention; • 'Overlappingness': the ability to deal effectively with more than one matter at the same time; • 'Momentum': keeping events and activities moving at a fairly brisk pace; • 'Accountability': letting the students know that they themselves are responsible for their learning and the quality of their work; • 'Providing variety and challenge in seatwork': setting assignments that provide a sufficient element of challenge and

		<p>variety to maintain the students' interest and attention.</p> <p>Applies reactive classroom management effectively:</p> <ul style="list-style-type: none"> • Corrects bad behaviour immediately <p>Praises good achievement and effort</p> <p><i>Regulates one's own emotional balance including in the cases of problem situations (self-regulatory, self-management abilities)</i></p>
	Time & Resource management	<p>Structures the lesson to make efficient use of lesson the time</p> <p>Controls that the lesson lasts for the planned time</p> <p>Uses an appropriate pace</p> <p>Allocates time fairly amongst pupils</p> <p>Coordinates classroom resources and space</p>
Classroom climate (Classroom psychological environment)		<p>Creates inviting classrooms where (according to students perception) students feel mutual respect between teachers and students and where there are positive and cooperative relationships.</p> <p>Creates task-oriented classrooms where (according to students perception) students are aware of definite goal they have to pursue and belief that they are held accountable for achieving this goal. Large proportion of classroom time is spent on pursuing this goal.</p> <p>Creates well organised classrooms where (according to students perception) expectations for behaviour and learning are made explicit and an appropriate structure is provided by the teacher to guide behaviour and learning.</p> <p>Creates classroom climate with the following characteristics:</p> <ul style="list-style-type: none"> • <u>Clarity</u> around the purpose of each lesson. How each lesson relates to the broader subject, as well as clarity regarding the aims and objectives of the school. • <u>Order</u> within the classroom, where discipline, order and civilised behaviour are maintained. • A clear set of <u>Standards</u> as to how pupils should behave and what each pupil should do and try to achieve, with a clear focus on higher rather than minimum standards. • <u>Fairness</u>: the degree to which there is an absence of favouritism, and a consistent link between rewards in the classroom and actual performance. Treats different children fairly • <u>Participation</u>: the opportunity for pupils to participate actively in the class by discussion, questioning, giving out materials, and other similar activities. • <u>Support</u>: feeling emotionally supported in the classroom, so that pupils are willing to try new things and learn from mistakes. • <u>Safety</u>: the degree to which the classroom is a safe place, where pupils are not at risk from emotional or physical bullying, or other fear-arousing factors. • <u>Interest</u>: the feeling that the classroom is an interesting and exciting place to be, where pupils feel stimulated to learn. • <u>Environment</u>: the feeling that the classroom is a comfortable, well organised, clean and attractive physical environment. <p><i>Creates positive learning environment</i></p> <ul style="list-style-type: none"> • <i>motivates learners</i> • <i>varies motivational strategies for different individuals</i> • <i>builds positive relationships with learners</i>
Classroom		Makes sure necessary equipment and material is available in the classroom

physical environment		
Classroom culture		Encourages high standards of effort, accuracy, presentation
		Creates constantly demanding classroom and recognises students' self-worth;
		Provides opportunities for students to take responsibility for their own learning
		Attributes student success to effort rather than ability;
		Values resilience to failure (grit).
Assessment	Students' assessment	Focuses assessment on several levels: <ul style="list-style-type: none"> • understanding and meaning, • factual memory, • skills mastery, • applications in real-life settings
		<i>Uses different techniques to collect data on student knowledge and skills and different methods of assessing students work and understanding:</i> <ul style="list-style-type: none"> • tests • competitions • etc.
		Recognises students misconceptions and clears them up
		Reports the results of assessment to students: <ul style="list-style-type: none"> • e.g. students' written work have been marked or otherwise assessed
		Encourages pupils to do better next time
		Teacher's assessment
Homework		Sets homework to consolidate or extend the coverage of the lesson
		Follows up homework set on the previous lesson
		Explains what learning objectives students will gain from homework
Teacher beliefs and values		

Some of the dimensions include separate components, while others do not and have the same name for the component as for the dimension. Every component is characterised by a list of separate competencies.

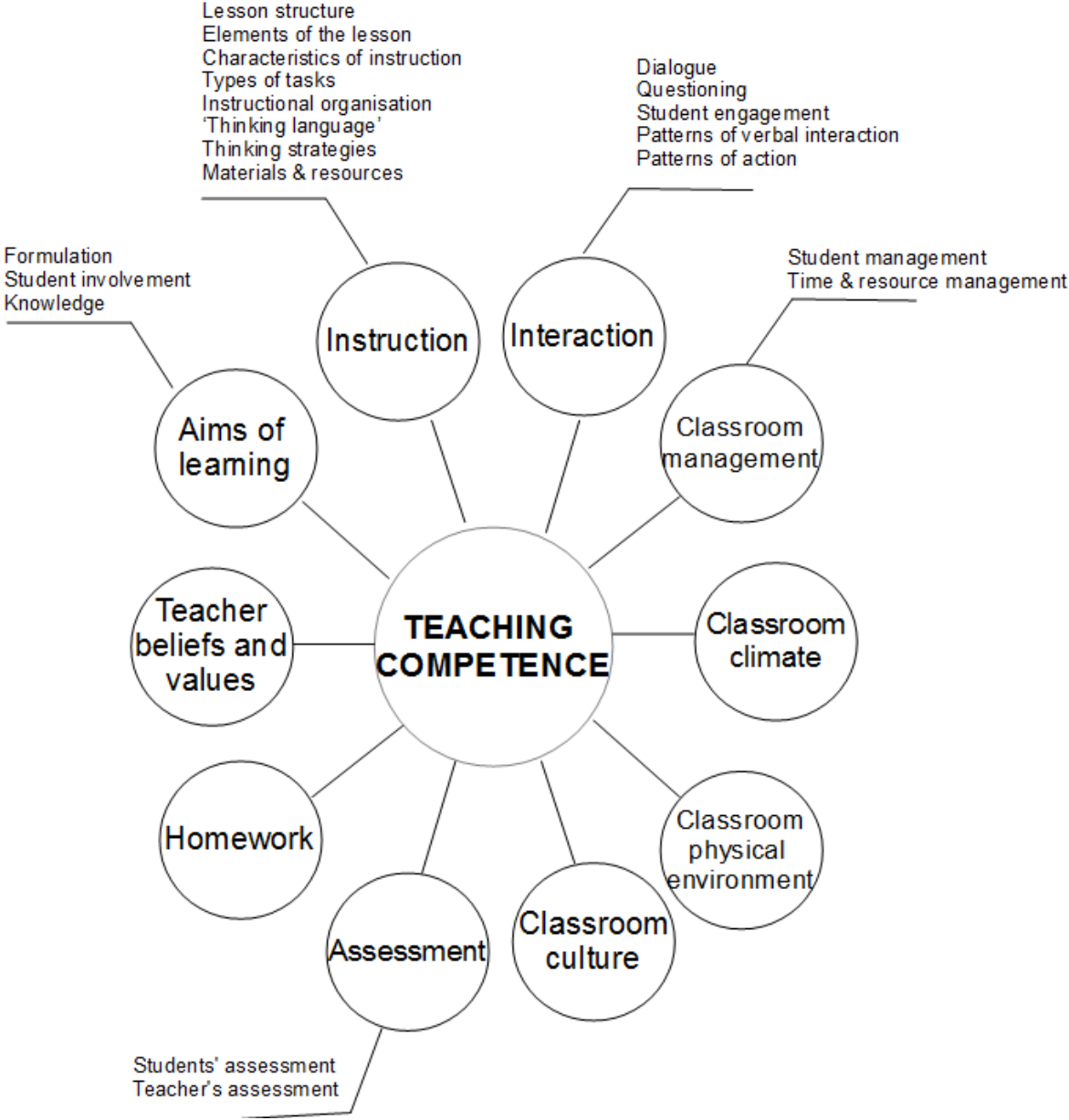


Figure 9 The model of the main components of teaching competence

I acknowledge that the list of components and competences is neither full nor exhaustive but merely represents those components which were identified in the studied research literature. For instance, it was discovered that the dimension of 'classroom culture' should include beliefs and values as well as modes of construing reality shared by all the students and a teacher in the classroom. It can be defined by (a) looking at

the roles and responsibilities of students and teachers, (b) the relationships between teachers and students and among students themselves, and (c) importance and nature of learning. The teaching competences associated with this dimension in the compiled table include mostly the idea of the importance and nature of learning and does not give details about other areas. This is due to the fact that these were either not identified in the literature or were partly included under the associated dimension of classroom climate. What concerns the dimension of 'Teacher beliefs and values', this is the only one which has not been detailed through separate competences. 'Teacher beliefs and values' can be defined by studying why teachers adopt particular practice(s), their beliefs about the nature of the subject they teach and what it means to understand it, teachers' theories on what learning is and how it happens. The analysis of the identified literature did not allow me to deduce specific competences associated with this dimension. Further studies of available research would be required for this purpose. Some aspects discussed in the theoretical literature, such as teacher professional characteristics and student characteristics were not included in the synthesis. Student characteristics were not included because, though being important for the teaching-learning process, they are not part of teacher's teaching competence. Professional characteristics were considered to be too indirectly linked with the teaching process as such. The importance of both dimensions is, however, recognised.

The model of the main components of teaching competence presents the first outline of the theoretical basis of my research. However, before it can get the full status of the theoretical framework one more aspect has to be studied and clarified. The model presents a general framework of teaching competence for organising effective teaching-learning process. I can say that these are threshold competences, the foundation on which other competences relative to specific approaches can be built on. The given research deals with the teaching competence for organising the Problem-Centred Education. Therefore, the next objective is to identify those competences which are specific for the Problem-Centred Education. The following chapter is dealing with this question.

Part two

The Problem-Centred Education, Its Place among the Existing Teaching for Thinking Approaches and Teaching Competences Required for Its Implementation

The idea of the so called '*teaching for thinking approach*' or '*problem education*' is not new. Some educational professionals consider it to be "one of the most effective means for activating students' thinking"⁴⁸ (Махмытов, 1975, p. 247). However, when speaking about it, one has to be aware that '*problem education*' is not a solid concept and can refer to different pedagogical approaches. Even though all of these approaches explicitly or implicitly put a 'problem' as their core stone, their theoretical foundations can be traced back to different philosophical and psychological views, thus giving rise to different methodological implications. The given research is focused on teaching competence which is required for organising specifically the Problem-Centred Education; therefore, the objective of the given chapter is two-fold: first of all, to define the theoretical foundations of the Problem-Centred Education and to position it among the existing '*teaching for thinking approaches*' and '*problem approaches*', and secondly, to identify which specific teaching competences are required from a teacher in order to be able to organise the given teaching-learning process.

In order to reach the first objective, the following sub-questions were posed:

1. Which '*teaching for thinking approaches*' exist?
2. Which problem do they target to address?
3. What is their theoretical basis and methodology?
4. Which teaching competences are required for implementing teaching for thinking approaches?
5. Which teaching competences are specific for the problem-centred approach?

While working on the first objective, I have arrived at distinguishing at least four main movements that can be placed under the umbrella of '*teaching for thinking approaches*' or '*problem education*': Problem Based Learning (PBL), Problem Education (PE)⁴⁹, the Problem-Centred Education (PCE)⁵⁰, as well as the so called Thinking Skills Approaches that call for activation of students' thinking. All these approaches were analysed and compared according to five criteria:

⁴⁸ From Russian, «Проблемное обучение является одним из наиболее эффективных средств активизации мышления ученика»

⁴⁹ From Russian, *проблемное обучение*

1. Theoretical basis behind the approach.
2. Target group: for whom were they developed?
3. Aim: why they were developed? Which problem do they target to address? How do they formulate the goal of the teaching-learning process?
4. Content: what do they offer to teach as content?
5. Methods and Interaction: How do they offer to teach this content?
6. Result: How do they measure success, i.e. that the teaching-learning process reached the defined goal?

2.1. Theoretical Foundations of the Problem-Centred Education (PCE)

In late 1990s a group of educational professionals who were interested in the problem solving theories called the Theory of Inventive Problem Solving (TRIZ) and the General Theory of Powerful Thinking (OTSM)⁵¹ (further referred to as OTSM-TRIZ theory) decided to apply these theories in the domain of education. Among these scholars were Alla Nesterenko (Russia), Alexander Sokol (Latvia), Tatyana Sidorchuk (Russia), Nikolai Khomenko (Canada/France), and Ingrida Murashkovska (Latvia). As a result, in addition to applying the OTSM-TRIZ theory for solving the problems faced by educational domain as such some approaches appeared which aimed at helping school students develop their problem solving competence (as viewed in OTSM-TRIZ) while studying a subject. Even though these are distinct approaches which may not share all the features, they are, however, very close to each other in their theoretical foundation, therefore in my research I refer to this group as the Problem-Centred Education.

According to the OTSM-TRIZ problem-solving theories any system during its evolution is overcoming contradictions between objective restrictions and the limits of a specific situation. The reason why the system appears and evolves is because it faces and

⁵⁰ From Russian, *проблемно ориентированное обучение [problemno orientirovannoe obucheniye]*

⁵¹ Theory of Inventive Problem Solving (TRIZ), from Russian «Теория решения изобретательских задач - ТРИЗ»; General Theory of Powerful Thinking (OTSM), from Russian «Общая теория сильного мышления - OTSM».

solves contradictions⁵². Contradiction is the cause why the system faces a problem. Solution of a contradiction is a step in the development of a system. Applying this view to the domain of education, the following dependence was formulated. The development of educational system as such is determined by the requirements imposed by the economic and sociological contexts, in other words, by the society; changes in the society provide objective restrictions to educational system. According to the principle developers of the Problem-Centred Education (Мурашковска & Хоменко, 2003; Нестеренко, 2007; Хоменко, 1993) the main tendencies in the development of the modern society (known as information or knowledge society) that are essential for the development of educational system include the following⁵³:

- The speed at which the volume of available information increases. As a result, the educational system has to increase the volume of information which has to be acquired by students during the educational process;
- The speed at which the information becomes outdated and renewed. As a result, there is not enough time to systemise and organise all the information and it is often included in the educational content and presented to students in a non-systematised way.
- The emergence of numerous sources that provide access to information. As a result, the school has lost its role of being the main source of information and knowledge for students.

Outlining these main tendencies allowed the Problem-Centred Education experts to formulate the following contradictions that according to them are driving the development of educational systems:

- The volume of information that a student has to acquire in the teaching-learning process has to be huge and constantly increasing in order to ensure a student receives all the information (s)he needs for acting successfully in the future life

⁵² The author of the paper is aware that the concept of '*contradiction*' is not specific to the OTSM-TRIZ problem solving theory and is employed in other theories as well (e.g. contradiction in dialectics). However, in the given case it is used specifically as it is conceptualised in OTSM-TRIZ. Throughout the thesis, whenever the concept of '*contradiction*' is employed with the reference to the Problem-Centred Education, it is used in a sense as it is conceptualised specifically in the OTSM-TRIZ theory.

and it has to be small and limited in order to preserve student's mental and physical health (since there are physiological and psychological limitations placed on the amount of information a person can acquire) and reduce the amount of time spend on learning (Нестеренко, 2006а, р. 16, 2007, р. 6; Хоменко, 1993, р. 2)

- The speed of renewing teaching content has to be high in order to ensure a student gets all the relevant information of the dynamic world and it has to be slow in order to facilitate the organisation of the teaching-learning process since it is easier to control the process where content is fixed and stable than a process where content is constantly renewed (Нестеренко, 2007, р. 6).

Following the rules of intensifying contradictions, Nesterenko has formulated the following driving problem of education: *“a teacher has to know the content of education in advance in order to organise the teaching-learning process and a teacher cannot know this content in advance since most of the information a student will need in future is unknown at the moment a student is involved in the process of learning”*⁵⁴ (Нестеренко, 2006а, р. 16, 2006b, р. 2, 2007, р. 6).

According to Murashkovska and Khomenko this problem sounds as follows: *„teachers must prepare students to the life that teachers know nothing about”*⁵⁵ (Мурашковска & Хоменко, 2003, р. 32).

The Problem-Centred Education has been developed as a solution to this driving contradiction or driving problem. As described above, it targets the question of **an ever-increasing content of education** which appears as a result of a general trend of ever-increasing volume of information in our information or knowledge society, of **the reduced amount of time** available for the acquisition of this content and of **vagueness or even absence of information** that students will need in future. As remarked by Murashkovska (Мурашковска, 2004, р. 3), the general tendencies to extend learning

⁵³ My aim is not to provide the exhaustive list of tendencies identified by the educational professionals of the Problem-Centred Education but to highlight those which are the most relevant for the given chapter. Therefore, for the full list of formulated tendencies please refer to the original articles.

⁵⁴ From Russian «содержание образования должно быть известно педагогу, чтобы обеспечить технологичность обучения, и не может быть ему известно, т.к. большая часть информации, которая потребуется ученику в будущем, в период обучения не существует».

time in the lifelong and lifewide learning perspectives or to re-arrange learning content and decide which one is the most appropriate one to be covered and which can simply be abandoned are the attempts done by the educational system to survive under the objective constraints imposed by the social and economic context. According to Murashkovska (Мурашковска, 2004, p. 4) these attempts do not solve the driving contradiction of education but merely turn around it. The Problem-Centred Education, on the other hand, offers to solve the contradiction by changing the view on **the structure of education content**. The structure of education content should not be guided by division of content into subjects (see Figure 10) as it is done currently but should be guided by the study of a problem (Мурашковска, 2004, p. 5)

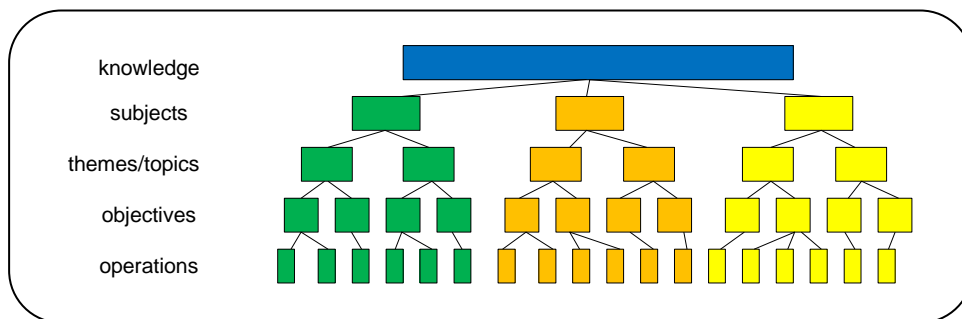


Figure 10 Model of the structure of education content guided by division of content into subjects (Мурашковска, 2004, p. 2).

A problem should become a cornerstone, a pivotal component for organisation of educational content, the central value in the system (Sokol, 2007, p. 42; Нестеренко, 2006a, p. 12, 2006b, 2007, pp. 6–7) and the meta-tools for defining, analysing and solving problems should become its new structural component (Нестеренко, 2006a, p. 12). These meta-tools have been adapted from the OTSM-TRIZ theory and introduced in the educational process (see Chapter 2.6 for the detailed information on the tools). The attention from teaching specific facts and methods⁵⁶ is shifted to teaching students models or meta-models and „specific subject matter content is studied within meta-models” (Sokol, 2007, p. 42) (see Figure 11). As a result, the volume of compulsory education content is reduced and at the same time all the information space becomes

⁵⁵ From Russian, «педагоги должны учить своих подопечных выживать в том мире, о котором сами педагоги не имеют никакого представления».

part of that content that students can use in order to get the new and relevant information when they have to (Нестеренко, 2007, p. 7). The given new conceptual solution distinguishes the Problem-Centred Education from other ‘problem’ and teaching for thinking approaches that merely use so called problem tasks as a means for activating students thinking and reaching subject-matter aims.

The aim of the Problem-Centred Education is defined as “*the development of a world view centred on a problem*” (Sokol, 2007, p. 43) and the **Problem-Centred Education is defined as** „*a teaching-learning process which includes meta-tools as part of its content; the given meta-tools allow to structure and reorganise information with the aim of identifying, analysing and solving problems in various domains*”⁵⁷ (Нестеренко, 2006a, pp. 3, 13)

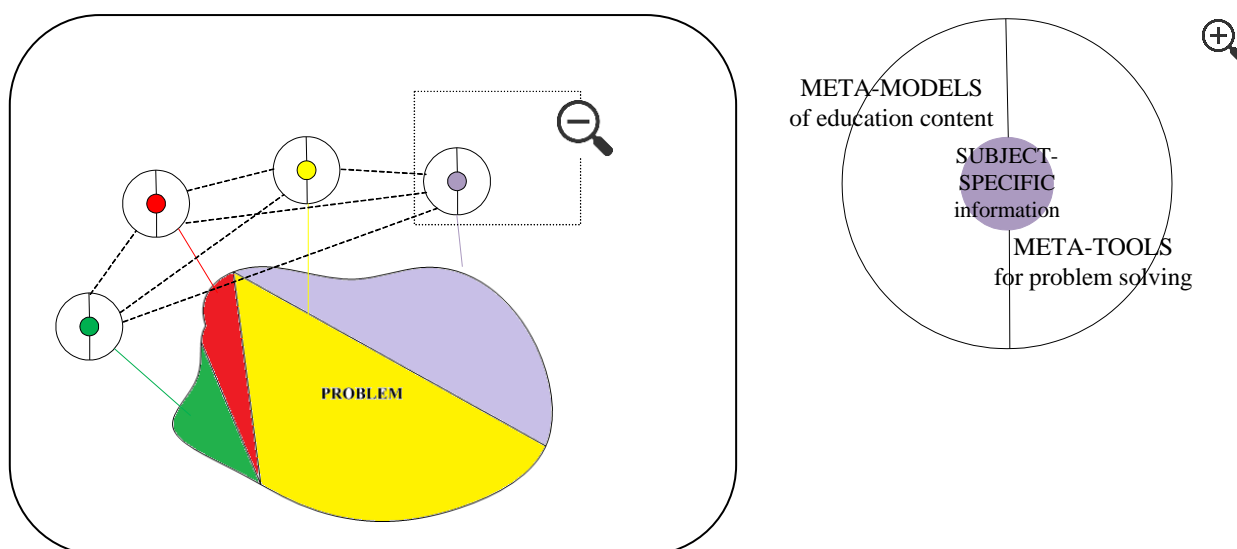


Figure 11 Model of the structure of education content guided by the study of a problem (inspired by Мурашковска, 2004, p. 8).

In the framework of the Problem-Centred Education students learn to set cognitive, practical and communicative aims and reorganise and restructure the information for reaching these aims. In addition, on the basis of the obtained information, students learn to set new aims that can be solved by applying this new information. (Нестеренко, 2006a, p. 13)

⁵⁶ From Russian, «способы действия»

⁵⁷ «Под проблемно-ориентированным обучением мы понимаем такое обучение, содержание которого включает метапредметные средства, позволяющие структурировать и преобразовывать информацию с целью выявления, анализа и решения проблем в различных областях знания».

Hence, the definition of PCE highlights the work with the information for identifying, analysing and solving problems. And meta-tools for identifying, analysing and solving problems become additional content that should be introduced into the teaching-learning process.

Of course, taking into account how the current public education system is organised, especially school education, it is difficult to imagine that a subject-based structure will be replaced by a problem-based structure⁵⁸. So at the current stage, the only change that can be expected is that the given structure finds its way in specific subjects, namely, that a content of a certain subject will be organised through problems with the meta-models and meta-tools being its structural components.

Following the provided formulation of the aim of the PCE and its definition, there are at least three main questions that arise: (1) what does it mean “*a worldview centred on a problem*” and how is a ‘*problem*’ defined in the framework of the Problem Centred Education (2) what does it mean to teach models or meta-models and to study specific subject-matter content within these meta-models and (3) what are these meta-tools that are used in the Problem-Centred Education as additional content which allows students to control the process of problem solving?

⁵⁸ It is worth noticing, however, that the so called IB schools already offer curriculum frameworks which are described as broad and balanced, conceptual and connected. They focus on “*broad and powerful organizing ideas that have relevance within and across subject areas*” (International Baccalaureate Organization, 2013, p. 8). For instance, in the Primary Years Programme (PYP) for learners in the 3-12 age range, the curriculum is organised through “*six transdisciplinary themes of global significance*” (International Baccalaureate Organization, 2013, p. 8). Moreover, Finland right now is planning a radical curriculum reform changing its curricular model from traditional subject teaching (teaching by subject) to a topic-based curriculum (teaching by topic, or “phenomenon” teaching) and moving to a more informal, cooperative style of learning (http://www.oph.fi/english/education_development/current_reforms/curriculum_reform_2016).

2.2. The View on the Problem within the Problem-Centred Education

The question of developing students' '*world view centred on a problem*' can be better explained by a model of the so called 'five images' offered by Murashkovska and Khomenko (Мурашковска & Хоменко, 2003, p. 32). According to these scholars, if the driving contradiction of educational system is formulated as the need to prepare students for the life teachers' know nothing of then the aim of education has also to be reformulated. Education can no longer cater for the mere transfer of accumulated experience and knowledge. The aim shifts to developing personality who is autonomous in getting new knowledge and who is able to efficiently adjust his world image according to the newly acquired information.

First of all, education should take into account the intersection of the two images: **the image of the surrounding world** (which includes various images, such as physical, mathematical, aesthetical world, etc.) and **the image of a person's aims, wishes or needs** (see Figure 12). In other words, a human being is interacting with the world trying to satisfy his needs. Hence, the more a human being understands how the surrounding world can help him in achieving his own aims, the more meaning the information of the surrounding world has for him. The subject-based education very often neglects the importance of this link and the interconnection between the various images of the surrounding world. As Murashkovska and Khomenko (Мурашковска & Хоменко, 2003, p. 32) put it, in the real world our wishes are more complex than to calculate the area of a rectangle and the solution for satisfying our needs lies on the crossings of several images of the surrounding world. Hence, a person should learn to work with a network of interconnected images of the surrounding world in order to achieve his personal aims.

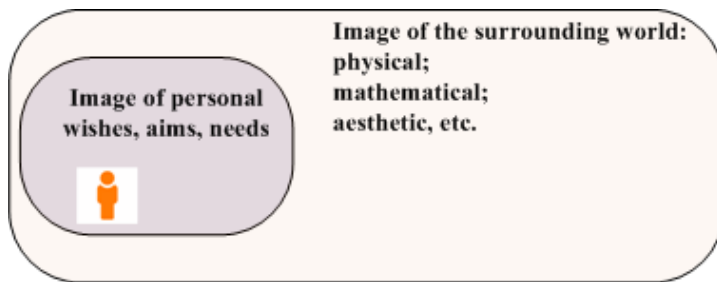


Figure 12 Model of interconnection of two images: (1) the image of the surrounding world (physical, mathematical, aesthetic, etc.) and (2) the image of personal wishes, aims and needs.

Moreover, in order to make his personal wishes and aims come true, a human being should be aware of one more image, that of the tools or methods, which would help him to transform a mere wish into the reality (see Figure 13). He should be able to imagine the network of images in their interconnection in order to identify a knot which has to be transformed in order to achieve his aim, and should know how to transform it. **The image of tools or methods** should provide an answer of HOW to make this transformation.

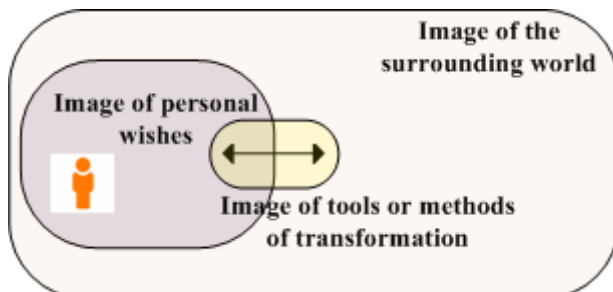


Figure 13 Model of interconnection of three images: (1) the image of the surrounding world, (2) the image of personal wishes and (3) the image of tools or methods of transformation.

One more essential image that education should help a person to develop is that of his resources, i.e. abilities and possibilities (see Figure 14). These can include physical and psychological, social and cultural, conscious and subconscious resources and others. **An image of resources** should allow a human being to change something in himself in order to increase his chances to reach his aim. On the other hand, it can allow him to reject his aim and change himself in order to avoid internal conflicts that may appear as a result of not reaching an aim.

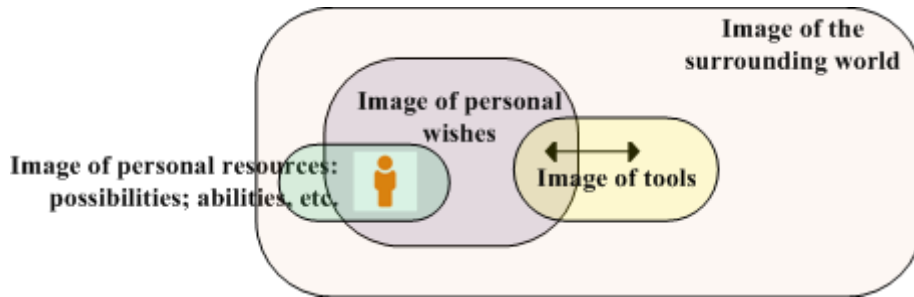


Figure 14 Model of interconnection of four images: (1) the image of the surrounding world, (2) the image of personal wishes, (3) the image of tools and (4) the image of personal resources (possibilities, abilities, etc.).

Last but not least, reaching one’s own aims leads to the transformation of both the surrounding world and the internal world of a human being. As a result, the images of these worlds do not remain constant but change and hence, have to be re-constructed again and again. This creates the need for a **meta-image of how to create and destroy images** themselves (see Figure 15).

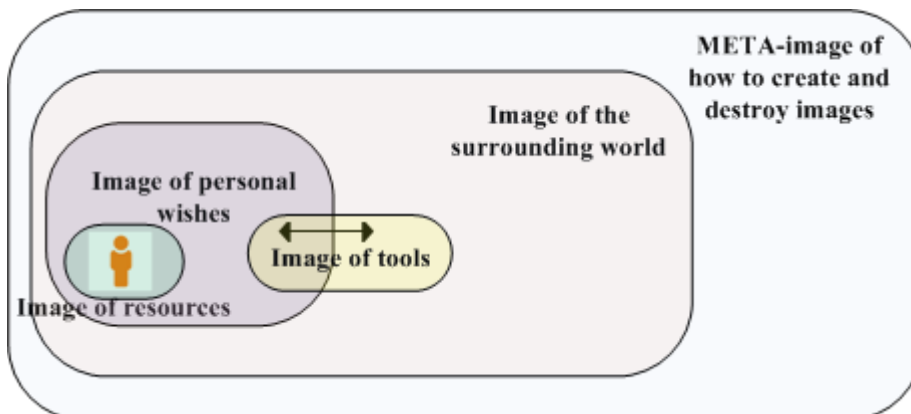


Figure 15 Integrated model of interconnection of five images: (1) the image of the surrounding world, (2) the image of personal wishes, (3) the image of tools and (4) the image of personal resources and (5) the meta-image of how to create and destroy images.

In order to succeed in the modern world a person has to be able to manage and operate with the dynamic images of his knowledge (surrounding world), wishes and resources, has to be able to manage and operate transformations of both the external and internal worlds. In the operation and management of the given network a person will be

constantly facing at least the following eight contradictions (Мурашковска & Хоменко, 2003, p. 33):

1. between the image of the surrounding world and the image of the wishes;
2. between the world of wishes and the world of resources;
3. between the separate worlds (physical, economical, ethical, etc.) within the image of the surrounding world;
4. between separate parts of one world within the image of the surrounding world;
5. between the image of the surrounding world and the image of tools for its transformations;
6. between all the images and the image of one's own resources for cognising and transforming them;
7. between the image of the resources and the image of methods for their transformation;
8. between the image of the aims and wishes and the image of methods for their transformation.

Hence, *developing a world view centred on a problem* can be explained as developing ability to identify and solve contradictions which appear as a result of interaction of the five dynamic images. In other words, **the aim of the Problem-Centred Education** is to develop the ability to be aware of and manage the network of the dynamic external and internal images, the ability to transform and change both external and internal world, the ability to identify and solve contradictions that arise between both external and internal worlds and the ability to change the five images themselves.

Coming to the question of **a notion of a problem** as seen in the framework of the Problem-Centred Education, we have to look at the concept through several perspectives.

From the perspective of the OTSM-TRIZ problem solving theory a problem can be defined as "*a contradiction between our wishes and objective laws of systems evolution which are manifested in peculiarities of a specific situation*" (Sokol, 2007, p. 44) In other words, a person faces a problem when he has a goal or a wish which cannot be achieved by applying available knowledge, so he is confronted with an obstacle on the way to his goal and faces a contradiction between his wish and peculiarities of a specific

situation. The contradiction is a cause of any problem so to make an operational definition of a problem one has to define the contradiction⁵⁹. Being based on the OTSM-TRIZ theory, the given definition of a problem incorporates the three main postulates of the classical TRIZ theory (Sokol, 2013, p. 22):

1. Objective laws of system evolution

There exist objective laws of systems evolution. These laws can be discovered, studied and purposefully applied for problem solving without non-systematic search for variants.

2. Contradiction as a problem cause

During their evolution the systems overcome the contradictions between objective restrictions and the limits of a specific situation.

3. Specific situation conditions

Any problem can be solved only for the conditions of a specific situation, using available resources.

The TRIZ problem solving theory is based on these postulates which allow it to direct a problem solver in the problem solving process. And specific OTSM-TRIZ tools allow a problem solver to systematically narrow down the search space and eventually bring him to the clear formulation of a contradiction and its resolution, which will be the best solution of a problem in the given situation. So when the concept of a **'problem'** is used from the OTSM-TRIZ perspective, it can either mean **an initial problem situation** - we want to achieve a certain goal but cannot do it due to a certain obstacle on our way, or **an operationally defined problem** – which is an initial situation analysed with the help of OTSM-TRIZ tools (which allow to systematically narrow down the solution search space in contrast to merely generating ideas) and formulated via the contradiction. Formulation of a contradiction, as seen in the OTSM-TRIZ theory, is an important part of a problem solving process. So mastering the OTSM-TRIZ tools that allow a problem solver to bring the initial situation into the form of a contradiction is important if one wants to be effective in solving non-typical problems.

⁵⁹ Contradiction is a specific concept of OTSM-TRIZ theory. It is a part of the set of ARIZ models (see Chapter 2.6.3 for more details)

The **Problem-Centred Education aims at** the development of learners' problem solving competence⁶⁰, which is defined as “*an ability and disposition to solve linguistic, sociolinguistic, pragmatic and other kinds of problems when no typical solution is available*” (Sokol, 2007, p. 56) and avoiding a large number of trials and errors (Sokol, 2007, p. 46). Hence, several OTSM-TRIZ tools (including those for defining the contradiction) are adapted to the Problem-Centred Education and are introduced in a teaching-learning process as part of its content; these are supposed to help learners find the solutions to the problems when no knowledge is available to them.

Since the concept of a problem and problem solving is far from being new, it is worth making a distinction between a concept of a problem as conceptualised in the OTSM-TRIZ theory and a problem solving concept as defined in other theories.

Having its roots in the field of Gestalt psychology (*Karl Duncker, Max Wertheimer, Wolfgang Köhler*), the classical problem solving concept was elaborated by Herbert Simon and Allen Newell (Simon, 1977, 1986, 1996; Simon & Newell, 1971) from the perspective of the Information Processing Theory.

The Gestalt perception of *a problem* defines the problem through the relations between the ‘given situation’ and ‘desired situation’:

“A problem arises when a living creature has a goal but does not know how this goal is to be reached. Whenever one cannot go from the given situation to the desired situation simply by action, then there has to be recourse to thinking. Such thinking has the task of devising some action, which may mediate between the existing and desired situations.” (Duncker, 1945, p. 1)

Thus, *problem solving* implies the transformation of a problem from a given state to the desired or the goal state. The action which has to perform this transformation is initially not known to the problem solver.

If Gestalt psychologists viewed this transformation as a restructuring of the problem representation in the mind of a problem solver which leads to a flash of insight, then Simon H. and Newell A. (Simon, 1977, 1996; Simon & Newell, 1971) were seeking to

⁶⁰ In the framework of the Problem-Centred Education ‘problem solving competence’ is also referred to as ‘inventive thinking skills’ when one has to refer to cognitive abilities connected to problem solving competence.

find what mental processes people use to solve problems and as a result offered and developed a notion of *a search in a problem space*.

„Problem solving is often described as a search through a vast maze of possibilities, a maze that describes the environment. Successful problem solving involves searching the maze selectively and reducing it to manageable proportions.” (Simon, 1996, p. 54)

The problem space – “*a space of possible situations to be searched in order to find that situation which corresponds to the solution*” (Simon & Newell, 1971, p. 151) - is the way the problem solver represents the task (i.e. the problem environment) in his/her mind in order to work on it. (S)he mentally moves through the problem space from the initial state (initial state of knowledge) to a target state (solution or solutions to a problem). The search in the problem space is carried from one knowledge state (what is known about the problem at a particular moment of time) to another until this state includes the problem solution (ibid.). Each knowledge state in the problem space is called a node, reaching which, a problem solver can choose an operator and apply it to reach a new node. Since the problem spaces, even those associated with relatively simple tasks, are enormous a problem solver searches selectively, examining small, promising regions of the space instead of systematically going through each and every possible knowledge state. **Heuristics** or rules of thumb help to reduce problem spaces to manageable sizes allowing a human being to solve problems. Heuristic (irregular formation from Greek ‘*heuretikos*’, which means ‘*inventive*’, related to ‘*heuriskein*’, ‘*to find*’ (Online Etymology Dictionary - <http://www.etymonline.com/index.php?term=heuristic>)) can be rules or strategies, principles or methods that help to increase the effectiveness and ease of problem resolution. However, they do not provide a direct answer themselves or guarantee a solution. Selective, heuristic search, not speed, has been the key organising principle of information processing in problem solving (Simon, 1986; Simon & Newell, 1971). In addition, Simon and Newell (Simon & Newell, 1971, p. 154) add that problem solving encompasses not only the activities which require to solve a particular problem in some problem space but also those activities required to construct a problem space in the face of a new task environment. Another thing which has been discovered about the classical problem solving is that it requires from a problem solver to have a

large amount of information stored in a memory and to be able to retrieve it when the cues for its relevance are recognised (Simon, 1986, p. 13).

In many classical problem solving situations (for instance, chess), all the elements of the problem definition (*initial state to start from, goal(s) to reach, problem space, a set of operators and heuristics to get from the initial state to the goal*) are well known, which makes the problem well-structured. At the same time, it is worth specifying that the researcher in cognitive psychology and artificial intelligence has been extended into targeting understanding of ill structured problems (Simon, 1986) when the goal is vague and is refined only in the process, when there are shifting problem formulations and operators for reaching the goal are not specified. Hence, the classical problem solving concept is evolving.

Some researchers (Beckenbach & Daskalakis, 2013) are integrating the perspective of the classical problem solving concept with the creativity research and modern cognitive psychology (relying on such scholars as *Joy Paul Guilford, Teresa Amabile, Robert Sternberg, Howard Gardner, Mihaly Csikszentmihalyi*, etc.) and speak about **creative problem solving**.

As it can be concluded from the analysis above, the classical problem solving concept is looked upon from the subjective, psychological perspective, i.e. how a problem is represented in the mind of a problem solver and how he moves through the problem space to the target state. Meanwhile in the OTSM-TRIZ theory, the concept of a problem includes the objective side – objective laws of system evolution. Moreover, it has a clear methodology for solving the problem step-by-step. Thus it's not about studying what the mind does when it is involved in problem solving (psychological perspective) as to telling it what it should do in order to arrive at the core of the problem and solve it. As mentioned elsewhere, OTSM-TRIZ theory offers meta-tools for problem solving and has its own apparatus of concepts (e.g. contradiction), which the classical problem solving concept does not offer.

From the psychological perspective, in the context of the Problem-Centred Education a **problem is viewed as** “*a subject's awareness of his inability to solve difficulties and contradictions faced in a certain situation by using his current knowledge and*

*experience*⁶¹ (Психология. Словарь, 1990. с.292-293 in Нестеренко, 2006а, р. 14). So, a problem is manifested in a psychological state of a mind of a learner who is confronted with the task he has no solution for.

When speaking about a problem in the context of the Problem-Centred Education, Nesterenko (Нестеренко, 2006а, р. 14) highlights a distinction between **a problem and a task**. If a problem is a learner's psychological awareness than **a task**, according to Leot'ev's view, is "*a goal given in certain conditions*⁶²" (Леонтьев А.Н., 1983, с.15 Нестеренко, 2006а, р. 14).

Coming from that, Nesterenko (Нестеренко, 2006а, р. 14) describes a task through the following parameters: clarity and measurability of the goal, operationality of the goal and clarity of conditions⁶³. Hence, when presented to learners **a task will cause a problem** for them when one of the following conditions is met:

1. Goal is not clear and measurable enough: it is not clear what the final outcome should be.
2. Goal is not operational enough: it is not clear what the methods for reaching the goal are.
3. Conditions are not clear: it is not clear what the initial resources are, transforming which would allow us to reach the goal.

As remarked by Nesterenko (Нестеренко, 2006а, pp. 14–15) this classification of tasks is close to that of classification of problem situations made by the representative of the Problem Education, Mathuskin (see *Chapter 2.4.1 for more information on the notion of the problem situation*), who defines three components of a task: goal of action, conditions of action and method of action⁶⁴. If one component is unknown to a learner, he is faced with a problem situation. Moreover, in cybernetics Wilson A. and Wilson M (1976, p.39 quoted in Нестеренко, 2006а, р. 15) developed a typology of creative tasks through the model of input-output-system. Variation of these variables allows getting

⁶¹ «Проблема – осознание субъектом невозможности разрешить трудности и противоречия, возникшие в данной ситуации, средствами наличного знания и опыта».

⁶² From Russian, «цель, данная в определённых условиях».

⁶³ From Russian «диагностичность цели, операциональность цели и определённость условий»

⁶⁴ From Russian «цель действия, условия действия, способ действия».

eight types of creative tasks, for example, output is given, input is given, the system has to be found, etc.

For the purposes of the Problem-Centred Education, Nesterenko (Нестеренко, 2006a, p. 125) identifies three types of tasks: goals are vague, resources are vague and both goals and resources are vague (see Table 14).

Table 14 Types of tasks and corresponding to them activity of learners in the framework of the Problem-Centred Education (Нестеренко, 2006a, p. 125)⁶⁵.

Clarity of goal (measurability)	Availability of the algorithm (operationality)	Clarity of conditions (resources)	Type of activity of learners
no	yes	yes	research targeting object exploration
yes	yes	no	research defined from the function
no	yes	no	

To sum up, in the framework of the Problem-Centred Education, the **notion of a problem** viewed from the perspective of the OTSM-TRIZ problem solving theories can refer to either an initial problem situation faced by a problem solver or a formulated contradiction. Thus, developing problem solving competence within the Problem-Centred Education refers to the ability to solve non-typical problems, to apply specific OTSM-TRIZ tools and transform initial problem situation into a clearly formulated contradiction and as a result its solution. In this respect, the notion of the problem solving competence is different from the classical concept of problem solving developed by Simon and Newell. From the psychological perspective, a problem would refer to a psychological state of the mind of a learner who is confronted to a task. In the teaching-learning process, students are not given problems to solve but rather the tasks that are expected to cause problems in their minds. In an everyday discourse, these two notions (a problem and a task) are often used interchangeably, which does not facilitate understanding.

⁶⁵ Translated to English by R.J.

2.3. The Place of the Subject-Matter Content within the Problem-Centred Education

The second question which has to be specified is the issue of models and the place of subject-matter content in the Problem-Centred Education.

As stated above, the new conceptual solution offered by the Problem-Centred Education as a solution to the driving contradiction of educational system is to single out features common for any education content, to build meta-models on their basis which would be independent of specific subjects and to teach students models or meta-models instead of 'pure' content, which should be studied within these meta-models. These meta-models will further serve as a basis for the newly received information allowing its effective organisation and transformation (Нестеренко, 2006a, p. 16, 2006b, p. 2).

In the framework of the PCE **a model as such is viewed as** *“a system represented in mind or in a material world, which being a representation or a reproduction of an object of the study is able to substitute that object in such a way that the study of that representation/reproduction allows us to discover new information about the object itself”*⁶⁶ (Штофф В.А., 1966, с 19 in Нестеренко, 2006a, p. 35). In other words, models are a schematic, rough representation of reality. They *“constitute a bridge between the observational and theoretical levels; and are concerned with simplification, reduction, concretization, experimentation, action, extension, globalization, theory formation and explanation”* (Apostel, 1961, p. 3 in Chorley & Haggett, 2014, p. 24). Allan Schoenfeld (Schoenfeld, 2000) views the notion of a model in scientific sense as *“a representation of a particular phenomenon, in which objects and relationships characterized in the model correspond to selected objects and relations in the phenomenon being represented”* (Schoenfeld, 2000, p. 248).

Models can be both practical and theoretical. In the framework of the Problem-Centred Education, these are the theoretical models which represent an interest, namely,

⁶⁶ From Russian «Под моделью понимается такая мысленно представляемая или материально реализованная система, которая, отображая или воспроизводя объект исследования, способна замещать его так, что её изучение даёт нам новую информацию об этом объекте».

models in the function of an image or representation of the reality, which combines the components of logical and sensory, abstract and concrete, illustrative and non-illustrative (Штофф В.А., 1966, с.33 in Нестеренко, 2006а, p. 36) . In order to define functions of theoretical models Nesterenko (Нестеренко, 2006а) relies on the classification of the British researchers Richard John Chorley and Peter Haggett (Chorley & Haggett, 2014, pp. 24–25), who define 8 main functions of theoretical models (for the purposes of her research, Nesterenko does not examine functions nr.3 and 8):

1. psychological function – models enable some group of phenomena to be visualized and comprehended which could otherwise not be because of its magnitude or complexity;
2. acquisitive function – models provide a framework wherein information may be defined, collected and ordered.
3. organizational function with respect to data and a fertility function – models allow the maximum amount of information to be squeezed out of the data.
4. logical function – models help to explain how a particular phenomenon comes about.
5. normative function – models help to compare some phenomenon with a more familiar one.
6. systematic function – models help to view reality in terms of interlocking systems, such that one view of the history of science is that it represents the construction of a succession of models by which systems have been explored and tested.
7. constructional function – models form stepping stones to the building of theories and laws. Models and theories are very closely linked, perhaps differing only in the degree of probability with which they can predict reality. The terms 'true' or 'false' cannot usefully be applied in the evaluation of models, however, and must be replaced by ones like 'appropriate', 'stimulating' or 'significant'. Laws are statements of very high probability and, as such, all laws are models, but not all models are laws.
8. cognitive function – models promote the communication of scientific ideas.

Shifting education content from pure, non-limited facts to modelling will allow reaching the given functions.

Speaking about the structure of the subject-matter content, Nesterenko (Нестеренко, 2006a, 2006b, p. 2) relies on the views of Vyacheslav Guzeev who distinguishes three structural components of any subject-matter content: facts (which describe objects and processes), tools⁶⁷ (which describe transformation of objects and processes, i.e. operations or algorithms of transformations), and dispositions⁶⁸ (beliefs, values, attitudes). In the framework of the PCE, instead of making students acquire 'pure' facts and procedures, students are working with the models of objects and processes and with the models of transformation and strategies (operations and algorithms) (see Table 15).

Table 15 Models of the structural components of subject-matter content (according to *Нестеренко, 2006, p 17*)

Structure of the content (information)	Facts	Methods for action/procedures
Model	Models of objects and processes	Models of transformation and strategies (operations and algorithms)

For example, instead of teaching students specific facts, such as specific historical events, they are offered a general model of a historical event which is described through a specific set of interconnected parameters. The next step is to build a model of any event which will further serve as a model for describing specific events, be it historical, economic, cultural or the like. The same holds true about procedures or methods for action. Instead of teaching students how to identify causes of a specific historical event, teachers can help students to build a more general model of how to identify causes of any event and this model will serve as a basis for various specific procedures (Нестеренко, 2006a).

Moreover, taking into account that one of the aims of the modern education is to develop students' ability to learn (learning to learn), their capacity to be autonomous in dealing with information and knowledge, an additional requirement which is posed to the Problem-Centred teaching-learning process is that students must be able to develop their own ways of building and exploring models, discovering rules of operating these

⁶⁷ From Russian «способы действий»

⁶⁸ Even though the component of dispositions is very important, it is not going to be discussed in the framework of this research due to the time and space limit.

models and discovering contexts for their application (Нестеренко, 2006а, p. 42). As a result, the role of a teacher shifts from leading students in getting the solution to a task to leading students in developing a model (a strategy or a tool) of how to cope with the given type of tasks. Typical tasks are treated as a typical problem, so the development and improvement of models (i.e. strategies or tools, 'HOW to do-s') for dealing with these typical tasks is brought to the foreground of the teaching-learning process.

Moreover, as highlighted by Sokol (Sokol, 2007, p. 158), real life will be putting learners in front of new problems, so it is not so much a repertoire of the developed models (i.e. strategies and tools, 'HOW to dos') that should be seen as the final product of the teaching-learning process, but rather methods of generating and developing models (strategies and tools) for typical problems, i.e. HOW to develop a model (a strategy or a tool) when a new task is presented (see Figure 16).

To sum up, in the framework of the Problem-Centred Education, students learn to solve problems for reaching cognitive, practical or communicative aims. Instead of focusing on subject-matter content information students build theoretical models of that content, namely, models of objects, transformation and strategies. Building theoretical models allow efficient organisation and transformation of information in the process of problem solving. The developed models further serve as a basis for newly acquired information and as a result work on diminishing the amount of separate content components which traditionally have to be acquired in the subject-matter teaching-learning process. The focus of work shifts from finding a solution to building a strategy for developing solutions when dealing with a given type of tasks. However, the final result expected from students is not to learn all the developed strategies by heart but rather to learn HOW to build new strategies when students face a problem. In order to ensure the effective organisation of the above defined problem-centred teaching-learning process students should be provided with meta-tools that would allow them to build specific models for specific learning contexts.

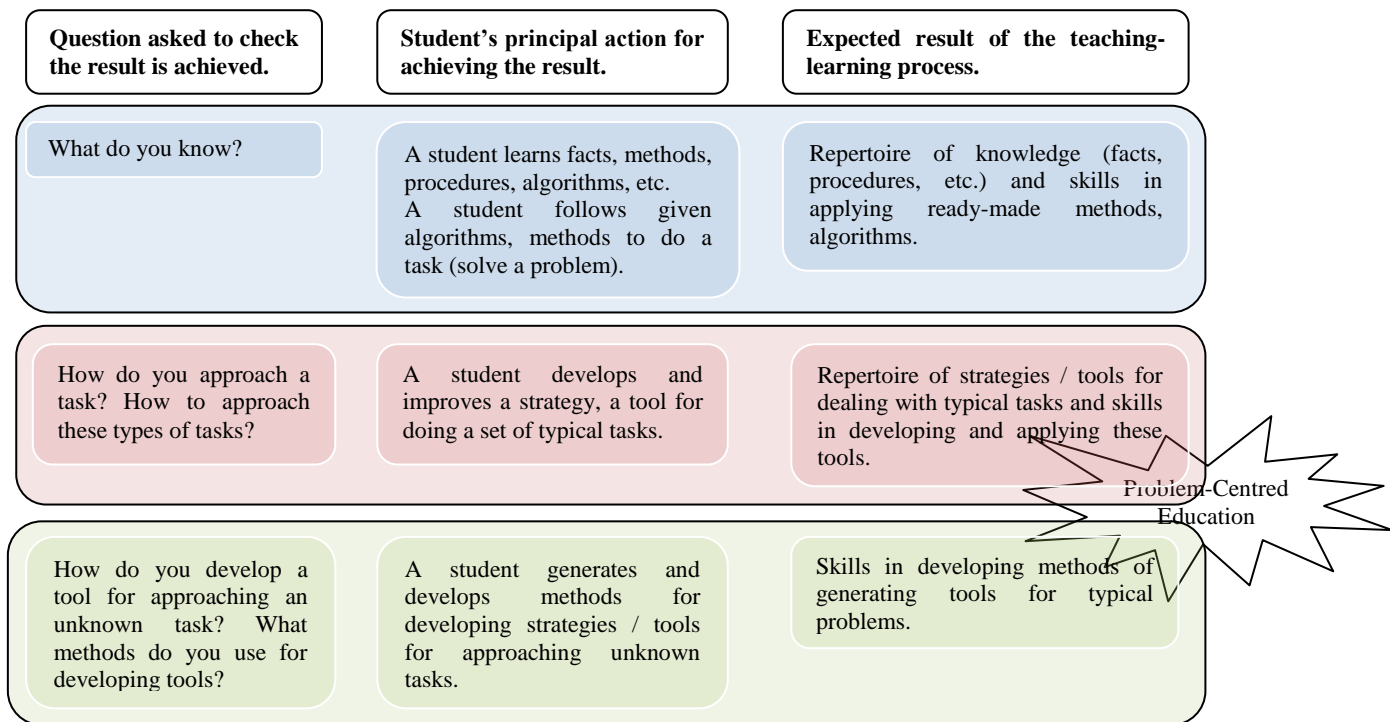


Figure 16 Shift (read top-down) in the expected final result of the teaching-learning process.

Before coming to the last question of meta-tools that are used in the Problem-Centred Education, it is important to draw the connections between the theoretical foundation of the PCE and the theoretical foundations of other problem approaches that exist alongside.

2.4. Relation of the Problem-Centred Education to Other Teaching for Thinking Approaches

As mentioned in the introductory word to this chapter, there are a lot of different approaches which exist on educational market that use the notion of a problem. Even though they may share some common features, it is worth knowing their differences since these are the differences which make these approaches unfold differently in the real classroom, thus bringing learners to different results in terms of their cognitive and problem solving skills and requiring from a teacher different teaching competences in order to put this or that approach into practice.

It is impossible to make an overview of all available approaches so I have limited myself to those which are more widely known and more often discussed in the educational literature.

2.4.1. The Problem-Centred Education vs Problem Education

The first movement is represented by Russian group of educational professionals and is called Problem Education (PE)⁶⁹. The beginning of its development is traced back to 1950s-1970s the principle developers being a group of educational professionals Mahmutov Mirza⁷⁰, Lerner Isaak⁷¹, Mat'ushkin Aleksey,⁷² Kudrjavcev Vladimir⁷³, Melnikova Elena⁷⁴.

Originating in the 1950s-1970s Problem Education has never targeted the problem of an ever increasing knowledge. Problem Education opposes itself to traditional, 'informative' or 'explanatory' education that presents knowledge as something fixed, static and abstract and hence makes students learn the final products of cognitive activity⁷⁵ without making them go through and experience the process of cognitive activity itself which resulted in the appearance of this knowledge (Кудрявцев, 1991, p. 4).

As put by Kudrjavcev (Кудрявцев, 1991, p. 4) the problem of traditional education is that the process of acquiring knowledge in traditional education does not resemble the process of how this knowledge is obtained in science. School does not develop students' thinking because traditional teaching-learning process does not follow dialectical principle (Ильенков, 1974, 2012b; Кудрявцев, 1991, p. 4).

As it can be seen from the statement above, the philosophical foundations of Problem Education are traced to dialectical materialism - the philosophical world view that stays in contrast to idealism and proclaims the primacy of the material world, the objective reality, the world outside consciousness over spirit (*Marx K., Engels F., Ilyenkov E.*).

⁶⁹ From Russian, «проблемное обучение» (ПО).

⁷⁰ From Russian, *Махмутов Мирза Исмаилович*

⁷¹ From Russian, *Исаак Яковлевич Лернер*

⁷² From Russian, *Матюшкин Алексей Михайлович*

⁷³ From Russian, *Кудрявцев Владимир*

⁷⁴ From Russian, *Мельникова Елена*

Dialectical materialist philosophy opposed to the idealistic one laid a foundation for the historical approach to human psychology (Ильенков, 2010) namely, psychological science of consciousness as a higher form of the reflection of reality (Рубинштейн, 2012), and developed the study of activity⁷⁶ and its structure (the major contribution being Activity Theory⁷⁷ developed by Russian psychologists Aleksey Leont'ev, Aleksander Zaporowec, Petr Galperin, and David Elkonin (Леонтьев, Запорожец, Гальперин, & Эльконин, 2005)).

Dialectics as such can, on the one hand, be considered as science - "*the science of the general laws of the motion and development of nature, human society, and thought*"⁷⁸ (Ильенков, 1984, pp. 4–5) (Ильенков, 2012а, pp. 30, 32) or "*logic and theory of cognition (knowledge)*"⁷⁹ (Ильенков, 1984, p. 2)) having its specific framework of categories and concepts. And, on the other hand, it can be regarded as a "*method of scientific understanding and practical activity*"⁸⁰ (ibid.), scientific understanding of any field of knowledge. As a method it aims at studying and understanding the processes and things in terms of interconnectedness, development, and transformation, with their opposite and contradictory sides in unity. **Dialectical contradiction**⁸¹ is one of the main concepts of the philosophy of dialectical materialism. Contradiction is present in all processes of objectively existing things and of subjective thought and it's through the resolution of the contradiction that the development occurs. "*Dialectics as logic is the means of resolving these contradictions*" (Ильенков, 1984, p. 383 e-book).

According to the view of dialectical materialism, any essential problem humanity has been facing in its scientific development appears in the form of a contradiction in a system of available knowledge and historically developed conceptions and notions. And only when such a contradiction is revealed, a human being feels the need for a deeper study of the subject of inquiry that caused this polarity of views, and feels the need to

⁷⁵ "cognitive activity" - from Russian «познавательная деятельность»

⁷⁶ "activity" from Russian «деятельность»

⁷⁷ "Activity theory", from Russian «Теория деятельности»

⁷⁸ From Russian, „диалектика есть наука о всеобщих формах и законах всякого развития, общих мышлению с "бытием"”

⁷⁹ From Russian, „Логика и теория познания”

⁸⁰ From Russian, „метод научного познания и практической деятельности”

⁸¹ Even though both OTSM-TRIZ theory and dialectics use the same term 'contradiction', their meanings are different. Further in the text, if I speak about dialectics, I am referring to the notion of a contradiction as seen in dialectics and can refer to it as 'dialectical contradiction'. However, if I am speaking about the

uncover the objective basis of the discord (Ильенков, 1974, 2012b, pp. 20–21). Dialectical materialism, which proclaims the primacy of the material world existing outside and independently of a human mind and perception, considers that the role of the science is to uncover ‘the thing in itself’⁸² or ‘the very essence of an object’, the objective side of a thing.

In its historical development, science has always started with a question that a human being asked himself when facing a certain unexplainable phenomenon in nature, therefore, the ability to ask good, strong, relevant questions is essential in the development of thinking. Before any answer appears, the question has to be formulated. So thinking, in a materialistic sense of this notion, starts with the problem, which is presented in the form of a contradiction.

“Thinking in the real sense of this word, starts only there where a human being becomes consciously aware of the contradiction that cannot be solved with the ready-made schemes and recipes, available algorithms and knowledge. Only in such a situation, the mind (irrespective of whether it is the mind of a grown up person or a child) has the urge to discover new knowledge, develop new method, new algorithm, and new action scheme. This and only this is the point where one can see the beginnings of the ability called thinking”⁸³. (Ильенков, 1974 translation RJ)

As mentioned above, the so-called historical principle is very important in dialectics. Applied to scientific knowledge, the given principle presupposes that scientific knowledge is the product of joint cognitive activity of several generations of scientists, a “*product of historical creativity of people*”, “*a cultural phenomenon*”⁸⁴ (Кудрявцев, 1991, p. 4). Hence, the ‘ready’ knowledge has **problematic nature**. A person who wishes to

Problem-Centred Education or OTSM-TRIZ theory, I am referring to the notion of contradiction as defined in OTSM-TRIZ and can refer to it as OTSM-TRIZ contradiction.

⁸² From Russian «вещь в себе».

⁸³ From Russian «Мышление в собственном смысле слова начинается именно там и только там, где сознание человека упирается в *противоречие*, не разрешимое с помощью готовых схем, готовых рецептов, готовых алгоритмов, готовых знаний. Только тут интеллект (безразлично, принадлежит он взрослому или ребенку-школьнику) оказывается перед необходимостью самостоятельно добыть новые сведения, самостоятельно найти новый способ, новый алгоритм, новую схему действий. Только тут, собственно, и просыпается способность, именуемая *мышлением*».

⁸⁴ From Russian «продукт исторического творчества людей», «явление культуры».

acquire this 'ready' knowledge and make it part of its own cultural repertoire has to overcome this problematic nature. On the one hand, (s)he has to become aware of, accept and solve the objective problem that caused the discovery of that knowledge. On the other hand, he has to reconstruct the logic of cognitive activity 'hidden' in that knowledge, i.e. cognitive activity that gave rise to this knowledge. Organising the teaching-learning process that allows to overcome this problematic nature of knowledge enables to keep the internal link between the objective scientific cognition and the teaching-learning process (Кудрявцев, 1991).

The acquisition of the learning content has to follow the same trajectory as it followed in its real historical development. Namely, students' minds have to be involved in finding new knowledge in contrast to being provided with the already well defined and formulated facts and a pool of examples supporting them. Learners should experience the 'painful' process of knowledge discovery, starting from becoming aware of the contradictions presented by a vivid life, posing a question that appears as a result of contradictory existing viewpoints on the object of inquiry, and ending with solving the contradiction, uncovering 'the thing in itself'. Only in the latter case, a learner will be developing his creative thinking, his ability for autonomous exploration of the reality in its contradictions, his ability to obtain new knowledge (Ильенков, 1974).

In his work '*Didactics and dialectics*' Ilyenkov (Ильенков, 1974) formulates three main implications that didactics can draw from dialectics:

1. Every acquaintance with the science should start with the acquaintance with the questions, the problem that caused the need to develop this science as a means of finding answers to these questions.
2. The real problem should be formulated in the form of an unsolved contradiction that manifests itself in a situation when "some people say this, while others say that" and it is not clear who is right. Only this kind of a situation pushes a person into an active search, creates the need of working out the objective side of the situation.
3. Instead of making learners acquire ready-made solutions and algorithms, they have to be presented with the problems, the contradictions that the humanity faced and sought these solutions for. If this is not done, learners will grow into

pedants who only know some facts they were taught but are unable to learn anything new independently.

Hence, the Problem Education puts the logic of dialectical contradiction as its main object of learning (Кудрявцев, 1991, p. 6) And the Problem Education is **defined as** an independent and complete didactic system that relies on specific psychological laws and mechanisms and puts as its main function the development of students thinking (Кудрявцев, 1991, p. 3; Матюшкин, 1972, p. 11; Махмутов, 1975, pp. 9–10). The notion of thinking is understood from the perspective of dialectical materialism and refers to **dialectical thinking, scientific thinking or creative thinking** (Ильенков, 2009, 2012b; Кудрявцев, 1991, p. 3; Лернер, 1982; Махмутов, 1975). In the framework of the Problem Education these three notions are used interchangeably. If the philosophical basis of the Problem Education is the dialectical materialism which shows the general strategy for developing students' thinking in the teaching-learning process, then the mechanisms and laws of this process are studied by psychology. The problem education relies on **psychological laws of thinking** and uses them for the purpose of **managing** the learning process of students (Кудрявцев, 1991, p. 8; Матюшкин, 1972, p. 139) The psychological basis of the Problem Education is the theory of thinking developed by Rubenstein and his colleagues (Рубинштейн, 1958; Рубинштейн, Абульханова-Славская, & Брушлинский, 2007) and further elaborated by other psychologists (Гальперин, 2011; Леонтьев et al., 2005).

According to Rubenstein's psychological theory of thinking, a human's life represents a constant inter-action between a human being – *a subject of inquiry* – and objects around him – *an object of his inquiry*. A human being acts on the objects around him and transforms them for his purposes. However, the true nature and features of these objects are always hidden from a human being. They always contain internal contradictions, problems and tasks that a human being has to solve while acting on them, while being involved in the process of their transformation. Hence, the objective world appears to have this 'problematic' nature, which triggers the need for human thinking.

The content of the Problem Education is comprised of problem tasks of varying difficulty. Students are systematically involved in finding evidential solutions to the

problem tasks. Solving these problem tasks under a guidance of a teacher enables students to acquire new knowledge and methods⁸⁵, acquire a system of mental actions⁸⁶ (as opposed to separate operations) that are required for solving non typical, unconventional problems, develop their skills in finding new knowledge, develop their creative thinking, imagination, motivation and intellectual emotions (Кудрявцев, 1991, p. 23; Махмутов, 1975). The acquisition of the system of creative mental actions will influence the quality of students' mental activity and „will lead to the development of a special type of thinking, called scientific, critical, dialectical thinking⁸⁷” (Махмутов, 1975). It is worth noticing, that the Problem Education does not reject traditional forms of teaching, such as explanation and reproduction. The Problem Education combines reproductive, productive and creative activities for learners, however, the organisation of the system of problem tasks prevails (Кудрявцев, 1991; Лернер, 1982; Махмутов, 1975, 1977). In fact, Lerner (Лернер, 1982, p. 41) remarks that before a learner is able to reach the stage of creative thinking, he has to go through the reproductive and productive stages and the ideal teaching-learning process includes these three stages. Even though, the author of the paper cannot argue against this statement, the problem that the educational systems face nowadays is the dramatic increase of content to be studied by learners and the lack of time. Thus, organising the teaching-learning process in the three stages for every important notion that has to be studied seems problematic in the context of modern life.

As it can be concluded from the description above, the Problem Education offers a **new way of organising learning content within the subjects** (Кудрявцев, 1991, p. 24), namely, through involving students in learning activities around a system of problem tasks. As formulated by Kudrjavcev (Кудрявцев, 1991, p. 24) **system of problem tasks** is a content of Problem Education and a **problem task** (sometimes referred to as a **learning problem**⁸⁸) is a unit of its content.

⁸⁵ “methods” from Russian «способы действия»

⁸⁶ “system of mental actions” from Russian «система умственных действий»

⁸⁷ From Russian „Постепенное овладение учащимися системой творческих умственных действий приведет к изменению качества умственной деятельности ученика, выработает особый тип мышления, который обычно называют научным, критическим, диалектическим мышлением.”

⁸⁸ Some experts in problem education (see for instance Mahmutov (Махмутов, 1977)) make a distinction between the two concepts. For the purposes of my research, I rely on the views of Kudravcev (Кудрявцев, 1991) and use these terms as synonyms.

Two main concepts are distinguished in the Problem Education: a **problem situation** and a **problem task**.

A **problem situation** is a subjective, psychological state of the mind of a learner who experiences cognitive difficulty (Кудрявцев, 1991, p. 28; Матюшкин, 1972; Махмутов, 1975, 1977). The concept of a problem situation is close in its meaning to a concept of **cognitive conflict** (or socio-cognitive conflict) developed and applied by other educational professionals (Douady & Pigeonnat, 2013) and cognitive psychologists. Drawing the connection with the Problem-Centred Education, a problem situation seems to be what Nesterenko called a problem viewed from the psychological perspective.

A problem situation is characterised by an intellectual difficulty experienced by a learner who cannot do a task or find a solution to a task applying the methods he already knows. In the mind of a learner it is presented as puzzlement, surprise, intellectual discomfort. According to Kudrjavcev (Кудрявцев, 1991, p. 28) and Matyushkin (Матюшкин, 1972, p. 173) a problem situation includes motives and needs of a learner as one of its component; in other words, the problem situation has to trigger learners' need in acquiring knowledge and methods that are hidden in a task. Kudrjavcev (Кудрявцев, 1991, p. 28) distinguishes between a **primary problem situation** and a **secondary problem situation**. The primary problem situation is characterised by a mere surprise in the mind of a learner who feels he is stuck and cannot solve the task. However, he is not yet aware of the contradiction which created this problem situation. The problem situation becomes a secondary one when a learner becomes aware of and clearly formulates the problem that has to be solved. Thus, from a problem situation it turns into a learning task.

A **problem task**, on the other hand, is one of the forms of creating a problem situation for a learner, alongside a **problem question**, a **problem assignment** or any other possible form of 'wrapping' a problem (ibid.). A problem task is an objective unit of information that a subjective mind is confronted with. A problem task contains components which are, on the one hand, in contradictory relations to each other and, on the other hand, in contradictory relations with a learner's current level of knowledge (Кудрявцев, 1991). It contains a dialectical contradiction and a learner does not know the methods of solving this contradiction (Кудрявцев, 1991, p. 25). Problem tasks have

the potential to create a problem situation for a learner. Drawing the connection with the Problem-Centred Education, a problem task seems to be what Nesterenko called a task.

Problem situations can be classified according to the **level of difficulty** (Лернер, 1982, p. 54; Матюшкин, 1972, p. 196). Difficulty is the concept which defines a learner and his perspective on the task – the level of difficulty varies depending on a learner. One and the same task may seem difficult for one learner and easy for another one, depending on his intellectual abilities. According to Lerner (Лернер, 1982, p. 54) difficulty for each individual learner can be measured by time it takes a learner to do a task, number of mistakes made by a learner, some physical characteristics experienced by a learner in the process of finding a solution (such as his pulse, blood pressure, etc.).

Problem tasks, on the other hand, are characterised by a concept of the **level of complexity** (Лернер, 1982, p. 54; Матюшкин, 1972, p. 196). Complexity is an objective criterion for characterising a task. The level of complexity of the task does not depend on the actor involved in doing the task. According to Lerner (Лернер, 1982, p. 54) and Matyuskin (Матюшкин, 1972, p. 196) there are several criteria for measuring complexity, such as: (1) the task is more difficult the more facts it offers that a learner has to relate to each other; (2) the task is more difficult the more steps are required for finding the solution; (3) the task is more difficult the more parallel, non-sequential (not related to each other) conclusions a learner is required to make as a result of analysing the requirements of a task; (4) the task is more difficult the higher level of generalisation is that a learner has to make when discovering 'the unknown' (Матюшкин, 1972, p. 33).

Two other essential concepts related to a problem situation and a problem task are '**the unknown**' and '**the solution**'⁸⁹ (Матюшкин, 1972, pp. 57–58). 'The unknown' is the main component of a problem situation, while 'the solution' characterises a problem task. In contrast to 'the solution' which represents a single unit specific for a single given task, 'the unknown' is characterised by certain level of generalisation that a learner has to discover. By discovering 'the unknown' a learner discovers a method (a HOW TO) which is relevant for solving a class of similar tasks. Hence, in order to create a problem situation for a learner, he has to be offered a theoretical or practical problem task, which

⁸⁹ 'The unknown' from Russian «неизвестное»; 'the solution' from Russian «искомое»

would include 'the unknown' as its main component that has to be acquired. For example, in a problem task which requires to find an area of a rectangle, 'the solution' is a specific number, an area itself, while 'the unknown' is the method of calculating areas of rectangles (Матюшкин, 1972, p. 35). So the **main components of a problem situation** are defined as (1) the need triggered in the mind of a learner to discover a new method, (2) the unknown – the method to be discovered, and (3) learner's previous level of knowledge which allows to estimate the level of the complexity of a problem task that can be offered.

When speaking about the structure of educational content, Lerner (Лернер, 1982, pp. 20–24) distinguishes its four components. Each component is characterised by the way of its acquisition and **method of teaching** (see Table 16). According to Lerner (ibid.), the comprehensive teaching-learning process must involve learners in going through all the four levels and the third level is critically important.

Lerner (Лернер, 1982) defines the concept of '*method of teaching*' in the following way. The teaching-learning process is the unity of the activity of a teacher and the activity of a learner. **Tools or resources** that a teacher can use in this process can be represented in different **forms**: graphical or pictorial (*images, graphs, videos, etc.*), in a form of tangible objects (*microscope, book, experimental material, etc.*) and in a verbal form (*story, lecture, explanation, etc.*). And **a method is** a way of organising learners' activity with the tools or resources, i.e. method of organisation of learners' cognitive activity. Any tool or resource can be used for the purposes of different methods. For instance, a simple picture can be presented to learners and accompanied by teacher's narration. In this teaching-learning situation, learners' cognitive activity will be limited to perception and awareness of new information. If learners are invited to answer questions about the picture they've just heard of, then their cognitive activity is involved in reproduction of knowledge and possibly methods. And only when students are given a picture and a task connected to its analysis, their cognitive activity raises to problem solving (Лернер, 1982). And it is this latter level of cognitive activity of learners which is targeted by the Problem Education. It should also be noticed that the level of problem solving is not solid but pre-supposes three sub-levels that a teacher can make learners reach with different methods (as seen from the Table 16) (Лернер, 1982). Mahmutov (Махмутов, 1984, p. 32) and Kudrjavcev (Кудрявцев, 1991, p. 32) also distinguish the fourth sub-level. The first sub-level is a problem narration, when it is a teacher who

builds his narration following the dialectical logic, namely, outlining the problem, presenting the dialectical contradiction, setting forth the hypotheses and their resolution as well as evaluating the offered solution. In this situation, the problem task for a learner is to follow the line presented by a teacher and to understand the dialectics of the developing knowledge.

The second sub-level can be achieved by the method of heuristics or method of 'partial inquiry' when a teacher describes a situation and a problem task is formulated and solved by learners with the help of a teacher. It's only on the third sub-level that a learner is able to solve the problem task himself without the help of a teacher. On this sub-level the teacher is working with the research method or method of inquiry. And as mentioned above, Mahmutov (Махмутов, 1984, p. 32) and Kudrjavcev (Кудрявцев, 1991, p. 32) distinguish the fourth sub-level when learner is autonomous in identifying the problem in addition to solving it independently. As it can be seen, the way of organising learners' cognitive activity when working with the Problem Education is varied depending on how autonomous learners are and how much experience with the Problem Education they have already had.

In contrast to the Problem-Centred Education, Problem Education does not tackle the problem of changing the structure of educational content, namely, subdividing knowledge into subjects. It should be noticed, that the Problem-Centred Education offers the change on the two levels: first, on the level of the structure of education content as such (see *Figure 11 above "Model of the structure of education content guided by the study of a problem"*), and second, on the level of how learning activity of students is organised in the teaching-learning process (see *Figure 1 above "The Thinking Task Framework"*).

Level of content	Component of educational content	Way of acquisition of the component (learners' cognitive activity ⁹⁰ associated with the method)	Method of teaching		Students' results
			Name of the method	Essence of the method	
Level 1	Knowledge	Perception, memorising and reproducing	Explanatory-illustrative method	Organising learners' conscious perception of 'ready' information. Use of illustrations (texts, images, videos, etc.) for easier perception	Presented 'ready' information becomes part of students' knowledge repertoire
Level 2	Abilities and skills	Drilling by following examples, algorithms, methods	Reproductive method	Offering tasks to learners doing which would make them repeat certain information, methods, and algorithms over and over again. Deciding on a necessary number of tasks to be done by students.	The drilled operations become part of students' skills repertoire
Level 3	Experience of creative activity	Solving problem tasks	Research method (method of inquiry)	Developing a system of problem tasks and offering learners to solve them independently.	Experience of creative problem solving, scientific thinking becomes part of students' thinking repertoire
			Method of heuristics or method of 'partial inquiry'	Giving a general problem which is difficult for students to solve, a teacher sub-divides the problem into smaller sub-steps (in the form of tasks or questions). A student is not independent in solving the main task (as in research method) but he is independent in his inquiry when dealing with the sub-steps.	Experience of creative problem solving, scientific thinking becomes part of students' thinking repertoire
			Method of problem narration	A teacher provides an example of dialectical thinking. A teacher formulates a problem and reasons aloud, formulates the contradiction, shows difficulties and controversies which appeared on the way to the solution, arrives at the solution itself.	Examples of dialectical thinking become part of students' thinking repertoire
Level 4 ⁹¹	Emotional attitude towards the objects of inquiry	Emotional involvement			

Table 16 Structure of educational content. Based on the description of Lerner (Лернер, 1982, pp. 20–24)

⁹⁰ 'learners' cognitive activity' from Russian «познавательная деятельность учащихся»

⁹¹ As mentioned by Lerner (Лернер, 1982, p. 24) every content component should be supported by learners' emotional involvement who should perceive and accept it as his own personal, essential value. This is a motivational aspect of any learning process.

As I have argued it elsewhere, the change on the level of educational system in terms of replacing a subject-based structure into a problem-based structure is hard to imagine taking into account the restrictions of the public education. However, the given model can be applied at the level of the content of separate subjects, which will be organised through problems with the meta-models and meta-tools being their structural components.

Applied at this level and compared to the Problem Education, it becomes obvious that in comparison to the Problem-Centred Education the Problem Education does not offer meta-tools as a structural component of its content. Coming to the question of models, in the framework of the Problem Education educational professionals are speaking about generalisation, which in its nature is close to the idea of models. However, the obvious difference would be that the Problem-Centred Education makes even one more step further and in addition to involving students in building models it pushes them to think of the methods for building models. This becomes possible because the Problem-Centred education is adopting the tools of the OTSM-TRIZ problem solving theories.

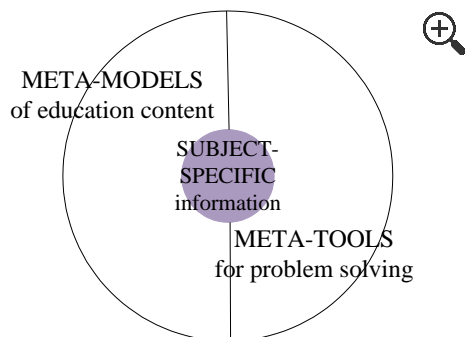


Figure 17 Model of the structure of education content guided by the study of a problem that can be applied at the level of the content of separate subjects (inspired by Мурашкова, 2004, p. 8).

On the level of how learning activity of students is organised in the teaching-learning process the Problem-Centred Education relies on the same psychological principles of learning as does the Problem Education. If in the Problem Education, one speaks about problem tasks (or assignments or questions) which should cause problem situation for learners, then in the Problem-Centred Education, the same concepts are named a task and a problem (from the psychological view) respectively. If we look at the Thinking Task Framework (see Figure 1), which provides a model of how a learning activity of

students should be organised in the Problem-Centred Education then step one suggesting to 'increase room for thinking' is the step which corresponds to the process of giving a task that would cause a problem for learners. As discussed above, Nesterenko distinguishes three types of tasks (see Table 14 above) that are typical for the Problem-Centred Education. However, other types of tasks (problem tasks) are also possible. The second step of the Thinking Task Framework invites a teacher to 'build the stairs with learners', which can be interpreted as helping students build models with the help of meta-tools. Just as in the Problem Education, this step involves applying psychological mechanisms of learning and **managing** the learning activity of students instead of merely letting them look for the solution following a trial and error method.

One additional step which is not discussed in the Problem Education is the third step when learners are asked to reflect on the steps that helped them to build the meta-models.

The use of the research method (or the method of inquiry) is another feature which approaches the Problem Education to the Problem-Centred Education.

The Problem Education was not the only one in the 1950s that targeted the change in the educational system and was definitely not the first one to push the ideas of activating learners' thinking in the teaching-learning process. Several schools and individual educational professionals in different countries (such as for instance, Johann Pestalozzi in Swiss, Jean Jacques Rousseau in France, Maria Montessori in Italy, John Dewey in the USA⁹², etc.) opposed in their own way traditional education (or classical didactics, or dogmatic teaching, as it is sometimes referred to), which made learners passive acquirers of ready-made facts voiced by a teacher. However, as highlighted by Mahmutov (Махмутов, 1975) and Kudrjavcev (Кудрявцев, 1991, pp. 19–20), the

⁹² John Dewey, though, cannot be considered completely as part of this group since he was the one who criticised the extreme opposites of 'education as development from within' (progressive school) and 'education as development from without (traditional school) (Dewey, 1938, p. 17). Dewey (Dewey, 1938, pp. 20–21) argued that if new philosophy of education is to be developed then it should develop its principles positively and constructively and not to proceed on the basis of mere rejection of old principles, as the so called progressive education was doing. So the first issue at hand is to develop a clear theory of experience upon which new philosophy of education would be built and then seek to answer a question of the place and meaning of subject-matter, methods of instruction & discipline, material & equipment, and social organisation (relationships) *within* experience. So the philosophy of Dewey was calling to build education applying the principle of interconnection of the psychological side (a child and his internal development) with the objective side (cultural heritage).

Problem Education cannot be put in the same line with them due to several reasons (see Table 17 for synthesised comparison).

Table 17 Comparison between Problem Education and approaches for activating students' thinking that existed before and alongside the PE

	Approaches activating thinking	Problem Education
Source of creative potential (against dogmatic force)	<u>Naturalistic nature</u> <ul style="list-style-type: none"> Inborn creative potential. Creativity as a psychological phenomenon (hence, subjective) 	<u>Cultural nature</u> <ul style="list-style-type: none"> Creativity as an objective social phenomenon Development of creativity is the internalisation of the historically accumulated creative activity of the humankind
Demands to the teaching-learning process	<ul style="list-style-type: none"> Should conform to natural laws of child's development; Teacher's task – create situations that can open child's natural creative potential 	<ul style="list-style-type: none"> Relies on objective psychological mechanisms; Teacher's task – knowing the psychological mechanisms lead the child in the development of creativity
Aim	<u>Development of empirical thinking</u> <ul style="list-style-type: none"> Empirical thinking implies treating both essential and non-essential features of an object 	<u>Development of theoretical thinking and generalised methods</u> <ul style="list-style-type: none"> Theoretical thinking implies understanding of essential features of an object. The main characteristic of theoretical thinking is conceptual understanding.
View on thinking	Equalled reasoning out loud to theoretical thinking, discourse to thought, and speaking to understanding.	Distinguish reasoning out loud from theoretical thinking, discourse from thought, speaking from understanding.
Main method	Method of inquiry <ul style="list-style-type: none"> Was characterised by the development of empirical thinking through practical activity (lack of theoretical input with the study of core concepts) Is characterised by the illustrative principle (activating various senses) Main attention is devoted to external activity of learners: the interest is provoked (problem situation created) but there are no methods that would lead students to the directed search. Instead, learners are involved in the autonomous, non-directed, chaotic search. 	System of methods (see Table 16)

First of all, the main idea of activating students thinking is closely related to the idea of creating relevant conditions for learners which would allow them to open up their natural

potential. According to this view, the sources of creative potential of a child are inborn in its biological nature. Creativity is treated as something subjective, as a psychological phenomenon. Hence, the intervention of a teacher in this process is reduced to its minimum. Teaching should be in line with the natural development of a child. The task of a teacher is to create situations that would allow the natural creative potential of each child to open up. Even though the method of inquiry is the main one used for activating students' thinking, there were no real tools for managing and controlling the process of learning and no qualitative description of problem tasks existed. Once a problem situation was created for students and their interest aroused, they were left with a non-controlled, chaotic process of finding the solution to the answer. So the method of inquiry resembles more an exploratory behaviour than a clearly organised method of scientific inquiry as seen in Problem Education.

Even though the Problem Education does not reject the idea of creative potential of a child, it relies on the philosophy of dialectics that treat creativity as an objective phenomenon. This creativity is not inborn and should be developed in the teaching-learning process. The Problem Education relies on specific psychological principles that allow a teacher to direct, manage and control the process of learning. It targets the development of the tools for controlling creative activity of learners. The Problem Education is a complete didactic system which combines reproductive, productive and creative activities for learners and when targeting creative activities it relies on three methods: research method or method of inquiry, method of heuristics or method of 'partial inquiry' and method of problem narration (*described in details above*). So the approaches for activating students' thinking that existed before and alongside the Problem Education cannot be equalled to it.

2.4.2. The Problem-Centred Education vs Problem-Based Learning

One more 'problem' approach that originated in Canada was called the Problem-Based Learning. Since the Problem-Based Learning highlights the problem as its essential

component of the teaching-learning process, it is necessary to outline the distinctions between the given approach and the Problem-Centred Education as well as the difference between the discussed above Problem Education.

The Problem-Based Education originated in the 1960s⁹³ finding its origin in McMasters University in Canada⁹⁴ when a neurologist Howard S. Barrows and his colleague Robyn M. Tamblyn decided to address the problem they faced in medical education, more specifically in the field of neurology. Being a professor of neurology, Barrows together with other faculty members noticed that the educational methods at hand were not effective in preparing medical students for their future profession as physicians. Many students were dropping out from the studies and those who did not were disenchanted with their medical education, had very poor basic knowledge of the main scientific concepts in medicine even though they were exposed to them during their courses and were not able to **apply** their knowledge to the patient problems (Howard S. Barrows & Tamblyn, 1980, p. ix; Schmidt, 1983, pp. 11–12) According to Barrows and Tamblyn (Howard S. Barrows & Tamblyn, 1980, p. 5) this was due to the fact that medical schools were too concerned of making students learn numerous facts (develop their factual knowledge) and essential medical concepts through lecturing and measuring students success by how well they retained and recalled that information. The aspect of the skills, or application of this knowledge to solving medical problems, was left aside. The Problem-Based Learning instructional method was developed to shift the emphasis in medical education from information retention to knowledge application. Hence, **the aim of the Problem-Based Learning method** is to provide students with an integrated body of knowledge that they will be able to use for medical problem solving (Howard S. Barrows & Tamblyn, 1980, p. 12; Schmidt, 1983, pp. 11–12). In other words, the aim is to develop students' basic and clinical science knowledge in medicine in relationship to the acquisition of medical problem solving skill or the clinical reasoning skill, which is manifested in the evaluation and management of patients' health problems (Howard S. Barrows & Tamblyn, 1980, pp. 5–6). The emphasis is put on the students' ability to **apply** the acquired knowledge. A consistent competent clinical performance by a student is a proof he possesses relevant factual knowledge but not the other way round

⁹³ A new Problem-Based curricular in the McMaster medical school was put in place in 1969 and graduated its first class in 1972 (Howard S. Barrows, 1996, p. 3)

(Howard S. Barrows & Tamblyn, 1980, p. 6). The **Problem-Based learning approach is defined as** “an instructional method that is said to provide students with knowledge suitable for problem solving” (Schmidt, 1983, p. 11). Or as put by Barrows and Tamblyn (Howard S. Barrows & Tamblyn, 1980, p. 1) it is “the learning that results from the process of working toward the understanding or resolution of a problem. The problem is encountered **first** in the learning process” and it serves as a stimulus for active learning, the focus for acquiring knowledge and clinical reasoning strategies. As highlighted by Barrows “information, concepts, and skills learned by the student are put into his memory in association with a problem” (Howard S. Barrows & Tamblyn, 1980, p. 13). In the context of the Problem-Based learning **to solve a problem means** to make appropriate use of [medical] knowledge for evaluating and managing patient’s health problem and problem solving skills refer to skills in applying knowledge.

Even though not directly, but the idea of the Problem-Based learning about being able to apply knowledge in a professional domain echoes with the competency-based movement that found its origin in the USA in the 1970s when an American psychologist David McClelland wrote his ground-breaking paper “Testing for Competence Rather Than for Intelligence” (McClelland, 1973). McClelland criticized the use of aptitude or intelligence tests as the main criteria for admission to colleges and getting high-level jobs claiming that there is no scientific evidence that these tests predict success in life, including competent on-the-job performance. Grades in school, he claimed, only correlate with results on aptitude tests and no evidence exists that they predict anything beyond that. Thus, instead of focusing on paper and pencil tests, criterion sampling based on job analysis should be performed. Only after analysing top-performance into its components, one can understand what makes some performers superior than others and which exactly behaviour indicators one should develop if he wishes to become a professional in his domain (McClelland, 1973). Just as the Problem-Based learning, the competency movement steps against intellect testing as the main criteria for measuring success, especially when it comes to a professional domain since it does not predict on-the-job performance. Clinical reasoning (or ability to analyse patients’ health problems applying one’s medical knowledge) is one of the competencies that is important for

⁹⁴ The method quickly spread to other universities in other countries, including the medical school in Maastricht, the Netherlands (Schmidt, 1983).

medical students and the Problem-Based learning can be used for developing it in the teaching-learning process.

Speaking about **the psychological and educational basis of the Problem-Based learning**, Schmidt (Schmidt, 1983, p. 12) refers to the Information processing approach to learning (or schema theory) that was introduced in education by an educational psychologist Richard Anderson in 1977, while Barrows and Tamblyn (Howard S. Barrows & Tamblyn, 1980, p. 15) point at the 'andragogical model'⁹⁵ developed by Michael Knowles in 1970s.

According to Schmidt (Schmidt, 1983, p. 12) the implications of the information processing approach to the educational instruction are threefold. First of all, the role of prior knowledge on learning is important. Therefore before any new information is provided, students' relevant prior knowledge should be activated. Secondly, the information processing approach identified the 'encoding specificity' phenomenon (Schmidt, 1983, p. 12), which means that in order to be effective, the situation in which something is learned should be close to the situation in which the acquired knowledge will be applied. Hence, the implication for education is to provide contexts for learning that would resemble the future professional context as close as possible. And thirdly, elaboration of knowledge is crucial for effective learning. Therefore, students should have the chance to discuss subject-matter with their peers and a teacher, to twist that information from different sides before it becomes part of their knowledge repertoire. The Problem-Based learning meets all the three requirements since the process of problem-based learning includes the steps which incorporate the three basic principles of the information processing approach (see Table 18).

⁹⁵ Malcolm S. Knowles has got credit for popularisation of the term 'andragogy' in the USA and Western Europe, which he originally defined as '*the art and science of helping adults learn*' (1980a:43 quoted in Jarvis, 2004, p. 126). The term gained prominence together with many criticisms of the concept of andragogy, which Jarvis claims not to be a theory of adult learning. Refer to Jarvis (Jarvis, 2004, pp. 125–131) for more discussion on the issue. Hence, in this paper, I refer to it as an 'andragogical model', rather than a theory. Despite the criticisms, the model had implications on the practice of teaching adults, including the development of the concept of self-directed learning.

Table 18 Steps involved in the Problem-Based learning. Based on Schmidt (Schmidt, 1983, pp. 13–15)

<p>Problem: A plumber sees his doctor with the following complaint: During a hard cough this morning I suddenly tasted blood in my mouth. As this has occurred more often these past few weeks, I'm becoming a bit anxious.'</p> <p>Task: Explain these phenomena in terms of underlying processes (physical, biological, psycho-social mechanisms that may be underlying the phenomena concerned).</p> <p>Possible practical task: If you were a doctor for this patient what kind of questions would you ask, what laboratory tests would you order, what physical examination would you perform and what treatment would you suggest?</p>		
Steps	Systematic procedure to analyse a problem	Additional explanation
Step 1	Clarify terms and concepts not readily comprehensible.	Can be either found in dictionaries or a group may reach agreed opinion about the meaning to be attached to the terms.
Step 2	Define the problem.	Decide which interrelated phenomena should be explained: which phenomena has to be explained?
Step 3	Analyse the problem.	Brainstorming ideas, opinions, knowledge about the underlying processes and mechanisms. Activation of prior knowledge (I've read somewhere that...) and formulation of relevant hypothesis (Could it be that...?)
Step 4	Draw a systematic inventory of the explanations inferred from step 3.	Summary of the problem analysis which main ideas may be depicted schematically. Preparation to study assumed processes and mechanisms more extensively: to what degree can the expressed knowledge and ideas be considered correct and complete?
Step 5	Formulate learning objectives.	Formulate theoretical questions evoked by the problem analysis phase and decide which questions to focus attention on.
Step 6	Collect additional information outside the group.	Individual work. Use of literature, audio-visual material, consulting experts, etc.
Step 7	Synthesize and test the newly acquired information.	Synthesizing and testing the newly acquired information. Informing each other of the findings.

Speaking about the design of the Problem-Based curriculum, Barrows (H. S. Barrows, 1986; Howard S. Barrows, 1996) pointed out that many medical schools started developing their own variations of the Problem-Based learning and as a result it can have different meanings depending on the design of educational method.

In the design of the Problem-Based learning, the design and format of the problems given to students is the main variable depending on which the PBL instructional method

may differ from classroom to classroom (H. S. Barrows, 1986, p. 482). All the facts relevant to the problem-solving may be given, some facts may be missing or many important facts may be missing requiring a free inquiry on the part of the students.

The second important variable for the Problem-Based learning pertains to the ideas of the andragogical model. Malcolm Knowles (Knowles, 1975) made a distinction between teacher-directed learning and self-directed learning, the main difference between which is that in the former it is the teacher who has the responsibility of what and how the learner should be taught when in the latter this is the learner. Only when a learner is given the possibility to decide on the sequence and the amount of information to be learned and is guided by a teacher on his way, he can grow such an essential component of maturing as the capacity to be self-directing. In this respect, the Problem-Based learning is the method which addresses the objective of developing self-directed learning skills.

The last major variable is the sequence in which problems are offered and information is acquired (H. S. Barrows, 1986, p. 482).

There are also other variables which would influence how the curricula is designed but using the combinations of the three main variable Barrows (H. S. Barrows, 1986, pp. 483–484) distinguishes the following methods:

- In *lecture-based cases*, first the information relevant to the problems is presented and the practical cases given to students only demonstrate the relevance of that information. This is a purely teacher-directed learning with a highly low possibility for developing clinical reasoning.
- *The case-based lectures* first present some case histories to learners, which they have to analyse prior to acquiring information that will be covered during the lecture. Being teacher-directed, this learning method does not challenge clinical reasoning but merely causes some clinically oriented structuring of the information that will be covered during the lecture.
- *Case method* is the next option, when students are provided with a complete case for study and research that will be discussed in the class. The possibility for developing clinical reasoning is much higher since students have the chance to research the question and participate in its interactive discussion in the class.

However, the case material is organised and synthesized for students so the amount of reasoning involved in solving it is limited.

- In the *modified case-based method* students are presented with a patient problem and information is not fully organised so students have to decide on inquiry actions. Being more self-directed the method loses in giving students the opportunity to carry out full and free inquiry that occurs in the clinical situation and does not ask students to apply the results of learning by reasoning through the problem again.
- *The problem-based method* offers students the patient problem that allow for free inquiry. Evaluation and exploration of a problem is supported by teacher's facilitation and it allows to activate students' prior knowledge and to reveal any loopholes in understanding previously acquired knowledge. This method followed the steps described in Table 18 above. It's only weak point is that when the process of problem solving is over the newly acquired information is not actively applied to a reevaluation of the problem.
- *Closed loop or reiterative problem-based method* is an extension of the problem-based method which gives space for students to evaluate their self-directed learning, information resources used and reasoning applying newly gained understanding and to return to the patient problem and to see how they may have solved it more effectively with newly acquired understanding.

These are only the last two methods that would relevantly address the main educational objectives of the Problem-Based learning, which include (H. S. Barrows, 1986, pp. 481–482; Howard S. Barrows, 1996, p. 6; Howard S. Barrows & Tamblyn, 1980):

1. Acquisition of knowledge base structured around the cues presented by patient problems;
2. Development of effective clinical reasoning process (problem-solving skills involved in clinical reasoning);
3. Development of self-directed learning skills;
4. Increase of motivation for learning

Some scholars remark (Hmelo-Silver, 2004, p. 249) that there are controversial research results on the effectiveness of the Problem-Base learning in comparison to the

conventional methods of teaching. Taking into account the taxonomy of the problem-based methods discussed above, there is no surprise this is the case (Howard S. Barrows, 1996, p. 7). Before any effectiveness can be established, one has to clearly compare the curriculum design used for organising the Problem-Based learning, let alone to take into account such important factors as understanding and skills of a teacher who is organising the teaching-learning process.

Even though, the Problem-Based learning was transferred to other domains it has been mainly used for the purposes of education connected to a certain professional domain: medicine, law, engineering, sociology, teacher education, business administration, etc. The results on the effectiveness of the Problem-Based learning come mainly from the research conducted in medical education. The research from other domains is scarce. Even though, it is said that the Problem-Based learning has also been applied for students at schools (see for instance claims by Howard S. Barrows, 1996, p. 10), the author of this paper remains sceptical about a clearly developed theoretical foundation⁹⁶ for transferring an instructional method developed for the purposes of professional-learning domain, to an absolutely different context of school education, especially taking into account its current subject-based structure and lesson system limited in time. Since the original educational objectives of the Problem-Based learning include both the acquisition of certain knowledge base through problem solving and development of clinical reasoning skills, it is worth asking which reasoning skills are targeted by the problems offered to school children in different subjects. The author of the paper did not find any published resource that would elaborate on this issue. The second question which remains unanswered is connected to the third educational objective, namely the development of self-directed learning skills. It is assumed that adult learners have enough capabilities to take responsibility for their own learning and the problem-based learning will help them to develop this capacity further. Once brought to a school context it is worth asking to what extent school children of different age groups are ready for working with the method that is targeting self-directed learning. Self-directed learning skills of children have to be developed so when employed in a school context teachers

⁹⁶ The author of this paper did not find any well-substantiated theoretical explanation of the possible transfer published in a book or in a peer-reviewed journal. The books which are available on the market mainly provide examples of the problems that can be used with students. So I assume that the principles of the Problem-Based learning established by its originators have not been revised and elaborated to fit new contexts and, if necessary, purposes.

would need to use additional methodology or techniques that would scaffold children on the way to their absolute autonomy. The problem-based learning does not offer any methodology or techniques but merely builds on what adult students already have, thus providing them more opportunity for developing their self-directed learning skills. The question of self-direction in children has to be studied thoroughly and the relevant methodology developed and integrated in the Problem-Based learning method before any qualitative transfer can be made.

As can be concluded from the analysis, the three approaches - Problem-Based learning, Problem Education, the Problem-Centred Education - differ in the majority of aspects. They were developed for solving different problems, target different aims and have different theoretical basis behind them. Even though the three of them have 'a *problem*' as their core stone, the concept of a problem itself may differ depending on which perspective we take, psychological, educational or perspective of the problem solving theory. The similarity all of them share is that all the three approaches aim at making students active participants of the learning process by involving them in inquiry in contrast to keeping them passive recipients of the transmitted information. They all assume to develop students thinking, when each of them different meaning in this concept: clinical reasoning (Problem Based Learning), scientific, dialectical, creative thinking (Problem Education), and inventive thinking skills or problem-solving competencies (the Problem-Centred Education). In addition, some procedures for organising the learning activity of students may also be similar for the three approaches. But at the closer look, the final result expected in every step of the procedure may be different, thus affecting how the particular step will be implemented by a teacher and learners.

2.4.3. The Problem-Centred Education and “*situations-problèmes*”

When speaking about ‘problem education’ in France, we find the notion of ‘*situation-problèmes*’ developed by the French scholars (Astolfi, 1993; Astolfi et al., 2008; Fabre, 1999; Meirieu, 1988, 2007, 2012).

According to scholars (Roland Charnay in Astolfi et al., 2008, p. 137), three didactic functions can be ensured by a ‘problem’:

- It can be a critérium for assessing learning which allows checking at the end of the teaching-learning sequence if a certain notion was understood by learners. This is the case of the “*pédagogie de la réponse*” – education which is focused on correct answers. It corresponds to dealing with the so called closed problems. For example, students could be first offered the rule of how to calculate the area of a triangle and then given a task (problem) where they have to apply the rule.
- It can be a motive for learning allowing to offer real-life situations motivating for students. This is the case of “*pédagogie du problème*” – problem education. It corresponds to dealing with the so called open problems. The aim of open problems is in a way to link problems studied at school with the intellectual habits of researchers. In other words, open problems allow students to practice, at their level of understanding and development, scientific reasoning of building hypotheses, testing them, drawing conclusions.

If one has to illustrate this second case, then it should be specified that the problem (a task) offered to students should neither give a hint on the method students have to use, nor give any guiding questions. Even though the problem should arrive from a conceptual domain that students have already worked on it should not in any case be reduced to applying the latest rules studied in class. Meirieu (Meirieu, 2012) mentions active methods and project-based learning as an example of methods belonging to problem education. For instance, a project asking students to construct a hot-air-balloon should lead to the acquisition of the gas dilatation principles.

- A problem can be the means for learning when it allows to involve a learner in the problem solving process that would lead him towards building certain intellectual tools. This is the case when one can speak about “pédagogie de la situation-problème” – education through problem situations. It corresponds to dealing with the problem situations.

Meirieu (Meirieu, 1987b, 2007, 2012) remarks that the notion of ‘problem situations’ finds its origins in the cognitive psychology of Jean Piaget as well as ideas of Jean-Jacques Rousseau.

Problem situation is characterised by a task, an obstacle, limitations, resources and interaction. A teacher has to ensure there is a problem to be solved which is impossible to solve without learning taking place.

In brief, education through problem situations can be summarised as follows:

« il est proposé aux sujets de poursuivre une tâche (la présentation à la classe du plus grand nombre de manières possible de disposer les cubes, la rédaction d'un feuilleton dont chaque épisode exclura l'usage d'une lettre). Cette tâche ne peut être menée à bien que si l'on surmonte un obstacle (le codage géométrique, l'utilisation d'un vocabulaire nouveau) qui constitue le véritable objectif d'acquisition du formateur. Grâce à l'existence d'un système de contraintes (le fait de ne pouvoir disposer de plus de cinq cubes, la lettre interdite), le sujet ne peut mener à bien le projet sans affronter l'obstacle. Grâce à l'existence d'un système de ressources (le papier et le crayon, les dictionnaires), le sujet peut surmonter l'obstacle. » (Meirieu, 1987a)

In the problem-situations students are driven by a task but a teacher is planning his lesson from an obstacle. So the first question a teacher has to ask himself when planning problem situations is which learning objective should be taken as an obstacle overcoming which would improve learners’ cognitive abilities. So the planning starts with an objective that plays the role of a cognitive obstacle for learners, it is this obstacle which is put at the core of the problem situation.

In the summary given above, a specific example of the problem situation is the task “write a TV episode”, with its limitation “you are not allowed to use a certain letter” (‘h’ for example) and resources ‘you can use dictionaries to help you’. And an obstacle which contains the true learning a teacher wants his students to go through is the need

to use new vocabulary. The teaching-learning problem addressed by this task is the lack of vocabulary used by students in their writing and everyday life. So we can see how being involved in the problem situation, students are driven by a task and the desire to accomplish it and in the process they overcome an obstacle and learn new vocabulary.

It is also mentioned that it would be recommended to define a 'task sheet' which would specify the criteria for controlling the quality of the final result: "the task is considered accomplished if...when...".

Astolfi (Astolfi, 1993) points out that while working on problem situation students interact and debate about their ideas in order to perform the task. Moreover, at the end of the sequence, a teacher may organise a discussion, a reflection of a meta-cognitive nature, on how the solution was reached and which methods, strategies were used. This may be the opportunity to formalise application of certain strategies. As highlighted by Meirieu (Meirieu, 2007) formalisation of the acquired knowledge and skills is an important step since it involves the idea of transfer, which is the only means to check whether the mental ability has been acquired by the mind: "*En effet, le seul moyen de s'assurer qu'une capacité mentale est stabilisée est de vérifier qu'elle est transférable dans une autre tâche.*"(Meirieu, 2007)

In order to construct problem-situations a teacher is offered some methodological recommendations in a form of four main questions to answer (Meirieu, 1987a):

1. What is my objective? What do I want my learners to acquire which would be a new step for them in their development?
2. Which task can I offer which would bring learners to reaching this objective?
3. Which measures should I put in place so that the mental activity required for doing the task would bring learners to reaching the objective?
 - a. Which materials, documents, tools, etc. should I provide?
 - b. How should I formulate a task so that students use the materials while doing the task?
 - c. Which limitations should be put in place in order to prevent learners from escaping the learning opportunity?

4. Which activities can I offer? How to vary tools, degree of guidance, work format, etc.?

The notion of '*situation-problème*' should be distinguished from the notion of a didactic '*situation*' which for Audran (Audran, 2008, 2010) is not under the exclusive responsibility of the teacher but is the joint responsibility of the pupil and the teacher Sensevy (Sensevy, 2008).

To qualify the "*situations-problèmes*" Audran prefers to use the French word "*dispositif*" to talk about the product of the teacher's action. The notion of the "*dispositif*" has been theorized by some French researchers (Jacquinot & Monnoyer, 1999) after the philosopher Michel Foucault used it in his book "*Surveiller et punir, naissance de la prison*" (Foucault, 1975).

The word '*dispositifs*' finds its origins in the Latin word "*dispositio*", the system used for the organization of arguments in Western classical rhetoric. It can be translated as "organization" or "arrangement". There is no direct equivalent of the word '*dispositifs*' in English but we can tentatively translate it as a didactic "organization" or didactic 'arrangement'.

The Problem-Centred Education requires putting in action these didactic "*dispositifs*" that teachers have to build in order to move from theory to practice

Audran (Audran, 2010, pp. 45–50) distinguishes three kinds of "*dispositifs*" in education and training:

1. institutional arrangements (legislative context, programs, teaching venues and institutions);
2. didactic organizations (what the teacher must do) that are "situated" and consequently that involve creating educative "situations";
3. instrumental organisations that are related to the use of tools and instruments.

Only the second type of '*dispositifs*' is connected to the Problem-Centred education since it refers to the question of transforming concepts (e.g. OTSM-TRIZ) into real practice.

The concept of the problem situation was formalised in late 80s, however, it still hasn't won its place in everyday classrooms. When asked about possible reasons, Meirieu (Meirieu, 2007) gives some clues why it may be so. One may be the fact that problem

situation is a formal concept which has to be filled with the content. It does not offer ready-made scenarios but is rather a model which invites teachers to apply it for building their lessons, which may not be an easy task. The second reason may be the fact that many teachers see problem situation as a mere motivating exercise to attract students' attention rather than a concept that can help to change educational paradigm. Problem situation requires a long term planning with long term objectives that should change the way students approach their learning rather than a one-shot activity.

Another possible reason for the existing resistance is that many teachers still mix the notion of a 'programme' and 'programming'. They believe that if there are 36 chapters in a manual and the same number of school weeks, it means they should dedicate one week per chapter. They do not realise that the programme merely indicates what students should encounter in the course of their education without specifying how much time should be spent on every concept. They treat programme in a lineal way and do not dare to take emancipated decisions. Problem situations mean putting forward more general ambitious aims within which one can work on smaller objectives and not necessarily in a linear way. Therefore, many teachers do not dare to use problem situations appropriately but are rather satisfied with using them randomly on a short term basis and thus feeling safe following the notorious programme.

If we now have to compare the notion of the '*situation-problèmes*' with other related 'problem educations', we can highlight several important observations.

First of all, the notion seems to be rather close in its aim to the notion of the Problem Education developed by Russian educational professionals. Both aim at making learners acquire a certain content through making them solve a learning problem. Both were developed for school education and work with school related content.

Some terms used in both approaches are similar though indicate different notions while others have different names for the same notion. The Problem Education speaks about the unknown hidden in the problem task while '*situation-problèmes*' mention an obstacle, which is a true learning content. While '*situation-problèmes*' is the notion which includes all the components of the didactic situation, the term 'problem situation' in the problem education merely indicates a state of psychological difficulty of a learner (a cognitive conflict).

It seems that two approaches can complement each other and share ideas on a better organisation of the teaching-learning process.

Just as with the Problem Education, the '*situation-problèmes*' does not include the idea of a systematic strategy building and does not offer any problem solving tools to be introduced in the educational content. This makes them different from the Problem Centred Education (PCE) which is the main object of the study of the given research. Nevertheless, its psychological and didactic basis is very similar to the PCE offering to provoke a cognitive conflict in students' mind, involve students in interaction for building a solution and reflect on the process and result. So we can assume that research on the effects and contributions of '*situation-problèmes*' may be used for improving the teaching-learning process required for organising the Problem-Centred Education.

2.4.4. The Problem-Centred Education vs Thinking Skills Approaches

The last step in positioning the Problem-Centred Education among the existing approaches is to draw parallels with the so called Thinking Skills Approaches. Before this could be done, some discussion on what is 'a skill' and 'a thinking skill' should be provided.

When trying to define the concept of a 'skill', various scholars agree on a number of features which characterise a skill. A skill is defined as an ability which goes beyond normal human capacities due to specific training and acquisition and allows a human being to perform certain tasks on a higher level of quality (G. Smith, 2002; G. F. Smith, 2002; Pring, 2004).

Skills can be consciously controlled (G. F. Smith, 2002), they are repeatable and transferable within limits (M. J. E. Smith, 1984). They can manifest themselves only in tasks or particular activities (G. F. Smith, 2002; Pring, 2004) therefore they are associated with procedural knowledge or what Ryle (Ryle & Dennett, 2000) termed 'knowing how'. Being associated with procedural knowledge, skills have much in

common with such overt forms of procedural knowledge as strategies and methods that are applied for task performance; partly they are internalised strategies (G. F. Smith, 2002). Pring (Pring, 2004) adds that a skilled person has a range of specific competences, what he refers to as '*can do's*'. Hence, a skilled performance can be described in 'can do' statements which describe specific actions that a person is skilled at. According to Pring (Pring, 2004), skills can be relatively easy assessed since specific conditions can be specified under which specific skills should be displayed.

What mainly constitutes the core stone of the debate on the concept of a 'skill', which continues in a debate on thinking skills as well, is whether skills are context dependent or not, in other words, whether performance of a skill can be assessed in a context dependent or context independent way. In their views on the domain vs generic skills the majority of the scholars (G. Smith, 2002; Hinchliffe, 2002) express scepticism regarding the possibility of all-purpose generic skills that can be learnt and taught independently of context and that have general application across domains. Skills are acquired in a context and, hence, context awareness while performing a task (Hinchliffe, 2002) and the role of declarative knowledge (G. Smith, 2002) alongside the procedural one is essential for successful deployment of a skill.

It is also important to mention the discussion on the relationships between a 'skill' and 'ability'. As remarked by Gerald Smith (G. F. Smith, 2002) the notion 'skill' has two connotations. It can either mean '*mere ability*', something which a person acquired, for instance, the skill of walking, or it can refer to '*special capacity*', in which case it would imply a highly competent performance. Referring to 'thinking skills', the concept implies the latter meaning (G. F. Smith, 2002) and thinking skill is defined as "*a teachable, consciously controlled, partially proceduralised, mental activity that extends normal cognitive capabilities in the performance of certain tasks*" (G. Smith, 2002, p. 210).

Despite some counter-arguments proposed by the opponents of treating thinking as a skill (see, for instance, Johnson in Johnson & Siegel, 2010), many scholars (see, for instance, E. de Bono, 1999, 2009a, 2009b; Feuerstein, 1980; Siegel in Johnson & Siegel, 2010; McGuinness, 1999; G. Smith, 2002; G. F. Smith, 2002) keep treating thinking as a skill and develop educational interventions that would enhance the thinking skills concerned.

Coming back to the thinking skills approaches (educational interventions) that are being developed by educational professionals nowadays, a clear distinction and classification of thinking skills approaches should be drawn

The first distinction that has to be drawn is that one between educational approaches to teaching for thinking and educational programmes for teaching this or that aspect of thinking. According to Sokol (Sokol, 2007, p. 23; Sokol, Lasevich, Jonina, et al., 2013, p. 1162), specific programmes are developed on the basis of certain approaches and they target the solution of a local educational problem. Approaches, on the other hand, are developed for and aim at solving a much more global problem. Several programmes can be developed from one approach. Approach, on the other hand, follows a certain theoretical framework (a theory or a set of theories) that constitutes its basis. According to this distinction, the following would classify as an approach: Teaching for Understanding approach developed within the Project Zero (Boix-Mansilla & Gardner, 2008; Brandt, 1993; Darling-Hammond et al., 2008; Fennema, Sowder, & Carpenter, 1999; Gardner & Boix-Mansilla, 1994; Perkins, 1993, 1998; Perrone, 1994; Wiskey, 1997) educational approach to teaching lateral thinking developed by Edward de Bono (E. de Bono, 1988, 1990; E. D. Bono, 1990), Philosophy for Children developed by Matthew Lipman (Lipman, Sharp, & Oscanyan, 1996), Developmental Education developed by Daniil Elkonyn and Vasilii Davydov (Давыдов, 1996), and numerous critical thinking approaches⁹⁷. The given approaches have different theoretical background behind and gave rise to different educational programmes (see Table 19 for a brief summary).

Table 19 Brief review of some thinking skills approaches, theories they are based on and programmes they gave rise to. In addition to my personal contribution, the table is compiled on the basis of the review offered by Sokol (Sokol, 2007, p. 23)

Theories	Approaches and their authors	Programmes
Cognitive psychology	Teaching for Understanding (part of the Project Zero). Main developers: • Howard Gardner (Boix-Mansilla & Gardner, 2008; Brandt, 1993; Gardner	Programs developed within Teaching for Understanding approach

⁹⁷ As remarked by Sokol (Sokol, 2007, p. 23), some approaches can develop to a degree when several smaller approaches would exist under the umbrella approach as it is the case of the critical thinking approaches.

	& Boix-Mansilla, 1994) <ul style="list-style-type: none"> • David Perkins (Perkins, 1993, 1998) • Vito Perrone (Perrone, 1994) • Martha Stone Wiske (Wiskey, 1997) Other scholars who contributed to the approach: <ul style="list-style-type: none"> • Linda Darling-Hammond and Alan Schoenfeld (Darling-Hammond et al., 2008) • Elizabeth Fennema and Thomas Carpenter (Fennema et al., 1999) 	
Cognitive psychology distinguishing divergent and convergent thinking; Ideas on lateral thinking developed by deBono himself	Educational approach to teaching lateral thinking (E. de Bono, 1988, 1990; E. D. Bono, 1990)	de Bono's Cognitive Research Trust (CoRT) Lessons
Socio-constructive theory of learning	Philosophy for Children (Lipman et al., 1996)	Lipman's novels and accompanying manuals
Dialectical logic (Ильенков, 1984) and a number of theories developed by Russian psychologists (Vygotsky, 1978; Леонтьев et al., 2005)	Developmental Education (Давыдов, 1996)	Developmental Education programs
Formal and informal logic	Critical thinking approaches	Programs for teaching elements of critical thinking (Baumfield, Butterworth et al. 2004)

The second important distinction concerns the relationship between cognitive skills, operations and processes and the subject-content or subject-specific knowledge within this or that educational approach or program. Several scholars (Burke & Williams, 2008; Loarer, 1998; McGuiness, 1999; Moseley et al., 2005) offer their classifications.

Moseley et al. (Moseley et al., 2005) notice that some educational professionals addressed only cognitive processes (for instance, Feuerstein and his Instrumental Enrichment Programme⁹⁸), others focused on specific processes, such as inductive

⁹⁸ It is worth mentioning that by developing his intervention programme in 1950s Feuerstein addressed a sociological problem. At that time many immigrants from the Middle Eastern countries came to Israel and it became obvious that the children of these immigrants did much worse in school than children from Europe and North America and hence were much less successful competing for jobs. The Instrumental Enrichment (IE) programme was designed to change the self-concept, motivation, and intellectual

reasoning (Klauer & Phye, 1995; Buchel et al., 1997 quoted in Moseley et al., 2005), and the third group argued that teaching thinking skills should be infused into academic subject teaching (Leat, 1998; Adey et al., 2001; Gouge & Yates, 2002 quoted in Moseley et al., 2005).

Loarer (Loarer, 1998) reviews specifically those methods for cognitive development (17 in total), which primary aim at the development of the intelligence, namely, a set of capacities and mental strategies which allow learning and adaptation to new situations. The content is not part of the cognitive development but the result of the cognitive interventions is supposed to improve content learning and general performance. The reviewed programmes include the following: Atelier de Raisonnement Logique (by Higele), Tanagra (by Pimor and Cottin), Ateliers d'activation du raisonnement logique - ACTIVOLOG (by Chazot and Perry). According to Loarer (Loarer, 1998), other methods offer a kind of a content of a more logical nature. In any case, these methods are still focusing much more on the thinking procedures than the acquisition of knowledge. For instance, Cubes de Mialet offer as a content base some logico-mathematical knowledge; method of Gerex-Soutien offers to develop transversal abilities, such as self-organisation, structuring, etc., as well as interdisciplinary techniques, such as mastering of the language, mathematical techniques, etc.; method ORC – Outil de Construcion des Connaissances – which offers learning transversal mental activities (discrimination, selection, classification, deduction, coding, decoding, measuring, etc.) and general learning dispositions (attention, determination/perseverance, communication, verification, exploration, assurance, anticipation, etc.). In addition, it focuses on developing of knowledge base in 3 main domains: linguistic, mathematical and technical.

McGuiness (McGuiness, 1999) mentions three models for delivering thinking skills that were identified: general approaches (content-independent and content-dependent), subject specific approaches and infusion approaches. Context independent general approaches are directed towards enhancing general thinking skills. These programmes

processing ability of these disadvantaged students (the intervention was planned to take a period of two or more years,) with the aim of bringing them up to the level of the average Israeli student by the end of high school. The concept of '*instrumental enrichment*' is contrasted to that of '*general enrichment*'. 'General enrichment' refers to special instruction in the content and methods of particular subject matter, and 'instrumental enrichment' refers to content-free learning of basic cognitive processes applicable across all subject domains (Feuerstein, 1980).

are strongly linked with Piagetian and post-Piagetian theories of cognition. The examples of these approaches include the famous Feuerstein's Instrumental Enrichment (IE), Blagg's Somerset Thinking Skills Course (a UK elaboration of the IE approach), de Bono's Cognitive Research Trust - CORT programme, Lake's & Needham's Top Ten Thinking Tactics. These approaches are additional to the normal curriculum and do not require any subject matter content since they claim to train general thinking skills. Content-dependent interventions also target the development of general thinking skills, but in contrast to context-independent interventions, these are situated within subject-matter domains using the thinking opportunities provided by these domains. For example, Philip Adey's CASE (Cognitive Acceleration through Science Education) programme is directed towards scientific-type thinking for 11-14 years. Subject specific approaches target subject specific learning (science, maths, geography) and are based on the view that thinking skills are linked with knowledge structures associated with different domains. The existing programmes include CAME (Cognitive Acceleration through Mathematics Education), Thinking through Geography (Leat, 1998 quote in McGuinness, 1999), Matthew Lipman's Philosophy for Children which is claimed to be particularly relevant in the context of social and moral education where the philosophical emphasis on questioning is important. And the last approach identified by McGuinness is infusion methodology. Infusion approach is defined as "*is the approach that teachers use when blending explicit instruction about thinking skills and processes with content instruction. It involves pedagogic approaches that enhance students' thinking and comprehension of the subject matter*" (Swartz et al. 1998:529 in McGregor, 2007, p. 125). An example of the infusion programme provided by McGuinness (McGuinness, 1999) is ACTS project (Activating Children's Thinking Skills) for upper primary level which was modelled on the methodology developed by USA scholars Robert Swartz, David Perkins and Sandra Parks.

The majority of scholars (Burke & Williams, 2008; Loarer, 1998; McGregor, 2007; McGuinness, 1999), (Kirkwood (2001a) in McGregor, 2007), (Mercer, Wegerif & Dawes in Li, 2011) nowadays acknowledge that in order for the thinking instruction to be effective it has to be (a) explicit and (b) infused in the subject matter knowledge.

The classification of the approaches and programmes offered by Burke and William's (Burke & Williams, 2008) is close to that of McGuinness's and the scholars remark that despite advocating different methods for enhancing students' thinking skills, the

programmes share some common features, such as (1) promoting relevant thinking dispositions (e.g., being persistent, thinking flexibly, adopting a questioning attitude), (2) encouraging the language of thinking (such as summarise, estimate, conclude, imply) which allow associating thinking words with their relevant cognitive processes, (3) developing meta-cognition, (4) teaching transferring of knowledge, skills, dispositions and strategies to students' everyday lives.

In the framework of the given research, I am not primarily interested in the approaches or programmes that offer pure cognitive development, namely, focus on pure cognitive processes freed of specific content. For the ease of distinction, I will be referring to them as **pure cognitive approaches**. Therefore, these are not included in the analysis. What is more relevant however are those approaches which are concerned with combining content instruction with the explicit development of certain cognitive skills (these can include both content-dependent, subject specific or infusion approaches discussed above), they are implemented in the real classrooms with regular students. In the framework of my research, these are specifically these approaches that are referred to as **Thinking Skills Approaches** or **teaching for thinking approaches**. The majority of these approaches to a greater or lesser extent rely on various findings in Cognitive Psychology and operate with such concepts as *thinking (skill)*, *cognitive skills*, *meta-cognitive skills*, *higher-order thinking (skills)*, *subject-matter skills/content*, *infusion*, *meta-cognition* and *meta-cognitive thinking (skills)*, etc.

Taking into account the numerous teaching for thinking approaches that exist nowadays, it is impossible, and irrelevant for the given research, to make summaries of all of them. What is more important, however, is to identify those approaches and research that, though relying on different psychological theories, target similar aims with the Problem-Centred Education and offer similar framework (model) for organising the teaching-learning process. The given exercise will allow us to benefit from the experience and research findings of other colleagues for reaching our own research objectives and solving our own research problems.

After analysing teaching for thinking approaches available nowadays and supported by numerous research, three main approaches were identified, which seem to be worth taking into account:

1. Teaching for Understanding approach developed by a group of educational professionals (Gardner & Boix-Mansilla, 1994; Perkins, 1993; Perrone, 1994; Wiskey, 1997) at the University of Harvard (including different projects developed on its basis, such as Cognitively Guided Instruction (Carpenter, Fuson, Hiebert, Human, & Wearne, 1999));
2. Cognitive Acceleration approach of Philip Adey⁹⁹ (Adey, 1999, 2006a; Adey et al., 2004b) developed in 1980s at King's College, London (originally developed for science education and further adapted to other subjects from pre-school stage to secondary level, which now includes such methods/programmes as Cognitive Acceleration through Mathematics Education (CAME), Cognitive Acceleration through the Arts, Let's Think programmes¹⁰⁰);
3. Pedagogies or instruction for teaching higher order thinking developed and promoted by Israel researchers and educational professionals (Gallagher et al., 2012; Zohar, 2004, 2008).

The common feature for all these approaches and programmes is that they all aim at shifting the classroom practice from rote learning of facts and algorithmic problem solving towards a focus on higher order forms thinking and deep understanding. They rely on the recent findings in cognitive psychology for developing their pedagogies and promote constructive view of learning. In general terms, they promote teaching for thinking at schools, where thinking means employing complex mental abilities for **using** knowledge (facts) contrasted to the mere ability of remembering and repeating the information. Basically, these approaches and programmes developed on their basis target the improvement of instruction to avoid students' rote learning, which was prevalent in the so-called traditional or transmission of knowledge pedagogy. As put by Gallagher et al. (Gallagher et al., 2012, p. 135):

“The emphasis on developing higher-order forms of thinking that go beyond the mere recall of information, aims to enable students to grasp a deep understanding of what they are learning, to be more critical of evidence and arguments, to be creative and generate new knowledge, as well as to

⁹⁹ Even though Philippe Adey is the one who is mostly quoted in regards to the development of the Cognitive Acceleration approach, the originator of CASE approach who actually recruited Philip Adey for the project is Professor at Chelsea College Michael Shayer (Adey, 1999, p. 4)

¹⁰⁰ Cognitive Acceleration programmes are now promoted under the title of Let's Think. The latest developed programme is Let's Think in English - <https://www.letsthinkinenglish.org/>

problem solve and make decisions in the face of uncertainty. While these forms of thinking have traditionally been valued in education, they have not always been systematically and explicitly pursued as curriculum goals.”

Even though, these are achievements in the cognitive domain which are emphasised (thinking and problem solving, manipulation of symbols, and language learning), as claimed by Gallagher (Gallagher et al., 2012) many of the existing frameworks also take into account psychosocial domain and cultural values (interpersonal skills, working with others, empathy, self-management, participating, attitude, motivation, etc.).

The concepts that are often used by educational professionals dealing with the teaching for thinking approaches include: *thinking*, *teaching thinking*¹⁰¹, *teaching thinking skills*,

¹⁰¹ Even though the term '*teaching thinking*' has been extensively used in the research literature I would like to point at some terminological issues that may appear regarding the notions '*teaching thinking*' and '*teaching for thinking*'. The author of the paper did not find any discussion on it in the '*teaching thinking*' literature. However, certain useful parallels can be drawn with the discussion held in the literature on creativity.

Some researchers on creativity (Vehar, 2013) (Robinson, 1999) are advocating for rigor in language making useful distinctions between the notions of *teaching creativity*, *teaching for creativity*, and *teaching creatively*.

According to Rhodes (Rhodes, 1961, p. 305), "*creativity is a noun naming the phenomenon*". Therefore, to say that one *teaches creativity* would mean that one teaches the *phenomenon*, or more precisely, that one teaches *about the phenomenon*. According to Vehar (Vehar, 2013) this can imply at least two different meanings. On the one hand, researchers can study the phenomenon of creativity, namely, theory and research and teach it to someone. On the other hand, those who are involved in teaching about the phenomenon of creativity are, in fact, teaching a *creative process*, namely, "*the process that is necessary for the phenomenon to occur*" (Vehar, 2013, p. 384). This process requires and fosters mental activity or mental process that is referred to as *creative thinking*. The result of this teaching should manifest itself in a creation of a new product. Educational professionals who are involved in teaching *creative process* or *teaching creativity* in its latter sense can teach students different creative problem solving techniques and methods or foster their divergent thinking or lateral thinking (E. de Bono, 2009a) that is often associated with creativity.

In their report to the UK government entitled '*All our Futures: Creativity, Culture and Education*' (Robinson, 1999), the UK National Advisory Committee on Creative and Cultural Education (NACCCE) offered their own definition of *creative teaching*, defining it in two ways: first, *teaching creatively*, and second, *teaching for creativity* (Robinson, 1999, p. 102). *Teaching creatively* refers to teachers using imaginative approaches to make learning more interesting, exciting and effective. They develop and apply approaches that motivate their students' learning. Creative teaching is a key component of any effective teaching but it does not guarantee that learners will develop their own creative abilities. On the other hand, *teaching for creativity* refers to forms of teaching that are aimed at the development of creative thinking of learners. In this sense, it is an equivalent to the notion of *teaching creativity* (meaning, *teaching creative process*) discussed by Vehar (Vehar, 2013). *Teaching for creativity* includes at least three general tasks (Robinson, 1999, p. 102). First, encouraging learners to believe in their creative potential, developing such attitudes as high motivation and independence of judgement, willingness to take risks and be enterprising, to be persistent and to be resilient in the face of failure. Second, helping learners identify their strengths and abilities. And last, developing learners' common capacities and sensitivities, curiosity, and memory, as well as making learners aware of what is involved in being creative. Even though the authors of the report acknowledge the integral relationship between *teaching for creativity* and *teaching creatively*, since teachers cannot develop creative abilities of their learners if their own creative potential is suppressed, some researchers (Jeffrey & Craft, 2004) warn against dichotomising between the two terms and argue that the nature of the relationship between them has to

thinking curriculum, inquiry-oriented curriculum, higher order thinking (skill), learning/teaching for understanding, pedagogies of teaching thinking, instruction of higher order thinking (skills), active construction of knowledge, infusing thinking into the subject-matter instruction, etc. I would like to highlight again that these are not pure cognitive approaches in a sense that they do not remove any content from its instruction and acknowledge the importance of factual knowledge. These approaches address the question of integrating domain-specific or subject-specific content and thinking skills instruction and can be referred to as *content-dependent, subject-specific* and *infusion approaches*. They are developed to answer the following question - How to help students construct their knowledge (acquire domain specific or subject-specific content) in a meaningful way and make them able to use that knowledge effectively for explaining scientific, cultural, social, etc. phenomena and for tackling complex mental tasks presented in a form of a problem. Using knowledge presupposes its deep understanding; hence the concept of understanding is being applied. Within the Teaching for Understanding approach the distinction is made between knowledge, skills and understanding. Knowledge is “*information on tap*” (Perkins, 1998, p. 40) and one can prove he has it when he can reproduce it. Skills are “*routine performances on tap*” (Perkins, 1998, p. 40) and one can prove their presence if one is capable of turning the tap. And the concept of understanding is defined as “*the ability to think and act flexibly with what one knows*” (Perkins, 1998, p. 40), or in other words, it is “*flexible performance capability with emphasis on the flexibility*” (Perkins, 1998, p. 40). This performance view on understanding is contrasted to the possession view applied in cognitive sciences when understanding is conceptualised as a representation, image or mental model that people have. So in the framework of the “Teaching for

be explicated more. For the study of creative pedagogies the researchers (ibid.) suggest to focus both on the teacher and the learner. *Teaching creatively* can be interpreted as ‘effective teaching’ and *teaching for creativity* as having ‘learner empowerment’ as its main objective (Jeffrey & Craft, 2001).

Drawing parallels with the domain of teaching thinking we can deduce that ‘*teaching thinking*’ can refer to two processes: (1) teaching *about* thinking as a phenomenon, i.e. about theory and research in the domain of thinking, and (2) teaching the process that is necessary for the phenomenon to occur. In other word, teaching how to think effectively or developing thinking skills, i.e. higher-order mental processes. The result of this teaching should manifest itself in effective solution of problem tasks that require application of these higher-order mental processes. ‘*Teaching for thinking*’, on the other hand presupposes only one meaning and refers to forms of teaching that are aimed at the development of thinking skills of learners (higher-order mental processes). It is a synonym for the notion ‘*teaching thinking*’ in its latter sense. For the purposes of the clarity, the author of the paper will be privileging the use of the notion ‘*teaching for thinking*’ throughout the text. When the notion of ‘*teaching thinking*’ will be used, it will normally be specified with the notion of ‘skills’, i.e. teaching thinking skills, hence giving it the meaning of ‘*teaching for thinking*’.

Understanding” approach ‘learning for understanding’ means learning flexible performance. Understanding can be manifested when it is put to work, so it can be recognised through performance (doing tasks):

“Understanding is a matter of being able to do a variety of thought-demanding things with a topic—like explaining, finding evidence and examples, generalizing, applying, analogizing, and representing the topic in a new way. For example, if a student “knows” Newtonian physics in the sense of being able to apply equations to routine textbook problems, we would not be convinced that the student really understands the theory. But suppose the student could find examples in everyday experience. (Why do football linemen need to be so big? So they will have high inertia.) Suppose the student could make predictions that would illustrate the theory. (Imagine a bunch of astronauts out in space having a snowball fight. What happens if they throw and get hit by snowballs?) The better the student could handle a variety of thought-demanding tasks concerning Newton's theory, the readier we would be to say that the student understood. In summary, understanding is being able to carry out a variety of “performances” that show one's understanding of a topic and, at the same time, advance it. We call such performances “understanding performances” or “performances of understanding.” (Perkins & Blythe, 1994, p. 6).

The Teaching for Understanding approach offers a four-component framework (model) that should allow teachers planning and organising the teaching-learning process directed at building students’ understanding (Perkins & Blythe, 1994). The framework highlights four key concepts:

1. **Generative topics** – it is important to decide which topics are worth to be studied. The core Teaching for Understanding curriculum should be built of topics which are (a) more central to the discipline, (b) more accessible to students, and (c) more connectable to diverse topics inside and outside the discipline. Several weeks or even months can be devoted to one generative topic.
2. **Understanding goals** - after defining generative topics to be studied, a few specific understanding goals for the selected topic have to be formulated. These goals will give focus to teacher’s instruction. The best suggested phrases for

formulating goals include: “Students will understand that ...” or “Students will appreciate that....”

3. **Understanding performances** - understanding goals should be supported by understanding performances. Students should be engaged in performances that demonstrate understanding from the beginning to the end of the unit. Even though the authors do not offer any phrases for formulating understanding performance, we can assume that these can be better formulated though the phrases such as “Students will be able to ...(do something flexibly: explain, generalise, analogise, compare, etc.)”.
4. **Ongoing assessment** – in order to develop understanding, teachers should offer students criteria, feedback and opportunities for reflection from the beginning of and throughout any sequence of instruction. This is what nowadays has been basically called formative assessment directed towards improvement of the achieved result in contrast to summative one, which aims at measuring the final level of success normally compared to certain benchmark or standard.

In the framework of Cognitive Acceleration approach, the authors do not develop explicitly the concept of understanding. The approach originally aimed at helping students with grasping fundamental concepts in sciences and humanitarian domains. As put by Adey (Adey, 1999, p. 4) “[...] *the difficulty of science concepts tended to be masked by the rote learning of definitions, which avoided the problems of trying to teach for real understanding*”. As can be deduced from this outlining of a problem, the issue of teaching for understanding is addressed inexplicitly within the Cognitive Acceleration approach. The difference lies in a theoretical framework which stands behind the offered approach and its direct aims. Cognitive Acceleration is an approach¹⁰² based on

¹⁰² Cognitive Acceleration is sometimes referred to as ‘intervention’ due to two reasons. Firstly, because it is an intervention in ‘normal’ cognitive development of a student (Adey, 1999, pp. 14–15). In this sense, the concept of ‘intervention’ is contrasted to that of ‘instruction’. The instruction is defined as “*the provision of knowledge and understanding through appropriate activities*” (Adey & Shayer, 1994, p. 2) and its end product can be specified in terms of learning objectives. Theories of instruction concentrate on the effective presentation of material within specific content domains (Adey & Shayer, 1994, p. 7) ‘Intervention’, on the other hand, refers to “*manipulating experiences specifically aimed at maximising developmental potential*” (Adey & Shayer, 1994, p. 2). Intervention aims at manipulating environment in order to maximise cognitive development. It is connected to the distinction made between the concepts of ‘development’ (connected to the idea of maturation, unfolding) and ‘learning’ (purposeful activity which may or may not happen). Intervention is a special sort of learning in the developmental process (Adey & Shayer, 1994, p. 4).

the theory of cognitive stages of development developed by Jean Piaget and Lev Vygotskyan theory of social construction of knowledge, a zone of proximal development (ZPD¹⁰³) and metacognitive development of one's own thinking (Adey, 1999, p. 28, 2006a). Originally Cognitive Acceleration aimed at helping students reach, what Piaget termed formal operational stage and the original target group included students aged 11-14:

“By ‘cognitive acceleration’ we mean the process of accelerating students’ ‘natural’ development process through different stages of thinking ability, towards the type of abstract, logical and multivariate thinking which Piaget describes as ‘formal operations’. Formal operational thinking is characterized by the ability to hold a number of variables in mind at once [...]” (Adey, 1999, p. 5)

The modern Cognitive Acceleration is developed for younger students so in this case the intervention targets students' reaching concrete operational stage. Speaking about other domains, Adey (Adey, 1999, pp. 37–38) claims that even though Piaget described one particular set of schemas underlying formal operations (those schemata present in science, such as control and exclusion of variables, proportionality, classification systems, equilibrium, etc.), their general features, such as the ability to think with abstractions and multi-variable thinking, can be found in different types of schemas. So the task is to identify what would count as formal operations in different subjects, i.e. which schemas would underlie them, and develop activities that would 'accelerate' students in acquiring these operations while studying subject matter.

A five-pillar model has been developed for organising a teaching-learning process in the framework of Cognitive Acceleration (Adey, 1999, 2006a; Adey et al., 2004b; Adey & Shayer, 1994) (see Figure 18).

The second reason of referring to CA as an intervention is because CA is not a complete alternative science curriculum that would replace the regular curriculum. It is rather a set of activities that intervene in a regular curriculum once every two weeks (Adey, 1999, pp. 14–15).

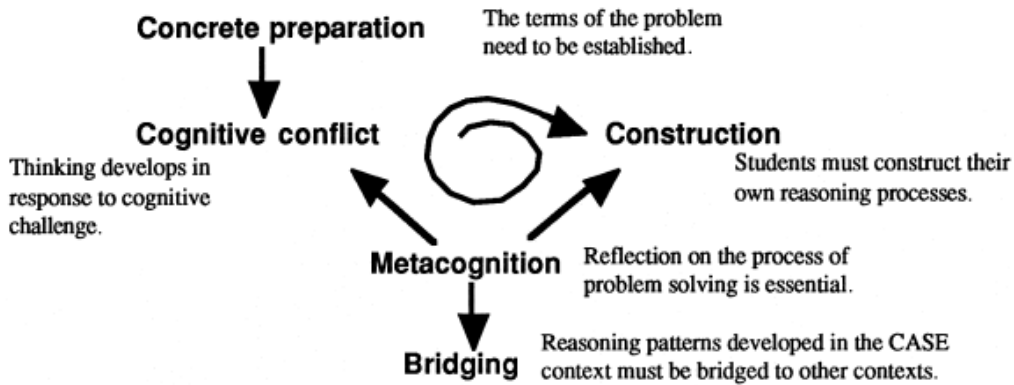


Figure 18 The five pillars of CASE theory (Adey, 1999, p. 5)

The core three pillars of the model are *cognitive conflict*, *construction* and *metacognition*. Two supplementary pillars added to it include *concrete preparation* (phase 0) and *bridging* (as the last phase).

The phases of *cognitive conflict* and that of *construction* are connected to the theory of a 'zone of proximal development'. Cognitive conflict occurs when the mind faces challenge, a problem a learner cannot easily solve for himself. Activities which provoke cognitive conflict can stimulate cognitive growth, i.e. are beneficial to the development of learners' thinking. These challenges should operate within the zone of proximal development of a learner and lead to the second phase – *construction* – where a learner co-constructs his knowledge and ways of thinking being mediated by teacher's questioning and collaborative work. Once the learning problem has been solved the next phase is to reflect on one's own thinking – *metacognition* - cognitive strategies and reasoning used for solving a problem, difficulties encountered, ways of seeking and getting help, etc. The supplementary phase of *concrete preparation* is required for introducing language of a problem, apparatus to be used and a context in which the problem is set. The aim of this preparation stage which precedes the core phases is to make sure the difficulties learners will face while dealing with the activities will be intellectual and not those connected to problems of misunderstanding language or context. The last phase entitled *bridging* is crucial for making a bridge or a link between

¹⁰³ ZPD is defined as "the distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86)

ways of thinking developed in particular context of particular CASE activities with other contexts in and beyond science. This is an abstraction phase when knowledge acquired within specific context is turned into a general thinking tool.

Various research results conducted on the efficiency of Cognitive Acceleration approach (Adey & Shayer, 1993, 1994, Shayer & Adey, 1992b, 1992a) show that even though the immediate effects on students' cognitive development over a period of two years may be moderate, there is a long-term effect on students' academic achievement.¹⁰⁴ The given results allow to assume that the intervention is effective in increasing students' general thinking capability. Moreover, a far-transfer effect has also been documented since the intervention delivered in science classroom brought positive effects on students' academic achievement in mathematics and in English literature. The gained effects in far transfer allowed researchers to get evidence that point to the existence of one general intellectual processing mechanism (general intelligence, or 'g') (Adey, 2006b, p. 2) that underpin separate domains that have their special characteristics (see Figure 19). Hence, the assumption is if one improves higher order thinking of students in one domain (science) then it will lead to the improvement of students' general intellectual ability across the board.

It cannot pass unnoticed that the five-pillar model offered within the Cognitive Acceleration approach is technically very similar to the Thinking Task Framework (Figure 1) offered within the Problem-Centred Education. The Thinking Task Framework also offers three core steps for organising the teaching-learning process, namely, create a problem situation, build a model, and reflect on the process. This only proves that the teaching for thinking approaches are not mutually exclusive and do not exist in a vacuum but rather complement each other. They rely on similar views of learning and hence, similar views on the teaching-learning process. However, these approaches cannot be equalled to each other since behind the technical similarity there are different explicit aims which are targeted and different ways of achieving these aims. Moreover, being developed in different traditions, the core concepts employed in these approaches

¹⁰⁴ Data was collected after the two years of the intervention programme and then one year (for classes that had their CASE in Year 8) and two years (for classes that had their CASE in Year 7) after the intervention programme was over when students were taking their General Certificate of Secondary Education (GCSE) national public exam. The collected data allowed to compare over a long period both cognitive growth and academic achievement. The data was available not only for experimental classes but also for control groups.

may differ so one has to be careful when drawing comparison between them not to assume that one 'term' (e.g. problem) has the same meaning in all the approaches.

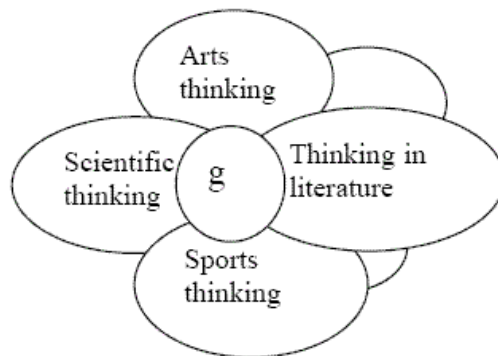


Figure 19 A general plus specialised model of thinking (Adey, 2006b, p. 2)

In respect to the technical similarities between the five-pillar model and the Thinking Task Framework, one should not fall into the trap that these similarities mean the approaches are the same. What is the same, however, is the general principle – in order to ensure there is a potential for constructive learning in the classroom learners should (a) face the challenge (which can be called cognitive conflict or problem situation); this challenge is assured by a task which they cannot cope with having the means available to them, (b) build the solution and (c) reflect on the process and product. Despite this similarity, the aim, methods, and content within this general principle are different. Unlike Cognitive Acceleration, the Problem-Centred Education does not explicitly aim at bringing learners' thinking to the stage of concrete operations or formal operations. So the selection of the content to be studied does not proceed from identifying schemas of formal operations (or concrete operations for younger learners) within the subject matter from which activities (tasks) can be drafted. The main content in the framework of the Problem-Centred Education is models of facts and processes, transformations and strategies. The tasks offered to learners should lead them to building these models and meta-tools of problem solving are provided as part of the content which should help to build the models. So the main question for constructing activities (tasks) is which model learners will have to build, which generalisation we want them to come up to.

Both Cognitive Acceleration and the Problem-Centred Education rely on the same socio-constructive view of learning, so they may share the main teaching methods used

in both approaches. The developers of Cognitive Acceleration do not specify the main teaching method which should be employed on the lesson. Knowledge is constructed through teacher's questioning and collaborative work. So we can assume that ability to mediate through questions is the key ability for a teacher on the CASE lesson alongside the ability to organise and manage collaborative learning of students. It should be noticed, however, that in his video interview about his work in the field of Cognitive Acceleration and his hopes for its future, Michael Shayer (Alan Edmiston, 2014) remarks that alongside keeping the concept of collaborative learning for organising the teaching-learning process within Cognitive Acceleration, it is essentially important to be aware of a possible trap stone behind it because "[...] *unless the teacher himself or herself can actually interpret each response of each pupil in terms of the level of thinking that is involved in relation to the teacher's own idea of actually what the whole scope of the context is that she is supposed to be teaching. Unless she can do that as well, she will not be able to manage the collaborative learning of her pupils because if you don't watch out, collaborative learning can lead to the blind leading the blind*" (Alan Edmiston, 2014, n. 6:46). In addition to the importance of questioning and collaborative work, the method of inquiry used in the Problem-Centred education presupposes the need of gathering a bank, a collection of objects of inquiry (be these physical or abstract objects, like sentences, for example) and analysing them for singling out important features which will allow learners to build a model of that object of inquiry.

2.5. Preliminary Conclusions

Conclusion 1

Taking into account a variety of similar terms which sometimes have different meanings or, on the contrary, different terms being similar in nature, it is important to specify the terminology which will be adopted in the framework of the given research. The following concepts that will be used further in the given research have the following meaning:

1. **A problem task (a problem assignment or a problem question)** is a task (an assignment or a question) which creates cognitive conflict in learners' minds. A

problem task can be made of **a system of tasks** – the main task and its sub-tasks - which learners have to solve in order to come to the solution of the main problem task.

Cognitive conflict is a psychological discomfort perceived by a learner, a psychological state of a mind of a learner who is confronted with the task he has no solution for. In the context of the PCE, the term '**challenge**' is used as a lay term for cognitive conflict.

2. **A problem** can have several meanings. It can refer either to a problem task or a cognitive conflict. It is better to avoid using this term in either of these senses in order to avoid the confusion.

This term can be also used as a layman term, in an everyday language in a class to denote the difficulty faced by students. For instance, a teacher's question "*which problem do we face*" can mean "*which difficulty?*", "*what is that you do not know?*".

A problem can also refer to a problem as seen in the framework of OTSM-TRIZ theory, namely as "*a contradiction between our wishes and objective laws of systems evolution which are manifested in peculiarities of a specific situation*" (Sokol, 2007, p. 44). It refers to an initial situation analysed with the help of OTSM-TRIZ tools and formulated in a form of a contradiction. When this is the case, then the term will be supplemented with the explanation "*a problem as seen in OTSM-TRIZ*". The aim of the Problem-Centred Education is to develop learners' ability to identify, analyse and solve problems (as seen in OTSM-TRIZ) in various domains. In other words, the aim is to develop **problem-solving competence** which is defined as "*an ability and disposition to solve linguistic, sociolinguistic, pragmatic and other kinds of problems when no typical solution is available*" (Sokol, 2007, p. 56) and avoiding a large number of trials and errors (Sokol, 2007, p. 46). For this purpose, the Problem-Centred Education introduces meta-tools as part of its content which allow to work with information.

3. A problem task can be characterised by its **difficulty** and its **complexity**, where difficulty is a subjective criteria for a learner and varies depending on learners' current level of abilities, whereas complexity is an objective criteria, which does not depend on the person involved in solving the problem task. So when developing a problem task it is essential to know how to vary its objective level of

complexity and be aware of the abilities of the learners in order to estimate the level of difficulty it will pose to them.

4. A problem task is always characterised by a certain **level of generalisation** that learners should make, in other words, it requires finding a method, a strategy, which can be applicable for solving a group of problems of the same type. This is referred to as '**the unknown**' and has the connection to the cognitive conflict: by discovering 'the unknown' a learner discovers a method (a HOW TO) which is relevant for solving a class of similar tasks. In other words, in order to create a cognitive conflict in a learner's mind, he has to be offered a theoretical or practical problem task, which would include 'the unknown' as its main component. **The solution**, on the other hand, characterises a problem task and represents a single unit specific for a single given task.
5. **Solving a problem task** means being involved in a set of sub-tasks (a system of tasks) organised in different forms (individual work, group work, plenary session), which leads to (a) building a strategy for solving the task and (b) applying the strategy to find a solution to a problem task.
6. The **method of teaching** is viewed as a way of organising learners' activity with the tools or resources, i.e. method of organisation of learners' cognitive activity. Tools or resources that a teacher can use in this process can be represented in **different forms**: graphical or pictorial (images, graphs, videos, etc.), in a form of tangible objects (microscope, book, experimental material, etc.), in a verbal form (story, lecture, explanation, etc.), in a form of tasks. There can be different methods: explanatory, reproductive or method of inquiry.
7. The **method of inquiry** is a method when learners are offered a system of problem tasks, which they have to solve in order to uncover 'the unknown'. A **method of partial inquiry** is when a problem task is sub-divided into smaller sub-steps (in the form of tasks or questions). A student is not independent in solving the main task (as in method of inquiry) but he is independent in his inquiry when dealing with the sub-steps.
8. **A model is** "*a system represented in mind or in a material world, which being a representation or a reproduction of an object of the study is able to substitute that object in such a way that the study of that representation/reproduction allows us*

*to discover new information about the object itself*¹⁰⁵ (Штофф В.А., 1966, с 19 in Нестеренко, 2006а, p. 35).

9. **Meta-tools** are problem solving tools which are derived from the OTSM-TRIZ theory. A meta-tool can come from any other domain as well, if it is quite general to be applicable for solving problems. For instance, concept maps can be considered to be a meta-tool.
10. **Metacognition** refers to reflection on one's own thinking, i.e. on cognitive strategies and reasoning used for solving a problem task, difficulties encountered, ways of seeking and getting help, etc.
11. **Infusion approach** – is an approach which targets at the development of certain thinking skills (problem solving competence) in the framework of a specific subject-matter teaching.

Conclusion 2

One of the tasks of the chapter one was to analyse which teaching for thinking approaches exist and how they compare to each other and particularly to the Problem-centred education. It was identified that among the six criteria used for comparison, namely, theoretical basis, target group, aim, content, methods and interaction, result, the majority of the approaches share a common vision on the method and interaction required for organising the teaching-learning process.

All the approaches to this or that extent speak about organising learner's activity through the **method of inquiry** and apply **three steps in the process** which are referred to under different terms in different approaches. Moreover, all the approaches highlight the **dialogic approach in teacher-student interaction** and the importance of questioning for the purposes of pursuing students' reasoning.

The general path of instruction, or lesson structure, for working through the content comprises the following three steps

¹⁰⁵ From Russian «Под моделью понимается такая мысленно представляемая или материально реализованная система, которая, отображая или воспроизводя объект исследования, способна замещать его так, что её изучение даёт нам новую информацию об этом объекте».

- Step1: create a cognitive conflict (a problem situation) by offering a problem task, giving a problem assignment, asking a problem question;
- Step 2: make learners build the solution (social construction stage);
- Step 3: make learners reflect on the result and the process of building the solution (meta-cognition stage).

The length of each phase may be different under different approaches and what exactly happens in stage two may also differ. The method of inquiry (or partial inquiry) is privileged in step two.

This finding is probably not surprising since all teaching for thinking approaches tend to oppose passive transmission of knowledge and try to find the way of making a learner an active participant of the process. Many of them refer to the findings of the cognitive psychology to build the system for organising the teaching-learning process.

Despite similarities, there are some important peculiarities for specifically the problem-centred education. The most important ones include the following:

- The PCE explicitly offers modelling as a part of its content: models of objects and processes, models of transformations and strategies;
- The focus of work shifts from finding a solution to building a strategy for developing solutions when dealing with a given type of tasks. The expected result from learners includes learning HOW to build new strategies when students face problem tasks and problems (as seen in the OTSM-TRIZ) in general.
- The method of inquiry used in PCE often requires the collection of a bank of objects of a study, which are analysed for identifying common features and building a model of an object/process on the basis of these features.
- The PCE explicitly offers meta-tools as part of its content, which are used for analysing information;
- The PCE can be considered to be an infusion approach since it integrates both subject-matter teaching and the development of problem solving competence.

- On a general level, the professional task of the teacher in the framework of the problem-centred education corresponds to the aim of the PCE and can be formulated as follows:
 - the development of a learners' world view centred on a problem, which can be explained as developing awareness and ability to manage the network of the dynamic external and internal images, the ability to transform and change both external and internal world, the ability to identify and solve contradictions that arise between both external and internal worlds and the ability to change the five images themselves.
 - the development of learners' problem solving competence conceptualised as ability and disposition to solve linguistic, sociolinguistic, pragmatic and other kinds of problems when no typical solution is available and avoiding a large number of trials and errors
 - the development of learners' ability to apply problem-solving meta-tools in order structure and reorganise information with the aim of identifying, analysing and solving problems in various domains.

Conclusion 3

Having discovered the main concepts and the main characteristics of the problem-centred education, I can now proceed to formulating the main competences which are required from a teacher who wants to organise the problem-centred teaching-learning process. These competences include:

1. Formulates 'the unknown' of the problem task (which strategy, generalisation are learners supposed to come up with). Aim.
2. Formulates the problem task which includes both the subject-matter aim and the thinking aim ('the unknown' of the task).
3. Develops a system of tasks (a problem task and sub-tasks), which has the potential to create and maintain cognitive conflict;
4. Develops a system of tasks (a problem task and sub-tasks) the result of which would be a developed strategy, which can be applicable for solving a group of problems of the same type;

5. Develops a system of tasks (a problem task and sub-tasks) which would require meta-tools for building a strategy.
6. Varies the complexity of a problem task depending on the learners' abilities;
7. Shows knowledge of meta-tools for building models;
8. Uses the method of inquiry or the method of partial inquiry for organising learners' work (involves learners in collecting a bank of objects and its analysis for building a model)
9. Organises the lesson with the general structure of three steps:
 - a. Cognitive conflict;
 - b. Building a solution
 - c. Reflection
10. Involves learners in reflection on the obtained result and its efficiency;
11. Involves learners in reflection on the process of solution, i.e. how the problem task was solved;

The given competences can be included under the dimension of Aim and Instruction (see Table 20). All other dimensions and components with its competences remain intact and required for the effective organisation of the teaching-learning process.

Table 20 Teaching competences specific for the problem-centred education (part 1)

Dimensions	Main components	Teaching competences required for the problem-centred education
Aims of learning	Formulation of aims	Formulates 'the unknown' of the problem task (which strategy, generalisation are learners supposed to come up with)
		Formulates the problem task which includes both the subject-matter aim and the thinking aim ('the unknown' of the task).
	Knowledge for reaching formulated aims	Shows knowledge of meta-tools for building models
Instruction (Teaching or Methods for reaching instructional aim)	General lesson structure	Organises the lesson with the general structure of three steps: <ol style="list-style-type: none"> 1. Cognitive conflict; 2. Building a solution 3. Reflection
	Elements of the lesson	Formulates and manages problem tasks: <ol style="list-style-type: none"> 1. Develops a system of tasks (a problem task and sub-tasks), which has the potential to create and maintain cognitive conflict; 2. Develops a system of tasks the result of which would be a developed strategy, which can be applicable for solving a group of problems of the

		same type; 3. Develops a system of tasks which would require meta-tools for building a strategy. 4. Varies the complexity of a problem task depending on the learners' abilities;
		Uses the method of inquiry or the method of partial inquiry for organising learners' work (involves learners in collecting a bank of objects and its analysis for building a model)
		Involves learners in reflection <ol style="list-style-type: none"> 1. Involves learners in reflection on the obtained result and its efficiency; 2. Involves learners in reflection on the process of solution, i.e. how the problem task was solved;

One distinctive feature of the Problem-Centred Education, which makes it different from all the teaching for thinking approaches discussed above, is that it relies on the OTSM-TRIZ problem solving theory which allows it to offer meta-tools of problem solving to learners. So the last question which has to be discussed on the way of defining theoretical framework of the Problem-Centred Education is what these meta-tools are that are integrated into the teaching-learning process as additional content and allow students to control the process of problem solving.

2.6. The Meta-Tools of the Problem-Centred Education

In her PhD thesis, Nesterenko (Нестеренко, 2006a) has formulated the requirements, theoretically supported and tested empirically didactic models that allow to organise the Problem-Centred Education (PCE). These didactic models become meta-tools for learners which are introduced into the Problem-Centred Education as a new structural content component and serve as tools for working with a problem. The requirements for the search for didactic models (or meta-tools) were formulated on several levels.

First of all, since building models is offered as education content, the meta-tools should comply with the following requirements (Нестеренко, 2006a, p. 18):

- they must be able to feature essential aspects of any objects, processes, transformations and algorithms;

- they must not experience any change over time or this change must be very slow;
- they must serve as a basis for the description of specific facts and tools;
- they must be oriented towards problem identification, analysis and solving.

Moreover, taking into account that a problem-centred teaching-learning process should involve students in constructing their own strategies for building and exploring models, the above mentioned requirements to the meta-tools was specified as follows (Нестеренко, 2006а, p. 42):

- The meta-tools must allow to teach how to build on their basis more specific models of facts and processes, transformations and algorithms;
- The meta-tools must allow to teach how to describe a problem situation (a non-typical situation) with the aim of analysing and solving it;
- The meta-tools must allow to teach how to solve problems, including non-typical problems;
- The meta-tools must allow to teach how to control one's own psychological resources in the process of problem solving.

In addition, the meta-tools represent a system, hence, the three main requirements to the meta-tools as a system which should allow organisation of the Problem-Centred Education were also formulated (Нестеренко, 2006а, p. 51):

- The system of meta-tools must allow to teach students all the stages of working with a problem;
- The system of meta-tools must be suitable for being integrated in the teaching-learning activities with operational and measurable aims and objectives;
- The system of meta-tools must be independent of the subject-matter education content (facts, methods and tools, values) and must permit to be treated as a separate content component which students learn as tools for identifying, analysing and solving problems.

One more level of requirements is derived from the connection of problem identification and solving in a teaching-learning process to the development of learners' thinking. In

the framework of the Problem-Centred Education **thinking** is viewed from the perspective of cognitive psychology. When discussing the issue Nesterenko (Нестеренко, 2006а, pp. 19–20) relies on the three basic characteristics of thinking as defined by a cognitive psychologist Norman R.F.Maier:

- thinking is a cognitive process – it appears in the mind but its results are observed through behaviour;
- thinking is a process during which a cognitive system experiences some manipulation with information;
- thinking is directed at something. Its results are observable through behaviour that is involved in or directed at solving a problem.

Thinking, therefore, can be characterised as behaviour directed towards identifying and solving problems. In this context, the sought for meta-tools for organising the Problem-Centred Education should comply with the following requirements:

- they must allow to teach students to perform thinking operations;
- they must allow to teach students to select and organise these operations in a way that would allow the effective processing of information in the process of problem identification, analysis and solving;
- they must allow to teach students to build effective strategy for identifying, analysing and solving a problem;
- they must allow to teach students to use personal resources and to be able to offset the missing qualities in the process of problem identification, analysis and solving.

The required meta-tools for organising the Problem-Centred Education which would comply with the above identified requirements were found in the General Theory of Powerful Thinking (OTSM) based on the Theory of Inventive Problem Solving (TRIZ)¹⁰⁶. For the ease of communication I will further refer to it as OTSM-TRIZ theory.

¹⁰⁶ From Russian *Общая теория сильного мышления (ОТСМ), Теория решения изобретательских задач (ТРИЗ)*.

TRIZ is a theory which is based on the objective laws of system evolution (Altshuller, 1984; Альтшуллер, 2007; Нестеренко, 2006а, р. 31). The origins of TRIZ are traced back to 1940s to the former Soviet Union when an engineer Genrich Altshuller and his colleague Raphael Shapiro started their work on the development a method for solving engineering (technological) problems (Хоменко, 2008; Хоменко & Аштиани, 2007). The idea of developing the method appeared as a response to the then-prevailing conception of an inventor as a genius and an invention as a mystical act of insight. Instead of focusing on the subjective perceptions of inventors in their inventive process, Altshuller G. and Shapiro R. turned to the study of the objective side of inventive process, namely, historical analysis of evolution of technical systems (study of the history of development of inventions) through the analysis of available patents. The analysis of a large number of patents led them to the discovery of objective laws of how the systems evolve. On the basis of their discovery, they first developed a method for solving technical problems (Альтшуллер & Шапиро, 1956), which around the mid-1980s (Cascini, Frillici, Jantschgi, Kaikov, & Khomenko, 2009, р. 8) grew into the theory (Альтшуллер, 2007). In contrast to the existing non algorithmic approaches (such as, Brainstorming by Alex Osborn, Method of Focal Objects by Charles Whiting, Method of Morphological Analysis by Fritz Zwicky, Method of Synectics by William Gordon, etc.) which aim at intensifying the process of generating ideas and more or less regulating the process of their selection, TRIZ targets the task of reducing the search area for finding efficient solutions avoiding a large number of trial and errors. In other words, it offers algorithmic approach to problem solving in contrast to the exhaustive or trial and error search. Methodology for problem solving in TRIZ is based on (1) general laws of system evolution, (2) general principles of solving contradictions and (3) mechanisms of applying these general principles for solving specific problems (Хоменко Н.Н, 1998 in Нестеренко, 2006а, р. 32). TRIZ was initially developed for solving problems in technical domain, however, its main laws turned to be applicable to other domains giving rise to the development of the General Theory of Powerful Thinking (OTSM) (Cavallucci & Khomenko, 2006; Хоменко & Аштиани, 2007) which has actively started from 1990s.¹⁰⁷ OTSM aims at developing meta-tools that allow controlling the process of

¹⁰⁷ As highlighted by Sokol (Sokol, 2007, р. 38), specific tools developed in TRIZ do work beyond engineering domain. However, since they were not developed for that purpose, it is often difficult to apply them. OTSM, on the other hand, has improved several original TRIZ tools and adapted them for working

problem solving irrespective of the domain. For this purpose the OTSM-TRIZ offers the following meta-tools¹⁰⁸:

- general meta-domain models¹⁰⁹ that allow to describe a problem irrespective of the domain where the problem appeared;
- universally applicable technologies that allow to solve problems of various degrees of difficulty with the help of the meta-domain models;
- axioms of powerful thinking, i.e. general principles that indicate general direction for analysing and solving a problem when it is necessary to find new tools and develop a strategy of applying these tools.

Educational professional working on the development of the Problem-Centred Education (Sokol, 2007; Мурашковска & Хоменко, 2003; Нестеренко, 2006а) offer to include OTSM-TRIZ meta-tools as a new structural content component that would help learners in the process of problem identification and solving since they best comply with the identified requirements for organising the problem-centred teaching-learning process. It is also worth mentioning here that the application of the given meta-tools for organising the Problem-Centred Education is justified by some research results (Sokol, 2007; Нестеренко, 2006а; Сидорчук, 1998).

Sokol (Sokol, 2007; Sokol et al., 2008), has developed an approach to English as a foreign language teaching and learning in the framework of the Problem-Centred

with problems outside of engineering domain, hence we can see these tools as being domain independent. Even though they have the same name, some OTSM meta-tools differ from those used in TRIZ (for instance, TRIZ speaks about three types of contradictions and OTSM offers five, the notion of function is different in these two theories, the multi-screen tool has more axes in OTSM than it does in TRIZ). Moreover, OTSM offers some additional meta-tools which do not find their origin in TRIZ (for instance, the ENV tool). So, it would be more correct to say that the Problem-Centred Education relies on the meta-tools developed in OTSM. However, since OTSM finds its origins in TRIZ, I will further be referring to the OTSM-TRIZ theory as a source for meta-tools which become part of the Problem-Centred Education.

¹⁰⁸ In OTSM-TRIZ theory there is a distinction between models, technologies and axioms. For the ease of comprehension, in my research I am referring to the three of them with a general term '*meta-tools*'.

¹⁰⁹ As it will be described further, in OTSM-TRIZ theory, the notion of a '*model*' refers to such models as, for instance, ENV model, Multi-screen model, etc. However, in the context of the given research, the notion of a model is used in the sense of schematic representation of reality that students build. OTSM-TRIZ models are also models, i.e. schematic representations; they are domain-independent and therefore can serve as tools for building more specific models. In order to avoid the confusion in terms I will further be referring to them as OTSM-TRIZ models. So, in the context of the Problem-Centred Education students are building models or strategies and for the purpose of more effective strategy building they use meta-tools originating from OTSM-TRIZ theory, these meta-tools also include OTSM-TRIZ models.

Education. The approach is called the Thinking Approach to language teaching and learning. The aim of the tasks offered within the given approach is “to provide learners with a context for introducing and/or practising OTSM models and language practice is seen as occurring within work with a task” (Sokol, 2007, p. 149). The researcher does not provide a comprehensive description of which exactly OTSM-TRIZ meta-tools can be introduced to students, merely mentioning such models as the ENV model and the Multi-screen model. However, Sokol (Sokol, 2007) presents the offered curriculum as a list of skills and dispositions calling them **inventive thinking skills**, which he defines as “an ability to effectively solve non-typical (creative) problems in various domains avoiding a large number of trials and errors” (Sokol, 2007, p. 46). The given list of skills includes those skills that a learner has to develop in order to be competent in applying OTSM-TRIZ meta-tools in the process of problem solving. The general structure of the skills is presented in Figure 20.

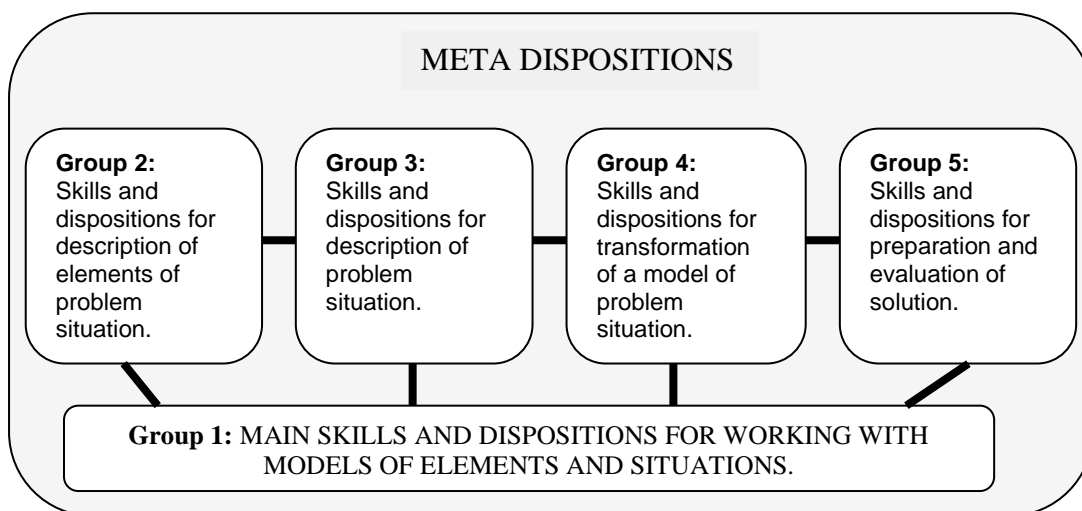


Figure 20 Structure of inventive thinking (Sokol, 2007, p. 46)

Since in the framework of the Problem-Centred Education students are supposed to build theoretical models (or strategies of how to cope with the tasks), one of the core group of skills that is required from them is the skills for working with models of elements and situations, as it can be seen from the above-presented structure. According to Sokol (Sokol, 2007 Appendix 1.1) these skills can be described as the list shown in Table 21.

Table 21 Group 1 of Inventive Thinking Skills: Main skills for working with models of elements and situations (Appendix 1.1 Sokol, 2007)

Group 1. Main skills for working with models of elements and situations.
<p>Build a necessary number of models for a description of a given element</p> <ul style="list-style-type: none"> • build a necessary number of different models on various levels of abstractness; • build a necessary number of different models with a different degree of precision; • build a necessary number of different models from various points of view; • build a necessary number of different models with a various degree of 'reality'; • build a necessary number of different models changing any other feature necessary in a given situation.
<p>Define limitations in the use of a given model</p> <ul style="list-style-type: none"> • check whether the model is applicable in a given situation; • find context for an effective application of a given model • find an adequate model for a given situation; • measure the degree of objectivity of a model used.
<p>Change between different models for a description of a situation</p> <ul style="list-style-type: none"> • look at own models from the point of view of an impartial observer; • see pluses and minuses of models of description that are different from one's own; • accommodate various models of description of a situation and draw connections between them.

Other groups of skills presented by Sokol will be discussed further with the description of the OTSM-TRIZ meta-tools.

The main meta-tools of the OTSM-TRIZ theory which require inventive thinking skills include: the ENV Model, the Multi-screen model, and a set of ARIZ models. These are described further in more details¹¹⁰.

2.6.1. Meta-Tool 1 of the Problem-Centred Education: Element – Name of Feature – Value of Feature (the ENV Model)

According to Nesterenko (Нестеренко, 2006a) the function of the model is to help a problem solver to describe objects (Elements) and methods of their transformation as

¹¹⁰ It is worth mentioning that OTSM-TRIZ has other models as well. However, many of them are very complicated for a regular teacher's understanding. I would even suggest that some of them are irrelevant and will not serve as a tool that will help a school teacher organise a better teaching-learning process. The tools described below are those which have already been introduced to teachers and found useful. Even though several tools are described, the one which has been used more often by teachers and accepted easier is that one of ENV. The offered description is rather simplified and is provided to give a general understanding of the tool without an attempt to provide exhaustive information. An interested

precisely as possible in the context of a problem situation. It allows to master ways of researching and describing objects and processes, establish changes and causality, thus formalising the description of dynamic objects. The more specific, clear and instrumental description is provided the easier it is to identify, analyse and solve a problem. The function of the ENV model is, thus, to formalize description of Elements of a problem situation to be analysed.

The ENV stands for Element, Name of Feature and Value of Feature.

- **Elements (or Elements of the World)** – are any units of information (everything we can think of) that can be described through names of features and values of features. It does not matter if it is substantial or non-substantial, if we could not touch or feel by our sensors directly or indirectly as well as any of imaginary things we can find in fairy tales and fiction stories and novels (Cascini et al., 2009, p. 23).

Any element can have an unlimited number of parameters and their values.

- **Name of Feature** – is a name of a characteristic (property, attribute) of an Element, its description. In other words, everything that is used to describe certain element and that can be presented as a Name and set of its Values. It is also referred to as a '**Parameter**'. A parameter always belongs to a certain Element and has at least two different values. It can be formulated in a form of a question that we ask about the Element. For instance, what is its colour? Parameter: colour. What is its height? Parameter: Height.

For the ease of description, in the text which follows I will be referring to the concept Name of Feature as a Parameter.

- **Values of Feature** – are all possible values that can be attributed to the description of an element. These are represented as an answer to a question. For instance, if the Parameter is 'colour' (*what is its colour?*), possible values will be 'red', 'blue', 'green', etc.

For the ease of description, in the text which follows I will be referring to concept the Value of Feature as a Value.

reader is invited to refer to original sources given in bibliography to discover more details about OTSM-TRIZ and its models.

There are three types of Values:

- Discrete (i.e. independent) values – these represent numerous independent units, such as for instance, values for the parameter ‘colour’ are represented by discrete values ‘red’, ‘green’, ‘blue’, etc.
- Ranked values – these represent independent units that can be ranked according to a certain degree. For instance, the feature ‘smoothness of surface’ can have several values which can be ranked from 0 to 4 according to the level of smoothness: 0 – *hummocky surface*, 1 – *undulating surface*, 2 – *rough, textured surface*, 3 – *even, smooth surface*, 4 – *perfectly smooth surface*.
- Continuous values – these represent a continuous array of values which can be assigned a mathematical value. For instance, the feature ‘length’ can be represented by such values as ‘1mm-10m’, ‘11m-1km’, etc.

The ENV model is typically represented by a graphic scheme shown in Figure 21.

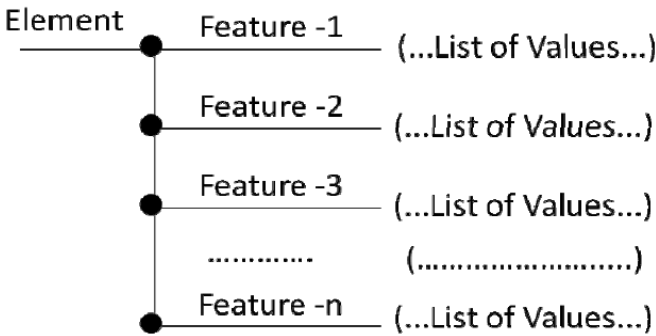


Figure 21 Graphic representation of a general ENV model (Cascini et al., 2009, p. 22)

In the everyday life, when we describe something it is enough to operate mainly with properties. For instance, when describing an apple we can say it’s a fruit, it could be green or red, it grows on an apple tree, etc. However, for the purposes of problem solving, it is better to split properties into their names and values, as it is done by the ENV model. For instance, an Element ‘apple’ can be described through its ‘colour’ (red, green, etc.), ‘hardness’ (hard, soft), ‘level of sweetness’ (very sweet), etc. It allows to formalise the description and later when operating with another model, that of

contradiction (described in more details below), define exactly which parameters must change which values.

Notions of Element, Parameter and Value are relative so if the situation requires, any parameter and a value can be treated as an element that has its own parameters and values. Doing this allows making a description more specific and nuanced. For instance, value 'red' can be treated as an Element which has to be improved in terms of its properties. Thus, it can be described through several parameters: saturation of the red colour (high, medium, low, etc.), dissemination on the surface (uniform, spots, lines, etc.)

While operating with the ENV model (or ENV meta-tool) two more supplementary concepts are applied: event and effect.

- **Event** – is the fact of a change of values of a certain parameter(s). It is described with the chunk of words WAS - RESULTED IN (or BECAME). For instance, if for a parameter 'water temperature' its two values change from 100°C to 80°C then the event will be described as follows:

WAS: water temperature 100°C

BECAME: water temperature 80°C

The given formulation aims at making the description of a problem situation as specific as possible which is essential for the purpose of identifying, analysing and solving a problem.

Sometimes the origin of why the event occurred is also indicated. It can be described with the chunk of words "ELEMENT 1 IS CHANGING THE VALUE 1 OF A PARAMETER OF ELEMENT 2 INTO A VALUE 2". In our example, we have an element 'water' which is changing the values of its parameter 'temperature'. If the change was caused by a cold spoon than applying the chunk above we would describe this interaction as follows "When put in a hot water, a cold spoon (*element 1*) is changing the temperature (*parameter of element 2*) of the water (*element 2*) from 100°C (*value 1*) to 80°C (*value 2*)".

- **Effect** – is a causal interconnection of a poly-system of Events. It can be described with a chunk of words "IF...THEN". For instance, "IF you put a hot object in water THEN water temperature will increase".

In the framework of the Problem-Centred Education students learn to apply the given ENV model as a meta-tool for building specific theoretical models for the purpose of defining, analysing and solving subject-specific problems. In addition, students learn to operate with the above described related concepts.

While applying the given meta-tool, students are expected to develop the following thinking skills (Нестеренко, 2006а, p. 76):

- ability to build the missing parts of an ENV model:
 - (*if Element is unknown*) ability to find elements on the basis of their descriptions as lists of parameters and / or a list of their values;
 - (*if Name of Feature (Parameter) is unknown*) ability to find parameters for given elements and their values;
 - (*if Values are unknown*) ability to find a list of values for given elements and their parameters;
- ability to describe changes of values (Events) and connections between values (Effects);
- ability to build both specific and more general descriptions of an element;
- ability to use both discrete, ranked and continuous values for describing an element.

2.6.2. Meta-Tool 2 of the Problem-Centred Education: the Multi-Screen Model

Even though the Multi-screen model can be treated together with the ENV model, since it can be seen as the so called **Advanced ENV model** (Sokol, 2007, p. 149; Нестеренко, 2006а), for the purpose of clarity I am going to describe it as a separate OTSM-TRIZ model.

As mentioned above, in order to be able to solve a problem a problem situation has to be described as precisely as possible. However, this is not enough. In addition to it, an object has to be treated as a process and a problem solver has to keep trace of the

dynamics of its development and change depending on different factors (Нестеренко, 2006a).

If the function of the ENV model is to describe Elements as precisely as possible (empirical description), then the multi-screen model ensures a system approach to problem solving and is contributing to the development of a system view on the Elements around us (system description). The multi-screen model allows the problem solver “to describe an object as a system defined by a certain function¹¹¹” (Нестеренко, 2006a, p. 68). It helps the problem solver to develop a skill of tracking connections between various parameters of an object and their changes, keeping in mind a problem situation as a whole and being able to think of different options of its transformation. In general terms, **a system** is any Element defined by a function.

The Multi-screen model is typically represented by a graphic scheme shown in Figure 22.

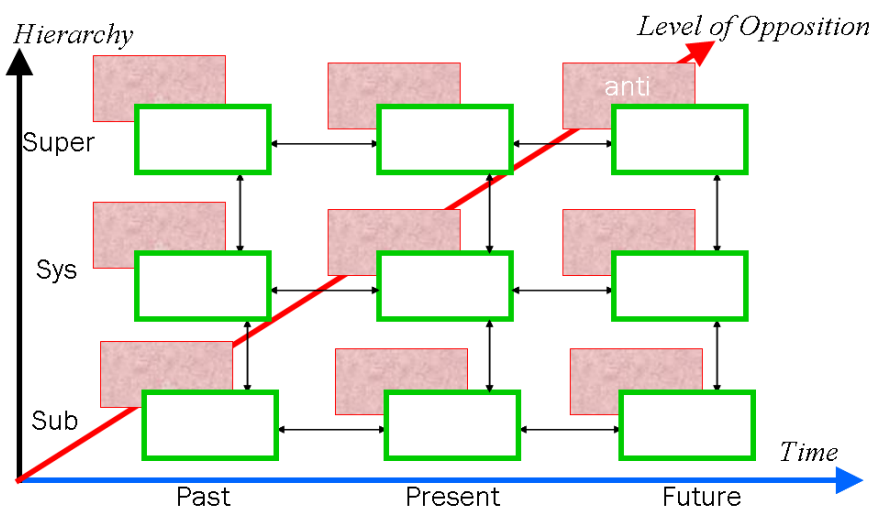


Figure 22 Graphic representation of a Multi-screen model (Cascini et al., 2009, p. 24)

As it can be seen, the model has several axes.

The hierarchical axis shows the hierarchical level of a system. Any system can be analysed into its constituting parts (**Sub-systems**) as well as the environment it belongs

¹¹¹ From Russian «[...] объект рассматривается как система, с точки зрения определённой заданной цели».

to **(Super-system)**. This axis requires the ability to see a system in a selected hierarchy of Elements of the world (systems).

The time axis allows to see the system in time **(past, present, and future of the system)**, to see how the past could have predetermined the present (“now”) and how “now” can predetermine the future, to see the state of the system on different levels of its development: ontogenesis – for a specific system, and phylogenesis – for a class of systems. In order to move on the time axis one has to define a certain time interval, which he uses to make steps into the past of the system and/or its future.

“Depending on the specific situation we can consider Time dimension as a historical time (if we study evolution of certain systems), as a process time (while analyzing a chain of events, even with their cause-effect relationships), as a life cycle of an element of a system or in terms of speed and acceleration if these variables are relevant for the specific situation”.(Cascini et al., 2009, p. 25)

The **anti-system** is a system which performs an opposite function. Whatever is the value of an Element taken into consideration, this axis suggests looking at the opposite values of the same parameter. This axis requires the ability to see, perceive, and use the opposites. In OTSM anti-systems are defined as *“systems that “challenge” our system, for example, systems competitors or systems designed to render our system inoperative”* (Khomenko, n.d.).

In the framework of the Problem-Centred Education students learn to apply the given Multi-screen model as a meta-tool for building specific theoretical models for the purpose of defining, analysing and solving subject-specific problems. According to Nesterenko (Нестеренко, 2006a, p. 76), while applying the given meta-tool, students are expected to develop the following thinking skills:

- Ability to build the description of an element on the basis of the function or on the basis of an offered problem;
- Ability to build a multi-screen view of an element;
- Ability to predict changes in the system relying on the laws of system evolution..

Group 2. Skills for description of elements of a problem situation.	Group 3. Skills for description of a problem situation.
<p>Describe elements by defining parameters and their values</p> <ul style="list-style-type: none"> • find elements on the basis of their descriptions as lists of parameters and / or a list of their values • define the function of an element as a change of one value under a specific parameter • describe a system as a group of elements aimed for the provision of one system shape feature • describe immaterial elements by means of lists of parameters and their values • describe parameters and their values as elements that have their own parameters and their values. 	<p>Describe situations going from concrete to abstract models and back</p> <ul style="list-style-type: none"> • vary the number of elements and their features when describing a situation • vary the degree of precision of elements and their features • define the most important features that can play the role of system shape features in a given situation.
<p>Describe elements as systems that have their sub-systems and are themselves parts of different super-systems</p> <ul style="list-style-type: none"> • describe an element as a collection of other elements • describe an element as a part of larger set of elements • describe an element as a part of the hierarchy of different other elements. 	<p>Describe situations going beyond possible and known</p> <ul style="list-style-type: none"> • define the difference between the real and the imaginary • use fairy-tale, fantastic and other imaginary transformations for solving a problem. • turn fantastic assumption into real ones • easily change from a fantastic description of a situation to a real one and back..
<p>Describe elements as systems that permanently change in time</p> <ul style="list-style-type: none"> • describe an element in the process of change according to the objective laws of system evolution • describe an element in the process of change according to the laws and effects characteristic of a given field • describe an element in the context of various lines of its evolution from the past to the present and to the future • define various degrees of predetermination of possible changes of an element. 	<p>Describe situations recognizing and distinguishing the influence of objective and subjective factors</p> <ul style="list-style-type: none"> • distinguish between objective and subjective factors when building models of elements • define those objective factors that determine the peculiarities of a given situation • establish connections between the objective factors determining peculiarities of a given situation and the subjective factors that call for its change.
<p>Describe elements as systems that have their own anti-systems</p> <ul style="list-style-type: none"> • describe anti-elements via opposite values of system shape features of an element • extend my consideration from specific values of features to various possible anti-elements that have such a feature • find possible anti-elements in the context of various hierarchies of a given element and the lines of its evolution. 	<p>Describe situations as a result of a change of values of parameters of elements</p> <ul style="list-style-type: none"> • describe events as a change of one and the same parameter of an element • vary the values of features of an element on a wide scale and trace the changes • trace qualitative changes of values of other parameters that appear as a result of a change of a given parameter. <p>Describe situations as an interaction of several elements</p> <ul style="list-style-type: none"> • describe events as a result of an interaction of several elements • describe events as causes and effects of some other events • present effects and laws as causes of interaction of several events.

Table 22 Group 2 and 3 of Inventive Thinking Skills: Skills for description of elements of a problem situation and Skills for description of a problem situation. (Appendix 1.1 Sokol, 2007)

Coming back to the list of inventive thinking skills described by Sokol (Sokol, 2007 Appendix 1.1), I can draw a parallel between the use of the ENV and an Advanced ENV model and the two other groups (Group 2 and 3) of the defined inventive thinking skills, namely, skills for description of elements of a problem situation and skills for description of a problem situation (see Table 22 for more details). The researcher provides a more comprehensive description of the skills that students have to develop while working with the ENV and the Multi-screen OTSM-TRIZ models.

2.6.3. Meta-Tool 3 of the Problem-Centred Education: A Set of ARIZ models (Contradiction – Ideal Final Result – Resources)

Since one of the objectives of the Problem-Centred Education is to help learners develop skills for identifying, analysing and solving a problem, in addition to empirical and system description of an object under study, students have to master a problem description of an object (Нестеренко, 2006а, p. 91). A problem description means that a student is able to move from a vague problem situation to a clear problem formulation and consequently to a model of a solution and specific solution. In order to be able to do it, students have to be introduced to the tools of how to transform an initial situation into a clearly defined problem and consequently a solution. For this purpose, the models applied in the Algorithm of Inventive Problem Solving (ARIZ) are offered to be introduced into the teaching-learning process (Нестеренко, 2006а, p. 76).

ARIZ defines several stages and steps of working through the problem. One synthesis of these steps is offered in Table 23. Each stage requires the ability of operating with certain models.

Table 23 A list of ARIZ steps (Cascini et al., 2009, p. 108)

Part 1: Analyzing a problem and creating a model.	Step 1.1. Describing a problem condition. Step 1.2. Identifying the conflicting elements of a system. Step 1.3. Creating a graphical scheme of a system of conflicts.
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	<p>Step 1.4. Selecting a graphical model of a system.</p> <p>Step 1.5. Aggravating the main conflict.</p> <p>Step 1.6. Formulating a problem model.</p> <p>Step 1.7. Searching for a standard solution</p>
Part 2: Analyzing a problem model.	<p>Step 2.1. Analyzing the operational zone.</p> <p>Step 2.2. Analyzing the operational time.</p> <p>Step 2.3. Analyzing su-field resources.</p>
Part 3: Defining an ideal final result (IFR) and physical contradictions which prevent the achievement of IFR.	<p>Step 3.1. Formulating an ideal final result (IFR-1).</p> <p>Step 3.2. Intensifying the IFR-1 definition.</p> <p>Step 3.3. A physical contradiction (PhC) on a macrolevel.</p> <p>Step 3.4. A physical contradiction on a microlevel.</p> <p>Step 3.5. Formulating an ideal final result (IFR-2) for different resources and specifying the initial problem</p> <p>Step 3.6. Using the system of standards (76 standard solutions to inventive problems, using a su-field model).</p>
Part 4: Mobilizing resources	<p>Step 4.1. Modeling a problem with "little creatures".</p> <p>Step 4.2. Using «a step back from IFR" method</p> <p>Step 4.3. Using a mixture of available resources</p> <p>Step 4.4. Introducing voids of different types into available resources.</p> <p>Step 4.5. Using substances derived from available resources</p> <p>Step 4.6. Checking whether a problem may be solved by replacing some substance with an electric field or interaction between two electric fields.</p> <p>Step 4.7. Checking whether a problem may be solved by introducing a "field – additive responding to a field" pair.</p>
Part 5: Checking a method of removing a physical contradiction.	<p>Step 5.1. Checking an answer.</p> <p>Step 5.2. Preliminary evaluation of an obtained solution.</p> <p>Step 5.3. Checking for the absence of the invention in the patent collection.</p> <p>Step 5.4. Evaluation of subproblems arising during implementation.</p>
Part 6: Using an obtained solution.	
Part 7: Analyzing the solving procedure.	

In a simplified way, the process would look as follows¹¹².

¹¹² This simplified description was documented while the researcher attended the seminar "Problem Management and Effective Education Based on TRIZ" organised in Latvia, Riga in 18-24 August, 2013.

First of all, it is important to obtain a formalised description of an initial problem situation. This is done following certain rules and applying criteria to check the quality of every performed step.

A **set of tools** is applied **for describing a problem**. It includes defining WHO faces the problem (who is the problem solver), his OBJECTIVE (what does the problem solver want) and what is the OBSTACLE on his way to reaching his aim.

Then, an **initial situation description** should be turned into a **model of this situation (model of problem situation)**. The aim of the first stage is to create a model of a problem to be solved.

This is achieved through the description of the initial problem situation through a **contradiction** (more specifically, **technical contradiction** or also referred to as a **contradiction of an element**). A technical contradiction is “*a conflict between two parameters used for evaluating the quality of a given system*” (Cascini et al., 2009, p. 105). Technical contradiction shows that a system confronted a conflict between two important parameters during its evolution. It can be represented through a phrase “an action A produces a desired effect, but also results in degradation of property B”, “If {describe the condition} then {some positive statement}, but also {some negative statement}.”

Then, the **contradiction of the parameter** is formulated: description of the situation where one parameter has two opposite values.

The transformation of the description of an initial problem situation into a problem model allows identifying and keeping only the most important components that are responsible for creating the problem situation. As a result it becomes easier to identify a relevant solution for resolving the contradiction.

The last step in analysis of the problem before the synthesis of the solution building can begin is the definition of the **Ideal Final Result**. Schematically, it can be formulated through the phrase “X-element, itself, without harmful side effects, eliminates <harmful action> and keeps the ability to provide <the useful action>”. This is a sort of an **abstract model of a solution**.

At the stage of building the solution, it is important to identify and analyse available **resources**.

As it can be seen, throughout the entire process, the problem solver has to operate with the ENV model, defining parameters and values while formulating the contradictions. In addition, he should have skills for dealing with the models of a problem definition, contradictions, the ideal final result, and resources.

Nesterenko (Нестеренко, 2006a) does not provide a description of skills that would manifest students' ability to master the given models. On the other hand, the analysis of a list of inventive thinking skills defined by Sokol (Sokol, 2007 Appendix 1.1) allows me to assume that Group 4 and 5 of the defined skills, namely skills for transformation of models of a problem situation and skills for preparation and evaluation of solution (see Table 24), correspond to those skills that students are supposed to develop while learning to apply the above described OTSM-TRIZ models.

When speaking about all the OTSM-TRIZ models that are integrated into the Problem-Centred teaching-learning process, Sokol (Sokol, 2007, p. 155) makes a useful remark. The given models are only useful when a student cannot solve a problem without them. Hence, their application should be meaningful for a student and not artificial.

In addition to the OTSM-TRIZ models, Nesterenko (Нестеренко, 2006a, p. 83) offers to include in the meta-tools a so called contextual block of models. If OTSM-TRIZ group of meta-tools allow to teach logical analysis of a problem, then contextual tools allow to teach how to use models of the information block in various contexts. They allow to increase the efficiency of the process of acquisition of the OTSM-TRIZ meta-tools by learners. Contextual models do not derive from the OTSM-TRIZ theory but were either adapted from other methods.

One of these tools is the so called 'Point of View' model. The function of specifically the Point of View model is to help learners develop the skills of viewing the situation from different points of view and to analyse and mobilise their personal internal resources. This is essential since problem identification and solving requires the ability to see a problem situation from various perspectives.

Group 4. Skills for transformation of models of a problem situation	Group 5. Skills for preparation and evaluation of solution.
<p>Transform the description of a problem situation considering the demands of ideality</p> <ul style="list-style-type: none"> describe a problem situation by means of formulating a specific Ideal Final Result for a specific contradiction build an ideal model of a problem solution describe a problem situation on different levels of ideality. 	<p>Build a solution to a problem</p> <ul style="list-style-type: none"> define positive effects of any partial solution appearing in the course of problem solving define the balance of positive and negative effects when shaping the final solution find partial solutions to the problem transform partial solution into a complex final solution that meets the demands of a given specific situation.
<p>Transform the description of a problem situation in view of emerging contradictions</p> <ul style="list-style-type: none"> combine the opposites define undesirable consequences of positive necessary results and positive consequences of negative undesirable results describe the underlying cause of a problem as a contradiction see a contradiction as an obstacle on the way from the resources of initial situation to the ideal final solution intensify contradiction in order to reduce the space of possible solutions describe a problem situation by means of various types of contradictions describe a problem situation by means of a system of contradictions. 	<p>Evaluate the solution of a problem</p> <ul style="list-style-type: none"> evaluate the proposed solutions in the context of general laws of systems evolution evaluate the proposed solutions in the context of subjective requirements of a given specific situation evaluate new implementations of the developed solution.
<p>Transform the description of a problem situation considering the available resources</p> <ul style="list-style-type: none"> define internal resources of elements define super-system resources of elements take advantage of a change of resources in time derive resources using laws and effects establish connections between features of resources of elements that are present in a problem situation and general laws of system evolution. 	<p>Evaluate the process of arriving at the solution of a problem</p> <ul style="list-style-type: none"> evaluate the process of problem solving and motivate the choice of this or that instrument evaluate if the problem solving tools are used correctly in the process of building a solution use the principle found for a given problem in the further practice of problem solving.
<p>Transform the description of a problem situation in view of peculiarities of a specific situation define the aims of analysis of a problem situation</p> <ul style="list-style-type: none"> analyse any problem situation taking account of its peculiarities and variants of their development define which objective laws, trends and effects prevent the problem-solver from reaching the aims of analysis define the elements that cause a conflict between the aims of analysis and objective laws, trends and effects 'break' objective laws of evolution abiding by the same laws and following them. 	
<p>Transform the description of a problem situation in view of typical solutions</p> <ul style="list-style-type: none"> build various models of a typical problem describe a problem situation via various types of typical problems transform the description of a typical problem into the description of a typical solution. 	

Table 24 Group 4 and 5 of Inventive Thinking Skills: Skills for transformation of models of a problem situation and Skills for preparation and evaluation of solution. (Appendix 1.1 Sokol, 2007)

The model includes two concepts: an observer (or problem solver) and his/her assessment (point of view on the situation) (Нестеренко, 2006а, р. 85).

An observer is a person or a group of people that possesses personal resources (such as perception, aims, values, etc.) and has a defined connection towards an object or a situation under study.

In other words, an observer is someone from whose point of view or through whose eyes we are looking at the problem situation.

Nesterenko (Нестеренко, 2006а, р. 85) has offered the following features that characterise an observer:

- Values, aims and motives;
- Emotions, feelings, mood;
- Perception and sense organs;
- External features that can influence observer's perception of a situation (e.g. size, weight, etc.);
- Super-system an observer is a part of (family, group of friends and acquaintances, social group an observer belongs to, etc.)

All these features should not be viewed as being constant but on the contrary as those changing in time.

Assessment (or point of view on the situation) is a feature that characterises a problem situation from the point of view of an observer. Assessment can have three features: positive, negative or neutral.

The assessment given to a problem situation by an observer should be analysed through the features that characterise the observer, since these can influence or have an impact on how the situation is viewed from his/her point of view.

As mentioned above, the Problem-Centred education is open to include other meta-tools, which can help learners to build strategies. For the purposes of this research, I will only be considering the main meta-tools discussed above.

2.7. Preliminary Conclusions

Conclusion 1

The following general conclusions can be made after reviewing the meta-tools of the problem-centred education.

1. The meta-tools of the problem-centred education include the ENV model, the Multi-screen model (also known as the advanced ENV model), and a set of ARIZ models;
2. These meta-tools are supposed to be introduced in the teaching-learning process as a part of its content. Learning to use these meta-tools for building strategies or HOW TOs is supposed to help learners develop problem-solving competence as viewed in the problem-centred education;
3. These meta-tools should be introduced to students as a support tools when they face a cognitive conflict and have to build a strategy. The introduction of a tool should seem meaningful to students and should help them either build a new strategy or improve that strategy by applying new instrument.
4. The work with the meta-tool presupposes the acquisition and mastery of inventive thinking skills which are described as a system of skills and dispositions structured under five groups:
 - a. Main skills and dispositions for working with models of elements and situations;
 - b. Skills and dispositions for description of elements of problem situation.
 - c. Skills and dispositions for description of problem situation.
 - d. Skills and dispositions for transformation of a model of problem situation.
 - e. Skills and dispositions for preparation and evaluation of solution.

This is also one of the differences of the problem-centred education from other teaching for thinking approaches; it aims at developing students

inventive thinking skills (offering a clear list of skills it promotes) which differ from the cognitive skills targeted by other approaches (e.g. creative thinking skills or critical thinking skills). It does not, however, mean that while working on the problem tasks students will not be fostering other set of cognitive skills, critical skills including. What is important to highlight is that the explicit skills which the problem-centred education targets are specifically inventive thinking skills.

Conclusion 2

As it follows from the above formulated conclusions, the following adjustments should be added to the list of competences required from a teacher who wants to organise the problem-centred teaching-learning process.

- Formulates a problem task that allows the introduction, use of and reflection on the meta-tools for building a strategy (ENV, Multi-Screen, and ARIZ tools, etc.);
- Formulates inventive thinking skill(s) which learners should activate while working on a system of problem tasks;
- Involves learners in reflection on the meta-tools that helped to build a model.

These competences can be included under the dimension of Aim and Instruction of the teaching competence. As a result, the updated table of the teaching competences specific for the problem centred education can be formulated as seen in Table 25.

Table 25 Teaching competences specific for the problem-centred education (part 2)

Dimensions	Main components	Teaching competences required for the problem-centred education
Aims of learning	Formulation of aims	Formulates 'the unknown' of the problem task (which strategy, generalisation are learners supposed to come up with)
		Formulates the problem task which includes both the subject-matter aim and the thinking aim ('the unknown' of the task).
		Formulates a problem task that allows the introduction, use of and reflection on the meta-tools

		for building a strategy (ENV, Multi-Screen, and ARIZ tools, etc.); Formulates inventive thinking skill(s) which learners should activate while working on a system of problem tasks;
	Knowledge for reaching formulated aims	Shows knowledge of meta-tools for building models: ENV, Multi-Screen, ARIZ tools.
Instruction (Teaching Methods or for reaching instructional aim)	General lesson structure	Organises the lesson with the general structure of three steps: 4. Cognitive conflict; 5. Building a solution 6. Reflection
	Elements of the lesson	Formulates and manages problem tasks: 5. Develops a system of tasks (a problem task and sub-tasks), which has the potential to create and maintain cognitive conflict; 6. Develops a system of tasks the result of which would be a developed strategy, which can be applicable for solving a group of problems of the same type; 7. Develops a system of tasks which would require meta-tools for building a strategy. 8. Varies the complexity of a problem task depending on the learners' abilities;
		Uses the method of inquiry or the method of partial inquiry for organising learners' work (involves learners in collecting a bank of objects and its analysis for building a model)
		Involves learners in reflection 3. Involves learners in reflection on the obtained result and its efficiency; 4. Involves learners in reflection on the process of solution, i.e. how the problem task was solved; 5. Involves learners in reflection on the meta-tools that helped to build a model.

So far all the described competences were either deduced from the theoretical literature or identified in available research. Another useful source, however, which hasn't been studied, yet is the real practice. Since teaching competences have direct connection to teacher's classroom behaviour it would be useful to make use of observations of the real practice with the aim of improving the formulation of the identified teaching competences and potentially identifying new ones, because despite the meticulous study of theoretical literature some essential competences might have been left out. This problem led me to the next part of my research which is an empirical part.

2.8. Lesson Observation – Another Source for Identifying Teaching Competences Required for the Problem-Centred Education

In my research I am interested in how teachers transform certain theory into their everyday practice. As mentioned in the introduction, we have been working with a group of teachers who were using the Thinking Task Framework (see Figure 1) to change their regular practice and build the problem-centred teaching-learning process in their classroom. This gave me access to the lessons of those teachers and allowed me to count on their collaboration. The Thinking Task Framework, on the other hand, served as a starting point for building the lesson observation instrument.

The lesson observation was conducted with other two teachers who have certain understanding of the problem-centred education and could thus express their opinion on the competences observed or not observed on the lesson. Based on their interpretation of the formulated competences and their comments, I intended, on the one hand, to improve the list of competences which are specific for the problem-centred education, and on the other hand, have a lesson observation instrument which can be used for observing other teachers' practice.

In order to conduct the lesson observation, I first of all had to create a lesson observation instrument. The categories for this lesson observation instrument were derived from the Thinking Task Framework and from the research on teaching for thinking approaches since the problem-centred education is a part of that group of approaches. It was impossible and unnecessary to include all the identified components of teaching competence because it would make a lesson observation instrument unmanageable. Hence I selected only those components which seemed to be the most essential ones.

Then, I formulated some indicators that can be used to assess teaching competences under the defined categories. As a result, I have built the first draft of

the lesson observation instrument (see Table 26 below) which is organised in seven categories and 11 indicators assessed under these categories¹¹³:

1. Setting lesson/task aims;
 - a. An ability to make lesson/task aims explicit to students
2. Formulating the task as a problem to be solved;
 - a. An ability to formulate the strategy-based tasks for students to be solved
3. Using OTSM-TRIZ meta-tools;
 - a. An ability to introduce and manage the usage of the **ENV** thinking model of the OTSM-TRIZ
4. Organising the regular improvement of generic strategies;
 - a. An ability to organise students' improvement of the generic strategies
5. Conducting metacognitive reflections;
 - a. An ability to organise reflection on the results of the lesson;
 - b. An ability to organise reflection on the process of doing the task and on the application of OTSM-TRIZ meta-tools
6. Self-assessment of one's own work;
 - a. An ability to involve students in assessment of their own work
7. Questioning
 - a. An ability to involve students in voicing out their thoughts
 - b. An ability to involve students in explaining the reasons behind their thoughts or expand and specify their answer
 - c. An ability to involve students in commenting on each other reasoning (in assessment of peer reasoning).
 - d. An ability to give time to think to all students and not rush into asking the first student raising his hand.

¹¹³ The first draft of the instrument was developed in 2013. Therefore, the terminology used there may not be consistent with the terminology developed throughout the thesis. This was adjusted as the instrument got elaborated and improved.

Category	Indicators	Values (Quality criteria in a form of statements)
Setting lesson/task aims	An ability to make lesson/task aims explicit to students (make it explicit to the students why they are/were doing what they are/were doing)	0- The teacher is NOT discussing the aim of the lesson/task at all (does not mention it). 1- The teacher INFORMS students about the aim of the lesson - states explicitly what her/his aim is without involving students. 2- The teacher INVOLVES a few students in the aim formulation (asks students what the aim is/was, asks what are the reasons for doing this or that task) but evaluates their replies with 'right/wrong'. 3- The teacher INVOLVES a few students in the aim formulation (asks students what the aim is/was, asks what are the reasons for doing this or that task) without evaluation 'right/wrong' but leading them with the questions to come up with the aim formulation.
Formulating the task as a problem to be solved	An ability to formulate the strategy-based tasks for students to be solved	0- The main lesson task the teacher formulates is purely KNOWLEDGE-based, i.e. only one specific answer is sought for, no need to build the solution (make a hypothesis) and verify it. 1- The main lesson task the teacher formulates is PARTIALLY STRATEGY-based, i.e. students are asked to build the solution (make hypothesis, build a model of the rule/formulate the rule), find examples to support their solutions (models/rules), and verify the applicability of their models (find exceptions to their models/rules). 2- The main lesson task the teacher formulates is STRATEGY-based, i.e. students are asked to build the solution (make hypothesis, build a model of the rule/formulate the rule), find examples to support their solutions (models/rules), and verify the applicability of their models (find exceptions to their models/rules).
Using OTSM-TRIZ thinking models	An ability to introduce and manage the usage of the ENV thinking model of the OTSM-TRIZ	0- The STRATEGY-based task students are doing does NOT require using ENV thinking model for building the solution OR students are NOT using it (the teacher does not introduce the model and does not require to use it) 1- The STRATEGY-based task students are doing REQUIRES using ENV thinking model for building the solution AND students are building the strategy using the ENV BUT they do NOT do it explicitly (it is not explicit to students what is ENV, that they are using ENV, the teacher does not call it and explain it explicitly). 2- The STRATEGY-based task students are doing REQUIRES using ENV thinking model for building the solution AND students are building the strategy using the ENV AND it is explicit/clear to them (they know this model and explicitly/clearly refer to it, the teacher is asking to refer to it, reminds them about it, etc.).
Organising the regular improvement of generic strategies	An ability to organise students' improvement of the generic strategies (note taking with the goal of improving the generic strategy - HOW to parts)	0- The teacher does NOT ask students to write AND improve their strategies. 1- The teacher INVITES students to write their strategies but does NOT come back to them and does NOT ask to improve them/does not offer tasks that would challenge those strategies or would make students improve them. 2- The teacher INVITES students to write their strategies AND offers tasks that would challenge those strategies and would make students improve them/INVITES students to improve the strategy that has been developed after a new important feature appears.
Conducting metacognitive reflections	An ability to organise reflection on the results of the lesson	0- The teacher does NOT ask any student to say what he has achieved during the lesson (what is the personal result for him, what he has learnt/understood, what still remains unclear). 1- The teacher ASKS a few students to say what they have achieved during the lesson (what is the personal result for them, what they have learnt/understood, what still remains unclear) BUT does NOT comment on the received answer or clarifies it (if relevant). 2- The teacher ASKS a few students to say what they have achieved during the lesson (what is the personal result for them, what they have learnt/understood, what still remains unclear) AND comments on the received answer or clarifies it (if relevant).
	An ability to organise reflection on the process of doing the task and on the application of OTSM-TRIZ thinking models	0- The teacher does NOT ask any student to reflect back on HOW the result was achieved (how they built the solution) and which THINKING MODELS helped them and HOW (why). 1- The teacher ASKS a few students to reflect back on HOW the result was achieved (how they built the solution) but does NOT explicitly invite them to reflect on which THINKING MODELS helped them and HOW (why). 2- The teacher ASKS a few students to reflect back on HOW the result what achieved (how they built the solution) AND explicitly invites them to reflect on which THINKING MODELS helped them and HOW (why).
Self-assessment	An ability to involve students in assessment of one's own work	0- The teacher does NOT invite student to assess one's own work. 1- The teacher INVITES students to assess one's own work BUT does not ask for explanation of their reasoning.

Category	Indicators	Values (Quality criteria in a form of statements)
of one's own work		2- The teacher INVITES students to assess one's own work AND asks for explanation of their reasoning.
Questioning	An ability to involve students in voicing out their thoughts	0- Less than 10% of teachers questions are open (why, what about, how?....). The majority of questions are closed (what, where) 1- More than 10% of teachers' questions are open but closed questions still constitute 50% of all the questions asked. 2- The majority of teachers' questions (more than 50%) are open.
	An ability to involve students in explaining the reasons behind their thoughts or expand and specify their answer	1- The teacher does NOT pursue students reasoning (does not ask to explain WHY the student thinks so, gives this or that answer) expand on the answer or specify it OR does it in a very limited way (less than 10% of the total questioning-reasoning interaction). 2- The teacher OCCASIONALLY (10-50% of all the questions including closed ones) PURSUES students reasoning, expand on the answer or specify it (asks to explain WHY the student thinks so, gives this or that answer). 3- The teacher REGULARLY (more than 50%) of all the answers asks students to explain the reasons of their answers/thinking, expand on the answer or specify it.
	An ability to involve students in commenting on each other reasoning (in assessment of peer reasoning).	0- When a student replies the question or asks a question the teacher does NOT involve any other student in commenting on the answer or replying the question. 1- When a student replies the question or asks a question the teacher INVOLVES one/two students in commenting on the answer or replying the question BUT does not build on the students replies further on and provides the reply himself/herself. 2- When a student replies the question or asks a question the teacher INVOLVES other students in commenting on the answer or replying the question, builds on the students replies further on and basically manages students' discussion by keeping students ask-answer-comment-reason-explain. Typical leading questions the teacher uses: how would your reply this concerns? How would you...etc.)
	An ability to give time to think to all students and not rush into asking the first student raising his hand	0- After asking the question the teacher provides an answer/opinion her/himself if no one raises the hand OR selects him/herself one student without making attempts to involve other students in coming up with ideas (reformulates the question, encourages to pay attention to certain aspect, thus is waiting for less than 5 seconds) 1- After asking the question the teacher invites the FIRST student raising his/her hand (or the one who is most talkative during the lesson) to reply without making attempts to involve other students in coming up with ideas (reformulates the question, encourages to pay attention to certain aspect, etc.) OR/AND waiting time is less than 5 seconds. 2- After asking the question and seeing only a few hands raised the teacher makes ONE of the attempts to involve other students in coming up with ideas (reformulates the question, encourages paying attention to certain aspect, thus waiting for more than 5 seconds for other students to think) AND selects at least the SECOND student who raised his hand. 3- After asking the question and seeing only a few hands raised the teacher makes SEVERAL attempts to involve other students in coming up with ideas (reformulates the question, encourages paying attention to certain aspect, waits for more than 5 seconds for other students to think). AND it is possible that the teacher eventually select the student who didn't raise his hand and asks what are the doubts preventing him from replying.

Table 26 The first draft of the lesson observation instrument for formative assessment of teacher's classroom behaviour. Developed by September 2013.

Each indicator is split into qualitative criteria described in a form of a statement having a quantitative value ranging from zero (important skill was not observed at all in a teacher's behaviour) to two or three (important skill was fully observed). Qualitative distinctions between criteria are marked with contrasting words, such as, for example:

- Never – seldom – occasionally – often – regularly
- A small number of – the majority of
- not – partially – fully
- not – inform - involve

In order to validate the lesson observation instrument, i.e. to make sure it does not lack any essential indicators and that quality criteria are formulated clearly and do not cause misinterpretation, the researcher invited two teachers (T1-iv and T2-nk) to observe the lesson of their colleague (T4-os).

All three teachers worked in the same secondary school in Latvia (Daugavpils). The observers were the head teachers of their respective departments and had long experience in working with the problem-centred education or another teaching for thinking approach:

- T1-iv was an English as a foreign language (EFL) teacher, the head of the English language department in the secondary school. She had more than 8 years of teaching for thinking experience working with the problem-centred education. Results of her expertise were supported by the research.¹¹⁴
- T2-nk was a Russian as a mother tongue teacher, the head of the Russian language department in the secondary school. In 1997 she received the title of the best teacher of Russian as a mother tongue. She had more than 3 years of experience of working with the problem-centred education. In addition, she

¹¹⁴ Refer to the following article for more details on the results: Sokol A., Oget D., Sonntag M., Khomenko N. (2008). The development of inventive thinking skills in the upper secondary language classroom. *Thinking Skills and Creativity* 3 (2008). ELSEVIER. 34-46.

had more than 10 years of experience of working with the Developmental Education¹¹⁵.

Teacher 1 and Teacher 2 were named experienced teachers.

- The observed T4-os was an EFL teacher with two years of teaching experience and one year of experience of learning to organise the problem-centred teaching-learning process. T4-os was named a non-experienced teacher.

All of three teachers have been involved in learning to organise the problem-centred teaching-learning process through the project “*STEP to Thinking - Summer Schools for Teachers Professional Development*” (2012-2014) supported by the Nordplus Horizontal Programme.

Lesson observation took place in September 09, 2013 when T4-os was working with her class of form 5 (10-11 year old students). The peculiarity of the given secondary school is that lesson observations are done on a regular basis therefore both school children and teachers are used to having external observers on their lessons. This allows me to assume that neither teachers’ nor students’ behaviour was influenced to a great extent by the presence of external observers.

Before the lesson, the researcher explained experienced teachers the aim of the instrument, each teacher was given a copy and had time to get acquainted with it and ask all the questions they had.

Then the experienced teachers and the researcher attended the lesson and filled their lesson observation instruments separately. The comparison of the results and the discussion on the usability of the instrument was held directly after the observed lesson. The discussion was recorded on two audio files so that not to lose important points later. The results of the observation and the main comments raised during the discussion are reported in Table 27 below.

¹¹⁵ For references on Developmental Education (from Russian, Развивающее обучение), check the following authors Leont’ev A., Davidov V., Elkonin D., Repkin V. (from Russian, Леонтьев А., Давыдов В., Эльконин Д., Репкин В.).

Table 27 Summary of results and discussion on the validation of the first draft of the lesson observation instrument.

Category	Indicator	T1-iv	T2-nk	RJ	Comments ¹¹⁶
Setting lesson/task aims;	An ability to make lesson/task aims explicit to students	0	0	0	
Formulating the task as a problem to be solved;	An ability to formulate the strategy-based tasks for students to be solved	1	1	0	T2: The instrument lacks criteria which would show whether challenge is accepted by students or not. On this lesson the aim (challenge) is not taken by students. In order to understand that students accepted the challenge the following quality criteria can be used: students ask questions "how can we do it?" or express concern "it is impossible to do it", etc. T1: The task may be strategy-based as it was on this lesson; however, the steps were defined by the teacher not students. Strategy-based means it requires several steps to be accomplished. Moreover, building steps may be required and steps may be even defined by students but none of the meta-tools (ENV, etc.) may be required.
Using OTSM-TRIZ thinking models;	An ability to introduce and manage the usage of the ENV thinking model of the OTSM-TRIZ	1	1	0	T1: The task may REQUIRE using an ENV model and the teacher may not USE it. So the difference should be made between a task and what it requires and teacher's skill to use the task competently.
Organising the regular improvement of generic strategies;	An ability to organise students' improvement of the generic strategies	-	1	-	T1: It is essential to make a distinction between a skill to organise students' registering something and a skill to organise students' registering a generic strategy. Moreover, the skill of defining time for students when they will be able to do register something should also be included in criteria and indicators. Another comment concerns WHO is registering. 'INDEPENDENT improvement of strategies' should be highlighted. One more precision concerns the text in quality criteria which says 'write the strategy'. A better formulation would be '(re)write'.
Conducting metacognitive reflections;	An ability to organise reflection on the results of the lesson;	0	0	0	
	An ability to organise reflection on the process of doing the task and on the application of OTSM-TRIZ	0	0	0	

¹¹⁶ Even though I clarify who provided a comment (T1 or T2), it was a mutual discussion so T1/T2 refer more to a person who initiated the discussion on the topic rather than voiced the entire comment herself.

	thinking models				
Self-assessment of one's own work;	An ability to involve students in assessment of one's own work	0	0	0	
Questioning	An ability to involve students in voicing out their thoughts	0	0	-	
	An ability to involve students in explaining the reasons behind their thoughts or expand and specify their answer	0	0	0	
	An ability to involve students in commenting on each other reasoning (in assessment of peer reasoning).	0	0	0	
	An ability to give time to think to all students and not rush into asking the first student raising his hand.	1	0	0	T1/T2: It would be better to separate the skill of 'giving time to think' as such from 'rushing into asking the first student'.
					<p>General comments (T1/T2):</p> <ol style="list-style-type: none"> 1. Teacher-learning interaction patterns (from Latvian "sadarbības modeļi" are not included in the instrument). 2. Why doesn't the instrument take into account a subject-matter part (in this case, it is EFL)? Is it going to be included in any way?

The analysis of the results has shown that experienced teachers and the researcher were almost completely consistent in their evaluation. Where the difference was marked (or assessment was absent) it was due to the vagueness of the statements which described quality criteria. Several important remarks were, however, made.

The first major remark concerns the distinction between the potential of a task itself, its formulation, and the real execution.

For example, a teacher may be successful in formulating a problem task which has the potential to create a cognitive conflict in students' minds. However, the question is whether students will accept the challenge offered to them, i.e. whether the cognitive conflict will be created when the task is put into practice. The indicator of the success of creating a cognitive conflict is students' reaction who (a) start asking questions, or (b) express concern by exclaiming 'how can we do it?', "it is impossible to do it", etc. Another example, is a about formulating a problem task which is strategy-based (requiring several steps to be accomplished) and who finally builds the steps, a teacher or students. Just as with the cognitive conflict, a task itself can have a certain potential, however, how the teacher implements it in real practice may either serve to use this potential or to destroy it. The same concerns the potential of a

task in terms of using the meta-tools and the teacher actually using this potential and making students use the tool. Or moreover, a task may be strategy-based; however, no meta-tools are required in order to complete it. Therefore, in terms of competences we have to make the following distinction:

- the teacher formulating a problem task which has the potential to create cognitive conflict;
- the teacher succeeds in making students accept the challenge – the cognitive conflict was created in the minds of learners;
 - The indicator of the success of creating a cognitive conflict is students' reaction who (a) start asking questions, or (b) express concern by exclaiming 'how can we do it?', "it is impossible to do it", etc.
- the teacher formulates a problem task which has the potential of involving students in strategy building
- the teacher manages to involve students in building the strategy rather than building it for them.
- the teacher formulates a problem task which has the potential of introducing/practicing meta-tools while building a strategy;
- the teacher makes students use meta-tools while building a strategy.

In addition to the first major remark, T1 and T2 made important comments on students' note taking. While working on building a strategy, students should take notes in order to be able to trace their own steps and logic. So it is important that a teacher organises students note taking as such in addition to specifically organising students' registering a generic strategy they are building. Moreover, a time allocated to for students for putting down their ideas can be considered to be an indicator of whether a teacher succeeds in making them take notes or not. And the last aspect to consider about registering and improving strategies is who is doing it, students independently or rather a teacher dictating the path. In terms of the competences, we can define it as follows:

- the teacher organises students note taking while working on problem tasks (including asks students to write and improve their generic strategies);
- the teacher allocates time for students to write and improve their strategies;

- the teacher asks students to write and improve their strategies independently rather than dictating them what to write.

One more important remark was connected to separating the competence of giving students time to think and engaging different students in the classroom dialogue. I do not pay much attention to this remark here since these competences were separated in the theoretical framework which I built in the first chapter. The same concerns the remark connected to the absence of teacher-student interaction patterns (group work, individual work, etc.). The last remark is connected to including in the lesson observation aspects connected to a subject-matter part. Just as in the previous case, I believe that this remark is also covered by the competences included in the theoretical basis.

The study of theoretical literature as well as the analysis of the empirical part allows me to formulate the final components and list of teaching competences specific for the problem-centred education.

2.9. Preliminary Conclusions

Conclusion 1

After analysing all the defined competences, they were re-grouped together and classified under relevant dimensions and components (see Table 28). Certain competences which were identified on the previous stages of the research were merged together to avoid redundancy or placed under another category or dimension which was considered to better suit the competency.

Table 28 Teaching competences required for organising the problem-centred education

Dimensions	Main components	Teaching competences required for the problem-centred education
Aims of learning	Formulation of aims	Formulates aims: <ul style="list-style-type: none"> • the subject-matter aim; • the 'unknown' of the problem task (which strategy, generalisation are learners supposed to come up with);

		<ul style="list-style-type: none"> inventive thinking skill(s) which learners should activate while working on a system of problem tasks
		<p>Formulates problem tasks:</p> <ol style="list-style-type: none"> Develops a system of tasks (a problem task and sub-tasks), which has the potential to create and maintain cognitive conflict; Develops a system of tasks the result of which would be a developed strategy, which can be applicable for solving a group of problems of the same type; Develops a system of tasks which would require the introduction, use of and reflection on the meta-tools for building a strategy (ENV, Multi-Screen, and ARIZ tools, etc.) Varies the complexity of a problem task depending on the learners' abilities;
	Knowledge for reaching formulated aims	Shows knowledge of meta-tools for building models: ENV, Multi-Screen, ARIZ tools.
		Shows knowledge of inventive thinking skills
Instruction (Teaching Methods reaching instructional aim) or for	General lesson structure	Organises the lesson (or learning unit) with the general structure of three steps: <ol style="list-style-type: none"> Cognitive conflict; Building a solution Reflection
	Elements of the lesson	Manages problem tasks: <ol style="list-style-type: none"> Succeeds in making students accept the challenge – the cognitive conflict was created in the minds of learners; <ol style="list-style-type: none"> The indicator of the success of creating a cognitive conflict is students' reaction who (a) start asking questions, or (b) express concern by exclaiming 'how can we do it?', "it is impossible to do it", etc. Involves students in building the strategy rather than building it for them; Makes students use meta-tools while building a strategy; Organises students note taking while working on problem tasks (including asks students to write and improve their generic strategies); Allocates time for students to write and improve their strategies; Asks students to write and improve their strategies independently rather than dictating them what to write.
		Uses the method of inquiry or the method of partial inquiry for organising learners' work: <ul style="list-style-type: none"> involves learners in collecting a bank of objects and its analysis for building a model
		Involves learners in reflection <ol style="list-style-type: none"> Involves learners in reflection on the obtained result and its efficiency; Involves learners in reflection on the process of solution, i.e. how the problem task was solved; Involves learners in reflection on the meta-tools that helped to build a model.

As it can be seen, main competences connected to the problem-centred education include several groups of competences: formulating aims, formulating problem tasks, organising lesson (or a learning unit) following three steps, managing problem tasks, using the method of inquiry and involving learners in reflection. Each of this group includes specific competences which further define the required teacher's ability. These competences are mostly specific to the problem-centred education and some of them can hardly be found in other approaches. The given synthesis is not claimed to be exhaustive and I assume requires further elaboration. However, taking into account this is the first attempt to describe teaching competences required for organising a problem-centred teaching-learning process, I can assume it to be rather complete for the purposes of this research. It should also be highlighted that these competences are only a part of a larger group of competences which are required for organising effective teaching-learning process in general. They form the theoretical framework of the given research together with those other essential competences synthesised in chapter 1.5. of this research (see Table 13 and Figure 9). This is the object, which a teacher is supposed to understand and master in order to be successful in organising an effective teaching-learning process during which the potential of developing learners' problem solving competence is as high as possible.

Conclusion 2

After shaping the theoretical framework, I have to proceed to specifying the research problem which the given research is addressing.

When speaking about pedagogy and research in pedagogy, Pavel Pidkasisity (Пидкасистый, 1998, p. 5) makes a distinction between a practical problem and a research problem (or a scientific problem). If a practical problem derives from the practice or experience and can be attempted to be solved with non-scientific means, then a research problem reflects defects or gaps in scientific knowledge. By uncovering gaps and deficiencies in scientific knowledge practical problems create the need for further, deeper or new research. The research problem should answer

the question 'what has to be studied which hasn't been studied yet?' One practical problem can be solved as a result of solving several research problems.

If my practical problem lies in the domain of how to help teachers improve their practice in general and introduce the problem-centred approach into their classrooms in particular, then my research problem is to understand how teachers transform a certain competences they are supposed to have or acquire into their real teaching repertoire. The Thinking Task Framework (Figure 1) is a model which incorporates certain teaching competences that are required to organise the problem-centred teaching-learning process. It, namely, presupposes that the core components of teacher's competence should lie within the ability of problematizing the learning content and organising learners' inquiry and reflective process throughout the teaching-learning process. When being presented to the Thinking Task Framework, how do teachers interpret it and transform it into their own practice? Are these merely the competences incorporated in the model which pose difficulties for teachers or is there something else which does not allow teachers become successful in developing student problem solving competence? These are some of the questions which lead me to the main empirical part of my research.

Part three

The Study of Teaching Praxeologies for the Problem-Centred Education

In order to build the proper methodology for my research, let me better articulate the problem and explain the choice of the selected approach.

How do teachers build their conception of the problem-centred education and transform the theoretical ideas into their own real-classroom practice? This is the question which was formulated as the main question of the research. What does it mean to study the 'how' of the teachers' transformation of theory? We can look at this question from a different angle.

We can draw a parallel between school students who are doing their studies at school and teachers who pursue initial or continuous teacher education. Being as different as they are both of these target groups are exposed to a formal programme with its aims and objectives that they are supposed to reach. In other words, they are all exposed to certain objects of study working with which should result in them knowing that object and being able to operate with it. However, if at school pupils are in the majority of cases supposed to prove their knowledge by paper-and-pencil test then teachers have a more difficult 'exam', the proof of their success or failure will be manifested in their classroom when they try to manage a complex system of teaching and learning process. Therefore, we can speak about teachers' knowledge as a practice. Moreover, we are not speaking about a human practice in general but rather about a certain practice relative to a person using it in a specific setting.

Hence, our task is to understand how that person, being part of a bigger social system, makes some external knowledge part of his repertoire, how abstract competences formulated by educational professionals become part of their day-to-day living knowledge which is determined by their surrounding social milieu. Understanding the 'how' means comparing teachers' actual knowledge as a practice with the abstract 'must-have' list.

Since the study of knowledge as a practice deals with the study of human activity, I will use a theory of human activity, namely Anthropological Theory of the Didactics (ATD), as a methodological basis for my research.

3.1. Methodological Basis of the Research

The Anthropological Theory of the Didactics (ATD) (Chevallard, 2007a) finds its roots in **the theory of didactic transposition (TDP)**¹¹⁷ (Chevallard, 1982, 1989) developed by Yves Chevallard in 1980s. The main question which led to the development of the TDP concerns the origins of knowledge present in different didactical systems. It was developed as an extension of the Guy Brousseau's didactic situations – a concept which sees knowledge as encapsulated in didactic situations going through which a pupil learns. The TDP questioned the genesis of didactic situations – where do they come from? How and by whom are they shaped? (Chevallard, 2007b) – finding the answer in the concept of 'transposition', namely, claiming that knowledge is not given, it is build up, transformed and transposed – changed from one position to another. So the TDP aims at describing and explaining the phenomena of transformation of knowledge from its production (regarded as a tool to be put to use) up to its teaching (knowledge as something to be taught and learnt). So the concept of 'transposition' brings us to the idea of passing from scholarly knowledge to knowledge which is taught. As specifies Chevallard (Chevallard, 1982), to prepare a lesson on the logarithms means **to make** a didactic transposition of the notion of the logarithm and to prepare a lesson means to work **in** the didactic transposition.

Knowledge in the TDP is considered as *“a changing reality, which adapts to its institutional habitat where it occupies a more or less narrow niche”* (Chevallard, 2007b). So behind the existing relationship of a pupil, teacher and knowledge there is the institutions, which should be regarded on the same level as the persons: *“[...] one does not look first and foremost at what this or that teacher knows, or ignores, or can do or fails to master, but addresses the problem of what the profession as an institution – not its individual members – knows or ignores, or can learn, or, for the time being, seems unable to learn”* (Chevallard, 2007b).

The Anthropological Theory of the Didactics (ATD), which is a theory of human activity, goes even further and aims at describing the genesis and evolution of

¹¹⁷ From French “transposition didactique”

elements of knowledge in a given institution (where institution can be a class with its students and the teacher). The ATD allows to broaden the scope of didactics by generalising its object and including not only knowledge which is recognised by some authoritative institution but also those elements of knowledge which these authorities refuse to call knowledge but which anyway exist and have to be taken into account to explain “*the fate of ‘true’ knowledge*” (Chevallard, 2007b)

For this purpose it models these elements of knowledge in terms of **praxeologies**: “*Toute activité humaine régulièrement accomplie peut être subsumée sous un modèle unique, que résume ici le mot de praxeologie*” (Chevallard, 1998, p. 1) Praxeology (also referred to as praxeological organisation) is a four-component structure which models practice (praxis) and discourse on practice (logos). Praxeology is composed of a **practico-technical block** (the praxis part), which includes type of tasks and technique, and a **technologico-theoretical block** (the logos part) which includes technology and theory.

The four components are defined as follows (Chevallard, 1998, 2007a, Chevallard et al., 2015, 2015; Chevallard & Sensevy, 2014; Ladage, 2008):

- The basic unit of a human activity is attainment of a task. When a person acts purposefully his actions can be analysed in a finite **sequence of tasks**, where any task can be regarded as a ‘specimen’ of a **type of tasks**. Normally a type of a task is described by a verb of action - blow your nose, prepare a baby bottle, solve the quadratic equation – are all action verbs.
- The way of accomplishing some tasks of a certain type is referred to as a **technique**. The technique indicates how a certain type of task is done; there are many different ways of performing the task even if we speak about a simple task of ‘walking’, which has a number of different ways of how it can be accomplished. Since no technique can cope with the totality of tasks of a given type every technique has its **scope** – its range of success for a certain number of tasks of a certain type it can cope with.
- **Technology** (from Greek ‘reasoned discourse’ (*logos*) and ‘know-how’, ‘skill’ (*technê*)) is a rational discourse which justifies the use of a technique as a valid way of accomplishing tasks of certain type. Technology sheds the light on the logic of the technique, making it at least partially intelligible to the user.

The rationality of the technology belongs to a person (or an institution); it is not a universal rationality true for every single individual but rather a reason behind an individual's use of technique. If the technique is the response to the question 'how to perform the tasks of a certain type' then technology seeks to respond the question 'why does this technique works'. Sometimes the technology can be merged with the technique. For instance, Ladage (Ladage, 2008) gives an example of the recipes, describing the technique makes the technology self-explicit and valid. In any case, the technology is always present in human activity be it explicitly or requiring additional explanation.

- Since no technological justification is self-sufficient (Chevallard et al., 2015, p. 2616), the technology, relies on a higher level of generality, which is called the **theory** (or sometimes referred to as principles or postulates). These higher elements of knowledge often go unnoticed and sound more abstract and often difficult to understand. The theory governs the technologies, justifies them. As stated by Chevallard and his colleagues (ibid.) both the technological and the theoretical components of praxeology are often misidentified because the research often examines their implicit, unassuming parts when they are in fact composed of two parts, an "emerged" part and an "immersed" part. As put by Chevallard (Chevallard et al., 2015, p. 2619) "*What people do and how they do it owes much to "thoughts" unknown to them – unknown, not unknowable*". So a theory takes the form of a set of both explicit and implicit statements about the object of that theory.

That notion of a theory a person is endowed with is shaped by constraints to which the person is currently subjected within his institution.

The quadruple of type of task, technique, technology and theory is called a **punctual praxeology** because it is organised around the type of tasks considered as a "point". An integrated system of all the praxeologies that a person or institution can draw upon during his practice is referred to as a **praxeological equipment** of the person. The praxeologies are living entities; they emerge, develop and may become outdated. There may be new types of tasks that appear and require the entire praxeology to be constructed around them (Chevallard, 1998, p. 6). Some

praxeologies are seen in some institutions as necessary for a better functioning of that institution so they tend to be adapted by or, in better words, transposed to that institution since they will undergo different modifications before becoming part of the praxeological equipment of that organisation. This phenomenon is referred to as **institutional transposition**.

The anthropological approach of the TAD theory allows me to study how teachers' transpose the problem-centred education into their own praxeological equipment, i.e. to study their knowledge of the problem-centred education by studying their practice and describing their praxeologies. Through the analysis of teachers' practices (lesson observation) and discourse on practice (reflections and ideas about their practice, their interpretation of different elements of the problem-centred lesson as well as difficulties they encounter), we can construct teachers' real praxeologies as compared to the externally defined must-have' lists of teaching competences.

Selecting the praxeological approach for my research allows me to break with the reductive strictly rational models of knowledge, learning and human development. As claimed by Alberton and Brassac (Albero & Brassac, 2013), knowledge, being a cognitive state of mind, is not separable neither from individual processes of 'knowing' the matter nor from social environments that determine them. And as stated by the scholars (Albero & Brassac, 2013, p. 106), the results of the research in social sciences and neurosciences *«[...] démontrent de façon convergente et irréfutable qu'il est impossible de comprendre et d'améliorer les processus cognitifs individuels ni d'assurer leur partage et leur transmission sous forme de savoirs sociaux sans dépasser les conceptions réductrices – égocéphalocentrées ou strictement rationnelles – du fonctionnement humain »*.

The further empirical part of given research aims at constructing teachers' praxeologies (types of tasks, techniques, technologies and theory) relative to the problem-centred teaching-learning process. I look at the problem-centred teaching-learning process as such through the list of competences constructed as a result of theoretical study described in the first two chapters of this research. And teachers' knowledge is going to be constructed through their teaching praxeologies. The research is directed by the two research questions formulated in the introduction, namely:

1. How do teachers transform the theory connected to the problem-centred education into their classroom practice?
2. What are the difficulties and constraints that teachers face when trying to acquire components of the teaching competence required for organising the problem-centred teaching-learning process?

The research is focusing on five main cases (five teachers) and their teaching praxeologies. The profiles of those teachers are described in more details in the actual analysis. These teachers are coded with the capital T and a sequence number value followed by initials which allows us to both distinguish between the cases and preserve teachers' anonymity. As a result, the five cases are coded as follows:

T1-iv, T2-nk, T3-sg, T4-os, T6-as. This group includes mainly language teachers (English as a foreign language, Russian as a mother tongue), as well as a teacher trainer. These cases are considered the main ones since the researcher had access to more data on them. Other cases are also analysed in the research but the data on them is scarcer, therefore they are not included in the main cases. These are coded either with a capital or a small letter 't', followed by a sequence number starting with '9' and initials (for example, T7-ku, T8-dj, t9-ab)¹¹⁸.

The data collection methods I used include teacher's written answers to questions, field notes, direct lesson observation, interviews with teachers before and after the lessons.

Teaching competences for effective teaching-learning process alongside teaching competences for the problem-centred teaching-learning process were used as a theoretical basis which allowed focusing on identifying specific types of tasks directly related to these competences. These are these types of tasks that teachers had to build their praxeologies for.

¹¹⁸ Initially, the idea was to have a bigger group of 'main' teachers, therefore more teachers were coded with a capital 'T' (T7-ku, T8-dj). However, in the course of the research it became evident that there is not enough data on these participants. So they were moved in the group of not the main cases but the initial coding was preserved.

3.2. Study 1: Analysis of Teachers' Understanding of the Thinking Task Framework

The first study deals with the analyses of teachers' written answers on the questions connected to the 3-step lesson structure depicted in the Thinking Task Framework (TTF).

3.2.1. Aim of the Study and Data Collection Method

In September 2010 a group of teachers coming from several Nordic-Baltic countries such as Lithuania, Latvia, Finland and Norway, started working on the project "*Bringing Creativity and Thinking Skills in Educational Process*". The given project was supported by the Nordic Council of Ministers in the framework of the Nordplus Horizontal Programme. During the project lifetime the teachers were learning how to organise the problem-centred teaching-learning process following the Thinking Task Framework. During this process, the researcher was present during the workshops, took field notes on teachers' experiences and collected teachers' online diaries where they described their lessons. A year later, from March 21 to March 24 2011, these teachers were involved in the so-called meta-reflection week where they were asked to respond in writing to the questions sent to the group via email.

The aim of the meta-reflection week was to improve teachers' understanding of the Thinking Task Framework by reflecting and drawing conclusions on the process of developing students' problem solving competence or inventive thinking skills in the framework of the subject-matter teaching.

The aim of the study was to identify teachers' understanding of the three steps of the classroom instruction (create challenge, build a solution, reflect on the process and product) which is directed at the development of students' problem solving competence or inventive thinking skills.

The study question: What are teachers' praxeologies in respect to the three steps of classroom instruction?

In order to **collect the data** on teachers' understanding seven different questions were proposed for the discussion, each sent by email on a separate day giving teachers time to respond and comment on each other's replies:

1. What are possible ways of creating challenges in your subject? How do we know that the challenge is here?
2. How do we get our pupils / students to accept challenges?
3. What are possible ways of moving from step to step in the thinking task framework? Do you always move from Step 1 to Step 2 and then Step 3? How do you usually move?
4. How do you introduce (or remind of) thinking models for building algorithms to your pupils / students?
5. How do you get your students to organize their notes when working on algorithms? What are the efficient ways of doing it?
6. To what extent do strategies / algorithms students develop stick? How do you measure this? What are possible ways of affecting this process?
7. What are efficient ways of organizing students' reflection? How do you ensure that students also reflect at a meta-cognitive level (e.g. about the algorithms and ways of building them)?

However, as a result the data was collected only for the first three questions. Questions number 5, 6 and 7 got only one response and hence were not used for the analysis. Question 4 received responses from two teachers only, it was closely related to the third question and did not add any additional information, so was not used for the 'official' analysis. However, in the process of data analysis it became obvious that one more aspect appears throughout teachers' replies, these are teachers' concerns and difficulties. Hence, the question "*Which concerns or difficulties do teachers experience?*" was added to the analysis.

The 11 participants of the meta-reflection week who responded to the questions included:

- Two teachers from Finland (T3-sg and T7-ku) and one foreign trainee (t13-am) who stayed in Finland in the framework of her Comenius assistantship programme;
- Two teachers from Latvia (T1-iv, t9-ls);
- One teacher from Norway (t10-kg);
- Three teachers from Lithuania (t11-au, t12-gj, T8-dj);
- Two teacher trainers, former EFL teachers (T6-as; t14-el),

Some of these teachers (T2-nk, T3-sg, T7-ku and T8-dj) were already acquainted with the problem-centred approach because they had previously attended a professional development seminar. However, this long-term project was the first one they attended and it was the first time the TTF was presented to them. One teacher (T1-iv) was rather experienced in the approach and has been practicing it for around 10 years.

Teachers represented different subjects and different age groups:

	(pre)- primary school	Basic school	Secondary school	University
English as a foreign language	t13-am	T3-sg	T1-iv	
Math		t11-au, T8-dj		
Chemistry		t10-kg		
Teacher trainers				T7-ku, T9-ls
General education	t12-gj			

Some teachers worked in the same school (T8-dj, t-11-au, t-12gj from Lithuania) so they could attend each other lessons and share their understandings between them. Even though not working at the same school, two teachers from Finland (T3-sg and T7-ku) cooperated closely with each other and could also share some common understandings.

The sampling of the participants was based on the simple criteria of them being involved in learning to organise the problem-centred teaching-learning process. The teacher trainers' comments and questions were also analysed together with teachers' replies because they allowed tracing their understandings as compared to the understandings of other teachers.

3.2.2. Data Analysis Method and Procedure

The collected responses – texts of emails – were further analysed using the **qualitative inductive content analysis method** (Elo et al., 2014; Huber & Gürtler, 2013; Miles & Huberman, 1994). The given method allows revealing the categories of meaning hidden or latent in the data. It allows understanding the experiences and actions of people from their own subjective point of view. The understanding is achieved by transforming colourful individual formulations and verbal descriptions into a less complex system of codes, thus getting people's actions down to the frames of reference of their subjective or implicit theories. The analytical units are developed **during** data interpretation, thus the content analysis is referred to as inductive (Elo et al., 2014).

The coding system had the following procedure (Huber & Gürtler, 2013):

1. First, the researcher had a global view of the selected data set (responses to each question) without getting involved in codification trying to understand the content as a whole;
2. Then, preliminary interpretations and ideas were singled out;
3. After that, the researched selected **the unit of analysis** and the general strategy for interpretation – differentiation (Huber & Gürtler, 2013). "*The most suitable unit of analysis will be sufficiently large to be considered as a whole but small enough to be a relevant meaning unit during the analysis process*" (Elo et al., 2014, p. 5).
 - a. The selected unit of analysis was the paragraph, which contains one response to the question asked or one question, comment or concern expressed about the question asked or about the reply of one of the

teachers. It is worth noticing, however, that sometimes, a paragraph was reduced to a single sentence;

For example, the following reply to question three was de-constructed into two paragraphs because the teacher t11-au describes two possible ways of how she sees the movement through the steps in the Thinking Task Framework.

Q.3. What are possible ways of moving from step to step in the thinking task framework? Do you always move from Step 1 to Step 2 and then Step 3? How do you usually move?

t11-au

Paragraph:

[Because the Thinking Task Framework is composed of three main steps, it is possible to move through them in different ways. First of all, there must be a first step (Increase room for thinking). It is necessary a difficult task is not necessarily the first step. Then we naturally move into the next step. You cannot move directly into the third step (Reflection). In the second step, we build a solution for the task with the students. If all is well, we move to the third step. In an ideal situation we move to the first step which makes up an uninterrupted chain of events. In different tasks we move differently through the ThTF.

While the first two steps were easy to reach, initially it was challenging to reach the third step. At times, it seemed like my task was missing the third step.

Usually I am moving through all three steps and going back to the first step. (e.g. equations and inequalities).]

Paragraph:

[I had situation of 1-2-3-2. We had to reflect on: how we are working on numbers? What kind of parameters we are using? What was helpful? Then go back to the second step.]

b. Coding started with the search for general categories;

For example, all the following extracts from teachers' replies to the first question contain the idea of materials. Therefore, the general code "through materials" was assigned to each paragraph containing this idea.

Q.1. What are possible ways of creating challenges in your subject? How do we know that the challenge is here?

Category 'through materials'

t12-gj

Bringing new objects.

For example flash light- why do we need it, how can we use it? The kids are trying new objects and trying to find opportunities to use it.

Category 'through materials'

t13-am

my ways of creating challenges would be

-bringing concrete material into the working place (pictures or objects, books ...).

- c. These categories were then marked by codes;
- d. The differentiation of these units was done stepwise and in repeated sessions in order to uncover specific differences within the general categories.

For example, for the category 'through materials' we can distinguish between the idea of 'characteristic of the material: concrete/physical materials' and 'way of introducing materials: unusual, strange'

Q.1. What are possible ways of creating challenges in your subject? How do we know that the challenge is here?

Category 'through materials'. Sub-category 'concrete/physical materials'

t13-am

my ways of creating challenges would be

-bringing concrete material into the working place (pictures or objects, books ...).

Category 'through materials'. Sub-category 'unusual way of introducing materials'

t13-am

There should be something unusual about it or it should be introduced in such a way. Example: introducing a small bit about a character before reading a book (strange - he gets a beautiful present that usually makes everybody happy, however he is really sad).

4. The coding started with a sample of data, switching from comparing data within the sample to comparing data within the entire text and testing if codes are applied consistently.
5. As a result, a set of coding rules was developed allowing to see emerging categories and grouping them under more abstract categories.

The raw data is included in Appendix 5. The coded data is included in Appendix 6.

As claimed by Elo and colleagues (Elo et al., 2014), qualitative research has to be checked against the trustfulness of the analysis. For deductive content analysis, when two researchers apply the ready categorisation matrix to code the text, intercoder reliability (ICR) would serve as a criterion for assessing trustfulness. However, for inductive content analysis when the codes emerge "on the go" the ICR cannot be used. The suggestion would be to have one researcher responsible for the analysis with others carefully following-up on the whole analysis process and

categorization. The coding of the given study was performed by the author of the paper whose categorisation was then discussed with another researcher to ensure the adequacy of the analysis.

3.2.3. Results of the Study

Question 1: results

For the purposes of the analysis, the first question was subdivided into two sub-questions: (1a) What are the possible ways of creating challenges in your subjects? (1b) How do we know that the challenge is here?

The question 1a received comments from nine participants out of eleven: T1-iv, T3-sg, T6-as, T7-ku, t9-ls, t10-kg, t11-au, t12-gj, and t13-am. Seven main categories of how teachers can create challenge (cognitive conflict) were identified. Each main category has a number of sub-categories (see Table 29). The most diverse responses were obtained for the category which claims that cognitive conflict can be created through (2) types of tasks and through (5) developing tasks with specific characteristics. While the least diverse responses were obtained for the categories claiming that cognitive conflict can be created through (3) students involvement, (4) by thinking about students' motivation, (6) by using special techniques for treating students' answers or results and (7) by varying the level of difficulty of a task.

The first category - (1) materials – was identified only for two teachers – t12-gj, t13-am - both of whom work with (pre)-primary students. This should not be surprising since this is the age group which naturally requires tangible objects; therefore the teachers evoked them in their answers:

“my ways of creating challenges would be - bringing concrete material into the working place (pictures or objects, books ...).”

(t13-am; sub-category 1.1. concrete materials)

“Bringing new objects. For example flash light- why do we need it, how can we use it? The kids are trying new objects and trying to find opportunities to use it.”

(t12-gj; sub-category 1.3. ways of using (new) materials)

Table 29 Results for question 1a of Study 1

Question 1a. What are possible ways of creating challenges in your subject?						
1 Materials	2 Types of tasks	3 Students involvement	4 Thinking of students motivation	5 Task characteristics	6 Treating answers and results	7 Varying level of difficulty
1.1. concrete	2.1. competitions/ games	3.1. students questions	4.1. knowing your students' interests	5.1. task is open-ended (more than one possible answer)	6.1. refuse immediate/typical answer/result	7.1. finding the right level of challenge
1.2. unusual	2.2. competitions/ games + obstacle			5.2. task is closed (one answer) + obstacle		
1.3. ways of using (new) materials	2.3. real-life situations			5.3. no usual way of doing task is applicable		
1.4. ways of introducing materials: unusual	2.4. practical tasks			5.4. task is creative		
	2.5. drag & drop task			5.5. task sets certain obstacles/limitations		
	2.6. sort objects in groups task			5.6. task looks at the object of study from a different angle		
	2.7. sort objects in groups task + obstacle			5.7. way of introducing task: unusual		
	2.8. exclude each word			5.8. clarity of instructions		
	2.9. compare X with Y			5.9. clarity of aim for the teacher		
	2.10. point of view + obstacle			5.10. clarity of aim for students		
	2.11. change the text from A to B + obstacle			5.11. task is contextualised		
	2.12. change the text from A to B			5.12. task shows 'guessing' is a poor approach		
				5.13. task requires describing a step by step process		
				5.14. task motivates but students don't know how to do it		

The second category – (2) types of tasks – was identified for six teachers: T1-iv, T3-sg, T9-ls, t11-au, t12-gj, and t13-am. As mentioned above, this is one of the most varied category in terms of teacher replies, i.e. twelve different sub-categories were identified for it. One of the main important distinction which was identified is that several sub-categories differ only in terms of teachers' seeing the necessity of an obstacle or limitation while others merely mentioning type of a task. For example, while some teachers mention that a (2.1.) game/competition can help to create cognitive conflict, others add that (2.2.) game/competition should have an obstacle if cognitive conflict is to be produced in learners' minds:

“To write algorithms for equations and inequalities. One of funny ways to do it just have a game. By creating games, we create tasks.”

(t11-au; sub-category 2.1. competitions/ games)

“Yes/No game 'Guess the character from the text' by asking 5 questions. When they did not manage to do it, we discussed why and how to.”

(T9-ls; sub-category 2.2. competitions/ games + **obstacle**)

The same holds true about the sub-category (2.6) 'sort objects in groups' task and the category (2.12) 'change the text from A to B'. Both of them have corresponding sub-category with an obstacle, namely (2.7) 'sort objects in groups task + obstacle' and (2.11) change the text from A to B + obstacle'. Sub-category (2.10) 'point of view + obstacle' does not have a corresponding pair without an obstacle.

“Drag and drop activities or sorting activity so on.”

(t11-au; sub-category 2.6. 'sort objects in groups' task)

“Through sorting tasks – eg sorting words (classroom words [...] food words), sentences (describing someone, about a place, with a particular grammar structure) or pictures (eg families), where limitations are given (time, no of groups, how often same thing sorted in different ways.)”

(T3-sg; sub-category 2.7. 'sort objects in groups' task + **obstacle**)

“Through a task which interests them, eg changing a book to a film (script for small part of it), changing an interview into an article (for a specific audience)”

(T3-sg; sub-category 2.12. ‘change the text from A to B’)

“transformation tasks when they have to re-write the text in another genre and/or in another person's point of view with minimal changes of the original text (we have not done it yet) [...] The challenge in tasks d and e lies in achieving the anticipated outcome. keeping to the author's style find the linguistic means to create the text in which the characters will be not schemes ('She is busy. He is lazy.') but real people described through their actions, talks, deeds and in accordance with the genre and the plot of the original text.”

(T9-ls; sub-category 2.11. change the text from A to B + **obstacle**)

“I am speaking here about creating different texts. One thing I have decided for myself so far is to deal with one aspect at a time, let's say in the point of view tasks I create the tasks where they need to focus on the narrator and how the texts they create will change depending on the narrator they choose. Then, for example, a typical task of describing their family might become less typical if you ask them to write it from the point of view of their pet.”

(T1-iv; sub-category 2.10. ‘point of view + **obstacle**’)

A task in itself does not guarantee that students will experience cognitive conflict. One can successfully play a game without experiencing cognitive difficulty. Therefore, being aware of an importance to add a certain obstacle or limitation is essential for a teacher who wants to succeed in creating cognitive conflict in students' minds. Those teachers who merely enumerated types of task may fail to see the necessity of an obstacle or may forget about it.

The sub-category of 2.3.‘Real-life situations’ was mentioned by several teachers who acknowledged that creating cognitive conflict is easier when the task is approached to real-life of students:

'Creating the challenge would involve setting the scene carefully (and could be based on a real incident at school), and in step two they would be introduced to tools to help them think through the situation more carefully.'

(T3-sg, sub-category 2.3. real-life situations)

Other sub-categories were mentioned only once by one of the teachers.

The third category – (3) Students involvement – as well as **the fourth category – (4) Thinking of students motivation** – have only one sub-category each and have respectively one (t11-au) and two teachers (T1-iv, T6-as), who mentioned it.

It is worth mentioning that the claim that cognitive conflict can be created with the help of students questions is not specific and does not quite provide any details on how exactly it is supposed to challenge students:

"Sometimes it is easy to create challenges from student questions or real-life problems."

(t11-au; sub-category 3.1. students' questions)

The same can be true about the statement that one should know his students in order to produce cognitive conflict. It does not provide any clue on how it can be done:

"Yes, I am sure we have to think about the why in 'why would they want to do this task?'. For me, it's a part of getting them to accept the challenge."

(T6-as; sub-category 4.1. knowing your students' interests)

The fifth category – **(5) through characteristics of a task itself** – is the most varied one and was identified for eight teachers (T1-iv, T3-sg, T6-as, T7-ku, t9-ls, t10-kg, t11-au, t12-gj). The importance of obstacle has already been acknowledged while discussing the previous category, it has been outlined here in a separate sub-category (5.5) task sets certain obstacle/limitation:

“It was a kind of pretask to play around and experiment with one limitation that the music should sound exiting. The pupils built a list of features which they can try out when they need to make exiting music for their radio play.”

(T7-ku; sub-category 5.5. task sets certain obstacle/limitation)

Three teachers (T3-sg, T7-ku, t12-gj) remarked that if one wants to create a challenge a task should allow to look at the object of study from a different perspective:

“I see that taking a fresh point of view/a different angle of the topic will help to create a challenge. Giedre did that with her pupils with animals task. I think I tried that with the seashore plants. At least the pupils were not expecting to study the plants in that way.”

(T7-ku; sub-category 5.6. task looks at the object of study from a different angle)

Three teachers (T1-iv, T3-sg and T6-as) were speaking about the need of clarity of the task in terms of instruction and aim for both students and a teacher. In other words, it is essential that students understand why they do a certain task, what kind of a problem it will help them to solve and how it is connected to a bigger learning aim:

“Instructions have to be very clear to everyone, for example, the rules and limitations in games, the specific situation in another task, the exact form of sorting wanted etc. I think it helps if they know what they’re learning subject-wise, what the aim is.”

(T3-sg; sub-category 5.8. clarity of instructions)

“If we take the Poiint of View example, we bring students to the challenge of writing a good point of view (to put it bluntly, they realise that what they produce is crap) and it becomes our big task. It's important that they accept the challenge of working on this big task and remember that this is what they are doing. When this is achieved, we may decide to do a level or several down and work on a specific aspect of writing a story from another point of view (following the same three steps). However, I still think that it's important to

ensure that students (not only the teacher) are aware of the big task. This is what I mean by starting with a problem / challenge where students realise that there's something they want to do but can't. Moreover, I am sure that this is a very important part of the motivation we want to create (part of this value aspect we often discuss) - motivation to work on challenging tasks."

(T6-as; sub-category 5.10. clarity of aim for students)

"I think that we can check if the task is challenging enough if we have a very clear idea of what change in pupils' knowledge/skills we want to make, i.e. there should be a stage of " How to do it? I don't know how to do it and I want to learn/to find out how to do it." . I think this could be a good signal taht the task is challenging."

(T1-iv; sub-category 5.9. clarity of aim for the teacher)

Two contradictory sub-categories emerged in the course of the analysis with one teacher (t11-au) claiming that a challenging task has no one answer and another one (t9-ls) assuming that a task should allow for only one answer and contain an obstacle:

"In general, it is best to give an assignment that will not have an exact answer and in which we would teach continuity."

(t11-au; sub-category 5.1. task is open-ended (more than one possible answer)

Without denying the fact that open-ended tasks have the potential to create cognitive conflict, it is difficult to interpret from this brief answer how exactly it can be achieved. No reasons are given why open-ended assignment is the best and what exactly is meant by 'not have an exact answer'.

"I noticed that it is easier to start with the tasks that have one answer: Yes/No game 'Guess the character from the text' by asking 5 questions. When they did not manage to do it, we discussed why and how to."

(t9-ls; sub-category 5.2. task is closed (one answer) + obstacle)

Contrary to the previous comment, this one is clear about how exactly the task looks like and the role of an obstacle in it.

All other sub-categories were identified for one teacher only each.

The **last two categories** that were revealed during the analysis – **(6) treating students' answers and results and (7) varying the level of difficulty of a task** - contain only one sub-category each. But each sub-category was mentioned by three and four different teachers respectively. According to three teachers (T1-iv, T6-as, and t12-gj), the challenge can be created if a teacher does not accept the first, immediate answer or result produced by students. In other words, a teacher should find the way to show students that what they produced is not qualitative enough or does not correspond to the facts:

“If I got you right, one of the ways of creating a challenge is to make the students' idea of an answer unacceptable (eg by excluding the possibility of applying a certain parameter). Is it what you're saying?”

(T6-as; sub-category 6.1. refuse immediate/typical answer/result)

And according to four other teachers (T1-iv, T3-sg, T6-as and T7-ku) teacher should find the right level of challenge varying it depending on her students and the situation:

“Challenges need to be of the right level and children especially are easily demotivated if it's just too difficult.”

(T3-sg; sub-category 7.1. finding the right level of challenge)

The question 1b - How do we know that the challenge is here? - which is directly connected to the question 1a, received comments from six teachers out of eleven: T1-iv, T3-sg, T6-as, t10-kg, t11-au, and t12-gj. All of them mentioned one way of identifying challenge, by observing students' reaction to the task offered to them. The observed reaction can be different. At least nine options were identified in teachers' responses:

1. students keep silence (t11-au);

- “When an assignment is challenging it shows in the childrens’ expressions (2-5 minutes of silence), or sometimes a complaint.” (t11-au)*
2. students complain (T3-sg, t11-au);
“For some pupils it’s too difficult and they just want to give up, or get angry and start blaming the task, teacher, classmates, book, you name it!” (T3-sg)
 3. students feel stuck: have no idea HOW to do the task (T3-sg, t11-au);
“Some just say they have no ideas at all.” (T3-sg)
 4. students show motivation, start doing the task (t12-gj);
“In our toddlers class we know that the challenge is where if: the child is acting and trying to solve the situation”. (t12-gj)
 5. students show interest in the task (t12-gj);
“the child is showing interest in a situation” (t12-gj)
 6. students ask questions (t12-gj);
“the child is starting to ask questions” (t12-gj)
 7. students ask specific questions (t10-kg);
“We can be sure that the challenge is here when they start asking questions which are not general but focussed on a single parameter or value.” (t10-kg)
 8. students are motivated to do the task but feel stuck (T1-iv, T3-sg, T6-as);
“When the children want to do something with a new tool / object and don’t know how seems to be another indicator of a challenge, doesn’t it? If it is, this is probably one of the ways of creating a challenge?” (T6-as)
 9. students agree their solution is poor/wrong (T3-sg, T6-as).
“they can’t do these things at once, or do them badly and recognize themselves that they need (and hopefully want!) to improve and get better at it.” (T3-sg)

Some of the sub-categories look very close to each other, for example, nr.3 and nr.8. However, they were placed separately since there is a difference in a situation when students merely do not know how to do the task and when they want to do it but don’t know how.

Question 2: results

The second question sought to find out how teachers get their students to accept the challenge. It received comments from six teachers out of eleven: T1-iv, T3-sg, T7-ku, t9-ls, t11-au, and t12-gj. Seven main categories of how teachers get their students accept challenge were identified, each having a number of sub-categories (see Table 30). The most diverse responses were obtained for the categories claiming that (1) the use of specific technique can help to get students accept the challenge as well as (3) developing tasks with special characteristics.

Table 30 Results for question 2 of Study 1

Question 2. How do we get our students to accept challenges?						
1 Specific technique	2 Type of task	3 Task characteristics	4 No effort	5 Materials	6 Work format	7 Teacher characteristics
1.1. persuading/explaining	2.1. game	3.1. discovery tasks	4.1. use natural curiosity	5.1. tangible objects	6.1. pair work / group work	7.1. showing persistence, confidence, patience
1.2. provoking	2.2. debate	3.2. creative, unusual task				7.2. establishing tradition of risk taking
1.3. asking guiding questions	2.3. find a mistake	3.3. clear aim				
1.4. controlling level of challenge		3.4. requires work with strategies				
1.5. making students succeed		3.5. requires to move physically				
		3.6. task is contextualised				

The least diverse responses were obtained for the categories assuming that either (4) no effort should be made to get student accept the challenge, or that (5) materials or (6) work format can help a teacher in this endeavour.

The **first category – (1) specific technique** – was identified for five teachers: T3-sg, T7-ku, t9-ls, t11-au and t12-gj. None of the sub-categories are distinctive over others each being identified for one or two teachers only. According to teachers the following five techniques can help to get students accept the challenge, i.e. make students agree they have a problem and be motivated to solve it:

1. Persuading students, explaining (t11-au);

“Explaining that each and every one of you will find your individual way of solving problems. (I explained that there are as many ways of completing assignments as there are students in the class).” (t11-au, sub-category 1.1. persuading/explaining)

2. Provoking students (t9-ls, t12-gj);

“Me and my college started to create little provocations in our toddler group. (2- 3 year old kids).” (t12-gj; sub-category 1.2. provoking)

3. Asking students guiding questions (t12-gj);

“So we did not gave them the answer then they got stuck - we asked more questions and they helped to find answers.” (t12-gj; sub-category 1.3. asking guiding questions)

4. Controlling level of challenge of a task (T3-sg, T7-ku);

“The pupils created the challenge themselves. The trainee went along and didn’t help in creating the practical challenge. Will it be easier to accept the challenge when the pupils have set it themselves? On the other hand will the challenge be demanding enough? Sometimes the pupils design things which are far too complicated to make! The teacher has to step in and decrease the challenge. Limitations are good in avoidind disappointments (crying some time!).” (T7-ku; sub-category 1.4. controlling level of challenge)

5. Making students feel they succeed (T3-sg).

“They have to gradually build successful experiences and have a feeling that they know they’ll be learning and moving on.” (T3-sg; sub-category 1.5. making students succeed)

The **second category – (2) type of task** – was identified for four teachers - T3-sg, t9-ls, t11-au and t12-gj – and has only three self-explaining sub-categories identified for one or two teachers each. According to these teachers, one can make students accept the challenge if they offer them such type of tasks as (2.1.) a game, (2.2) a debate or (2.3.) a task which requires to find a mistake.

The sub-categories of the third category - **(3) task characteristics** - are more varied. At the same time, each of them was identified for one teacher only. The same holds true about the **remaining categories – (4) no effort, (5) materials, (6) work format, and (7) teacher characteristics** – which have a scarce number of sub-categories identified either for one or two teachers each. Thus we can see that for the second question teachers have rather different views on how they can get students to accept the challenges.

Question 3: results

The third question asked teachers about the possible ways of moving from step to step in the thinking task framework, how they usually move and whether they always move from Step 1 to Step 2 and then Step 3? It received comments from ten teachers out of eleven: T1-iv, T3-sg, T6-as, T8-dj, t9-ls, t10-kg, t11-au, t12-gj, t13-am, and t14-el. Two main categories were identified, as well as the ideas were collected on how teachers define for themselves each step (Table 31).

Table 31 Results for question 3 of Study 1

Question 3. What are possible ways of moving from step to step in the thinking task framework? Do you always move from Step 1 to Step 2 and then Step 3? How do you usually move?		
1 Different transition means to move from step to step	2 Sequence of steps	3 Steps defined
1.1. modifying task	2.1. 1-2-3	<u>Step 1</u> 1. description unclear 2. requires Ss knowing tools before step 1 3. -theoretical input given to Ss -question asked which requires step-by-step approach 4. Ss build algorithm and get stuck 5. step 3 can be transformed in step 1
1.2. postponing task	2.2. 1-2-3-1	
<u>1.3. (work on the concept of ENV) From simple task of organising information via ENV to task with obstacle:</u> 1. practicing separate ENV parts 2. offering task with obstacle	2.3. 1-2-3-2	
<u>1.4. From task to obstacle:</u> 1. task 1 is given 2. Ss succeed 3. Obstacle introduced (make certain nr.of groups, time limitation, increasing number of parameters, removing some parameters) 4. Ss stuck	2.4. task is given - Ss produce result - 1-2-3	
<u>1.5. From task to obstacle:</u> 1. Task 1 is given 2. Ss produce result 1 (not effective) 3. Teacher provides feedback 4. Ss improve result 1	2.5. 1-2-3-2-3-2-3-1	
<u>1.6. From task to obstacle:</u> 1. Ss work on standard situation	2.6. 1-2 [1-2-3] -3	

2. Teacher changes standard to non-standard 3. Ss are asked 'why'.		4. Teacher offers tool (reminds of tool)
<u>1.7. From task to obstacle and to solution:</u> 1. Ss are given task 2. Ss succeed 3. Teacher introduces obstacle 4. Ss are stuck 5. Teacher reminds about the tool 6. Class reflects on the tool 7. Ss find solution	2.7. no clear description is given	<u>Step 3</u> 1. -quick general reflection (did it help) -quick reflection on algorithm" 2. -test strategies -improve strategies" 3. -reflect on algorithm -reflect on how algorithm was developed -quick reflections -reflections of Ss differ" 4. -Ss assess each other algorithms -Ss exchange algorithms -Ss work with bank of algorithms" 5. Ss reflect on what helped to find solution" 6. Ss reflect on how solution was found" 7. Class established tradition of thinking back" 8. Ss have general reflection (was it easy/difficut/why)" 9. -Ss reflect on how algorithm was build; -Ss reflect on usefulness of tool"
<u>1.8. From task with obstacle to building HOW to OR finding solution:</u> 1. task is given 2. Ss are either stuck or apply tool to come to solution		
<u>1.9. From task with obstacle to building HOW to OR finding solution:</u> 1. Ss are stuck 2. Teacher offers tool 3. Teacher shows how to apply tool 4. Students find solution? OR build a strategy?		
<u>1.10. From task with obstacle to building HOW to OR finding solution (and reflection):</u> 1. Ss are stuck 2. Teacher reminds about meta-tools 3. Ss solve the task 4. Ss reflect on the tool		
<u>1.11. From task to building HOW to:</u> 1. task 1 is given 2. Ss succeed 3. Teacher uses results to build a strategy with Ss 4. task 2 is given which requires applying strategy 5. reflection		

The **first category** includes (1) different **means of transition from one step of the framework to another** one. Replies of eight teachers were categorised under this category: T1-iv, T3-sg, T6-as, T8-dj, t11-au, t12-gj, t13-am, and t14-el. One of the most interesting sub-categories include teachers perception of how they move from a mere task to obstacle (1.4. – 1.6.). Three different ‘paths’ were identified. The first one offers (a) to give a task to students, (b) wait till students succeed, (c) introduce an obstacle or limitation (such as time limitation, increasing number of parameters, removing some parameters) which should lead to (e) students feeling stuck:

“The entry below has a good transition from a sorting activity to a challenge. Students were doing a sorting activity, grouping cards on their own initiative then the teacher makes the task much harder (step 1 increase room for learning by making the task almost impossible - you hope!) by insisting on a certain number of groups of a certain size (15 equal groups of 5 cards each). Note: students oftentimes find novel ways around the restrictions... (15

randomly made groups)... some changes were then made so all students were stuck and could proceed without help..."

(T8-dj; sub-category 1.4. from task to obstacle)

The second 'path' is very close to the first one. The difference is that after (a) giving a task to students, they (b) are trapped to produce not a very effective result and (c) receive teachers' feedback which should lead them to (d) improving it:

"Sometimes the challenge has been a piece of writing and the feedback on the writing and how to improve it has been the impetus for bringing in the next step."

(T3-sg; sub-category 1.5. from task to obstacle)

In both cases there is a certain result produced by students before they either get a limitation or are provided feedback proving them that their result is poor.

One more distinctive sub-category (1.11) which was identified omits the obstacle and organises the instruction from (a) task, to (b) students success, (c) building strategy on the basis of students' results, followed by (d) a new task which requires applying the strategy and (e) by reflection:

"When writing about a special person I did Step 1 by asking them to write about a grandparent with no help, after which I used their sentences to build the ENV model . So, for example, we built up an ENV model for describing a person, and reinforced the idea by having them add to the model from the book. After that I gave the task, where they had to write about a person again, and after that we had the reflection I mention below, which I guess is Step 3? Or is it?"

(T3-sg; sub-category 1.11.from task to building HOW to)

The same sub-category can also be interpreted in a different way. Students are not shown directly that their result is poor but are rather helped to build a strategy on the basis of their first result which would serve as a tool to make them see their initial result was of poor quality. In this respect, the sub-category 1.11 resembles that one of 1.5.

The last 'path' identified for the sub-category 'from task to obstacle' is slightly different and includes (a) students working on standard situation which is followed by (b) teacher changing a standard situation to a non-standard and (c) asking students why question:

“Looking at your example below (where the variable is habitat) I can also imagine the animals having another situation with a food variable - some representation of their common type of food - and the teacher changes it so the animals become unhappy/sick. e.g. panda with carrots and rabbit with bamboo shoots (thinking of my 2.5 year old nephew who's fascinated with animals - and cars!) - is this the kind of activity?”

(T8-dj; sub-category 1.6. from task to obstacle)

Another option is when students are not given any chance to produce result or succeed and are directly faced with the task which has an obstacle. In this case the sub-category is described as (1.8. – 1.10.) 'from task with obstacle to building HOW to OR to finding solution'. Three different 'paths' were identified for this sub-category. The difference between these 'paths' is small but rather essential. The first one is concerned with what happens after students agree that they are stuck. The following options are possible:

- a. teacher can introduce a new meta-tool and show how to apply it (sub-category 1.9.);
- b. if students have already used the meta-tool before, the teacher can simply remind about the meta-tool and invite students to use it (sub-category 1.10);
- c. students may remember about the tool themselves and get out of difficulty themselves by applying it (this option is implicit in sub-category 1.8., which can also turn out to be the same as 1.10. if students fail to remember about the tool and should be reminded about it by the teacher).

Another difference is connected to what the introduction of a tool leads to. Does it lead to building a strategy, a HOW to, an algorithm, a generalisation of how this type of tasks should be done, the so-called 'unknown' of the task? Or does it lead to finding the solution, the answer?

“After setting the challenge, wait for them to get stuck, for example in the yes/no game and then work with them on building up a model (in this case ENV) which would help.”

(T3-sg; sub-category 1.9.from task with obstacle to building HOW to OR finding solution)

In the example above a teacher would work on a strategy on how to play yes/no game, ENV meta-tool will be applied to build that general strategy and apply it to specific cases in a yes/no game.

“STEP 2: Then I went directly to step 2 and reminded them of the 'variables and values' from the previous lesson. Together as a whole group we identified 4 variables and their values. Now they could do the 6 groups instantly because one of those variables had 6 values. STEP 3: Reflection: Did the model help them ? Yes it did! SO why didn't they use it then??”

(T8-dj; sub-category 1.10.from task with obstacle to building HOW to OR finding solution (and reflection))

In this second example, the reminding of a tool leads to students finding the solution (i.e. make 6 groups) for the challenging task offered to them, rather than generalising a certain strategy or HOW to. In this case, we also observe a general reflection on the meta-tool (referred to as a model in the teacher's text).

The sub-category 1.7.includes a full cycle of (a) from task, (b) to obstacle), (c) to reflection and to (d) solution:

“In the end they came up with a very good set of instructions that worked. They gave them to each other to test with random shape pulled from a bank of regular paper shapes I had made. STEP 1: So I started feeding in irregular shapes... In trouble again... they asked for help and this time I simply reminded them of the ENV tool which they had just used. We reflected at this point also on how the ENV had helped the first time. i.e. rather than look on each shape as a new unique problem look at it as a collection of parameters.”

(T8-dj; sub-category 1.7.from task to obstacle and to solution)

The first main conclusion which can be made after analysing the results of the category one of the third question of the study is that we can speak about several 'paths' for instruction when a teacher is moving from step to step in the thinking task framework. The first main link is TASK – RESULT – OBSTACLE:

a. task - good result – obstacle

From task to students producing good result to obstacle/limitation introduced to the same task or a new similar task with the obstacle to make students feel stuck. Limitation can be in the form of a time limit, limit of a number of groups, increased or decreased number of parameters used in the task, etc.

b. task – poor/ineffective result – teacher's action proving poor quality of result – students motivated to improve the result

From task to students producing poor result and a teacher using different techniques to prove students that their result is poor and keeping them motivated to improve it. Among others, the techniques which a teacher can use may be feedback, explanation, giving an example or even a strategy building as we saw in the 1.11 case.

The second main link skips the task and starts directly with the TASK WITH OBSTACLE/LIMITATION. When students try to do the task there are offered they fail to do it, feel stuck and do not know how to proceed. In any case, both two links end with obstacle. So the third link is the link between the obstacle and the strategy building. As mentioned elsewhere, two options were observed: (a) OBSTACLE – BUILDING A STRATEGY and (b) OBSTACLE – FINDING SOLUTION. If in the first case, the strategy which is build is more general and can serve for solving different tasks of the same type, then in the second case, students find the solution for a specific task. In both cases, in order to build a strategy or find a solution, students are introduced to or reminded of a meta-tool. As remarked by T8-dj, application of a meta-tool should be modelled for students before they can apply it themselves. Another comment which is close this idea of modelling of the use of a meta-tool is linked with the sub-category 1.3 *work on the concept of ENV, from simple task of organising information via ENV to task with obstacle*. According to two teachers – T1-

iv and T3-sg – at the initial stages it is useful to practice some parts of a meta-tool, such as an ENV tool, separately, in an easy context before giving students a content-related task with obstacle. These easy tasks can build the foundation for some of the skills which are required for working with the tools in a more abstract or more complex context:

“I don’t think I always move from Step 1 to 2. Sometimes I’ve started by finding out what they know already and introducing new vocabulary (eg families) by building up something that looks a bit like an ENV model using both pictures and writing, although I haven’t spoken about it as a model at all. We’ve been categorizing family members and looking at what they’re like. The actual challenge is going to come shortly when they have to sort pictures of families in different ways. To do this they’ll have to find different parameters and I’m not sure they’ll realize the original model could help them.”

(T3-sg; sub-category 1.3 (work on the concept of ENV) from simple task of organising information via ENV to task with obstacle)

Speaking about links to REFLECTION we could observe that it either comes at the stage of an obstacle, to remind students of a meta-tool and their previous experience, or after the strategy was built to make the process and the used meta-tools explicit to students.

Two more sub-categories which were identified for the first category of different transition means to move from step to step belong to one teacher – t13-am – and assume that the transition can be done by modifying or postponing the task.

“It happened that the task had to be changed, modified to suit the situation, (or then postponed till the next time, which is quite uncertain ...) I think I lack to fulfill this part.”

(t13-am; sub-category 1.1 and 1.2 modifying task, postponing task)

The given understanding is rather unclear in terms of what the teacher meant so it is left without any comment or interpretation.

The second category identified for the third question is (2) the sequence of steps that teachers see when they work with the thinking task framework. The given question did not reveal any surprising results. The teacher spoke about a mere movement from (2.1.) step 1 to step 2 and step 3, to some additional steps within other steps, as for example (2.5.) from step 1 to step 2 to step 3 and back to step 2 and 3 again before closing the loop with step 1:

“or it can take much longer...the reflect-rebuild or reflect-redesign cycle can happen many times before the students are ready to move on to step 1 again”

(T8-dj; sub-category 2.5. 1-2-3-2-3-2-3-1)

In addition to two main categories, some ideas on how teachers define each step were collected. They are self-explicit and presented in Table 31 above.

Aspect of teachers' problems: results

The last aspect which was revealed during the analysis and which was not initially present in the questions teachers were asked is the aspect of problems and difficulties that teachers experience while trying to put into practice the Thinking Task Framework. Comments of eight teachers were identified to contain information about problems: T1-iv, T3-sg, T7-ku, t9-ls, t10-kg, t12-gj, t13-am, and t14-el.

Table 32 Results for additional question of Study 1

Additional Question: Which concerns or difficulties do teachers experience?					
1 Motivation	2 Students accepting challenge	3 Treating students' results	4 Students developing strategies	5 Final result to aim at	6 Organisational issues
1.1. Mixed abilities	2.1. control degree of challenge	3.1. reject result 1	4.1. target user of strategy	5.1. short-term final result for teachers	6.1. note-taking
1.2. Age peculiarities	2.2. make students succeed	3.2. how to deal with answer	4.2. individual vs collective	5.2. long-term final result for teachers	6.2. time of activity
	2.3. create cognitive conflict	3.3. uniformity of results	4.3. procedure for developing strategies	5.3. quality criteria	6.3. organising students' conclusions
	2.4. interpret students' reaction		4.4. language difficulties		
	2.5. choose group vs individual work				

Six main groups of problems were identified (see Table 32) all of them having more or less the same number of sub-categories. Apart from a few sub-categories only, almost all the sub-categories were identified for one teacher only, which may indicate that teachers are at different level of mastery of the Thinking Task Framework and thus sharing some general problems (on the level of a category) do not experience the same specific problems (on the level of sub-categories).

Three teachers - T3-sg, t12-gj, and t13-am – expressed concern about **(1) keeping students motivated**. The problem seems to arise either due to mixed ability classrooms that teachers work in or students' age peculiarities:

“As you mentioned there is a problem with keeping children motivated, so the tasks need to be ... bendable. But then I have a problem when some children could go on and on and are really very inventive. I see we could really come far .. while the others are not there yet. I think it may be seen as more obvious at this age, the paces they are growing in are so diverse .. and they are so different as well. How do you deal with it? I would love it if all could be active to some extent.”

(t13-am; sub-category 1.1. mixed abilities)

“I agree with your comments, Geidre! It's sometimes hard to keep the children motivated (also 9 - 12 year olds!) and I sometimes forget how short their attention span is, so even if something is going well, you have to be ready to change direction quite soon.”

(T3-sg; sub-category 1.2. age peculiarities)

The given concern is probably not specific to the problem-centred education since the issue of teaching mixed-ability classrooms as well as adapting lessons to age peculiarities is rather common.

The second concern which was mentioned by four teachers - T1-iv, T3-sg, T7-ku, and t9-ls – is connected with **(2) making students accept the challenge**. The most frequent sub-category identified is connected to (2.1.) controlling the level of challenge and (2.3.) creating cognitive conflict. All other sub-categories were

identified only once for one teacher each. Even though teachers expressed their ideas in the previous questions on how they work on creating cognitive conflict, this still remains for them a difficult task to do.

An interesting category is connected to the difficulty of **(3) treating students' results**. Since one way of creating cognitive conflict is to make students see their result is poor, one potential problem mentioned by t14-el and t9-ls is (3.1) how to reject students result, in other words how to make students see that their result is poor:

"The other thing. I personally like the idea of creating challenges in those areas where you described them, at the same time, it seems that in many of your tasks there is no a direct outcome of children solutions. It means, they are not directly responsible for the outcome. What happens if they stick to their idea of singing - it still seems there is nothing bad. How do you explain them the consequences of "wrong solutions"?"

(t14-el; sub-category 3.1 reject result 1)

Another group of difficulties is the one connected to the stage when **(4) students develop their strategies**. The first concern expressed (4.1) merely refers to a teacher's misunderstanding of the aim behind the strategy and its target user:

"But I have a question here, for whom is the student creating the algorithm? For his own use or for others?"

(t10-kg; sub-category 4.1.target user of strategy)

The given concern may reflect a wider misunderstanding of a teacher behind the Thinking Task Framework and the problem-centred education in general.

The second concern is connected with the difficulty of how to solve the contradiction of (4.2) collective versus individual. Students work in a classroom and work on developing a strategy, so the strategy has to be similar for every student. At the same time each student builds his understanding at his own level and pace so his initial strategy will definitely be unique and different from that one of his peers. At the end, everyone should come to the same understanding. The question of how to balance

this individual versus collective is a problem a teacher has to solve while thinking of how to organise strategy building:

“Sorry, I have a few more thoughts that I would like to be discussed. Like if they are writing the algorithm for their own selves, it would be quite different for each student (faced with the same task). As we know each student has a unique way of thinking. Is it then right that we get them to create the same algorithm?”

(t10-kg; sub-category 4.2.individual vs collective)

In two last sub-categories, one teacher (t9-ls) is speaking about a general difficulty of organising the procedure of strategy building while another one (T3-sg) is referring to a specific language difficulty since she is teaching English to young learners so the foreign language difficulty comes into play for her.

The fifth group of concerns identified in two teachers' replies (T3-sg, t9-ls) is **(5) their awareness of the final result to aim at**. As it was mentioned elsewhere in the theoretical part of the research, it is important to plan the teaching-learning process from the aim (what do I want my students to learn), rather than activities (what do I want my students to do). Moreover, the aim should be formulated on different levels where short-term aims and objectives are connected to the long-term ones. Another important aspect is that not only teachers but also students should be aware of the aim. The first concern (5.1) shows that both teachers do not sometimes visualise the final result (which can also be a strategy) that they want to lead their students to. In other words, it is probably sometimes unclear for teachers what they want their students to learn in terms of the 'thinking content':

“The challenge in tasks d and e lies in achieving the anticipated outcome: keeping to the author's style find the linguistic means to create the text in which the characters will be not schemes ('She is busy. He is lazy.') but real people described through their actions, talks, deeds and in accordance with the genre and the plot of the original text. I am learning to do it myself - slowly though. The major difficulty for me is to visualise what should be 'the best' result myself. I understand there is no end to perfection - but still.”

(t9-ls; sub-category 5.1 short-term final result for teachers)

“reading the posts, I think I'm like Geidre, Alenka and Larissa in finding the algorithm difficult, and I can't imagine yet quite how it should look, or how to present it...I will have to practise myself as well.”

(T3-sg; sub-category 5.1 short-term final result for teachers)

The sub-category 5.3 quality criteria is connected to the 5.1 since it speaks about the means of assessing the quality of the final result, what do we lead our students to and what are the criteria to assess the final result:

“Another difficulty is to provide descriptors for evaluation criteria.”

(t9-ls; sub-category 5.3 quality criteria)

The last difficulty mentioned is connected to long-term planning and long-term final result that a teacher finds difficult to visualise. This concern is connected to continuity in planning, building a system of problem tasks:

“I think this idea you're talking about of systems of challenges makes clearer what I'm lacking at the moment - to know where I'm going beyond the next few lessons. At this stage each part of the process seems to take a lot of time, and then suddenly we've done it, and I think, 'What next?!' Of course I should know what next, and that's what I have to move on to.”

(T3-sg; sub-category 5.1 long-term final result for teachers)

The **final group** of difficulties which was identified is referred to as **(6) organisational issues**. It has three sub-categories, each identified for one of the three different teachers: T1-iv, T7-ku and t14-el. These difficulties are connected to the teachers' concern about (6.1) how to organise students' note taking while they develop their strategies and (6.2) write their conclusions, as well as concern connected to (6.2) time limit that every teacher face and the enormous amount of content which students have to acquire.

These are the main results which were revealed during the content analysis of teachers' written responses to questions. These results give us the first insight into different teachers' perception and understanding of the Thinking Task Framework.

However, what do these results tell us about individual teacher's teaching praxeologies. What can we discover about teachers if based on these results we try to build their praxeological profile in respect to the types of tasks connected to the application of the Thinking Task Framework? The following sub-chapter is trying to reveal the answer to this question.

3.2.4. Discussion of the Results: Description of Teaching Praxeologies

In order to reveal teaching praxeologies, I analysed separately each teacher's replies. The analysis revealed that only four teachers out of eleven (including two teacher trainers) have provided answers which allow building a full profile. These are T1-iv, T3-sg, t11-au and t12-gj. Other teachers did not provide any information on one or more questions.

The analysis revealed that the praxeological equipment of T3-sg and T1-iv were the most qualitative and may show a deeper understanding of how the Thinking Task framework has to be operationalised. The richest praxeological equipment was identified for T3-sg teacher for whom the biggest number of categories and sub-categories was identified.

Looking at the type of task "creating and identifying challenges" (Figures 23, 24) we can see that both teachers speak about three techniques of how this type of task can be achieved. They both speak about certain types of tasks, specific characteristics which a task should have and the need to vary the level of challenge. What is essential is that while speaking about types of tasks, they do not merely list different tasks, such as a game or a sorting task but are also aware that a task should contain an obstacle if we want to produce a cognitive conflict in learners' minds.

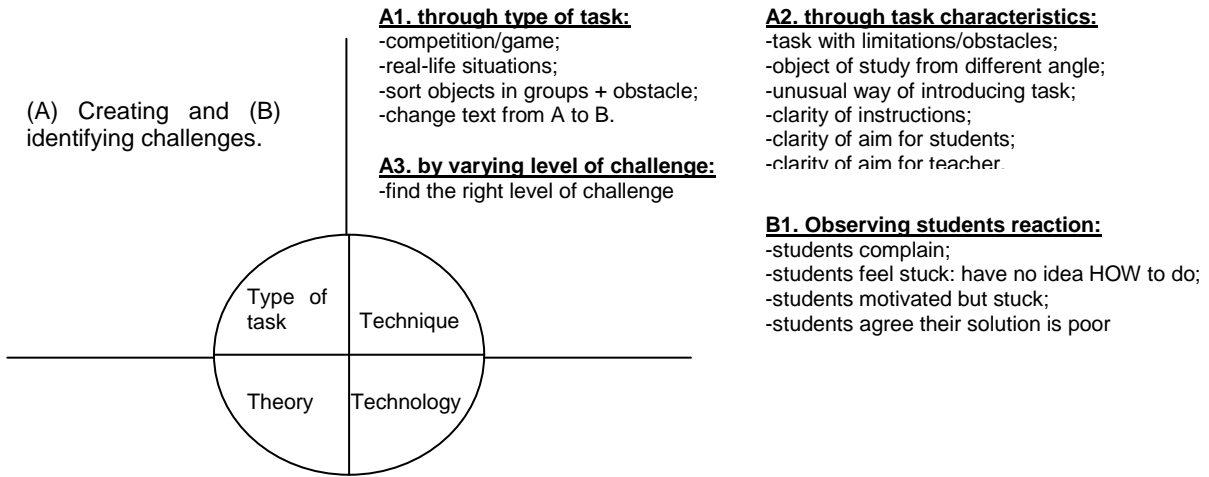


Figure 23 Praxeology of T3-sg. Type of task: creating and identifying challenges.

It's not a game or a sorting activity as such which creates a cognitive conflict, but rather an obstacle which learners face while doing this task, an obstacle, which makes it explicit for learners that there is something they don't know or are not able to do. This is this obstacle which produces a certain students' reaction indicating that the challenge is present: students want to do the task but don't know how.

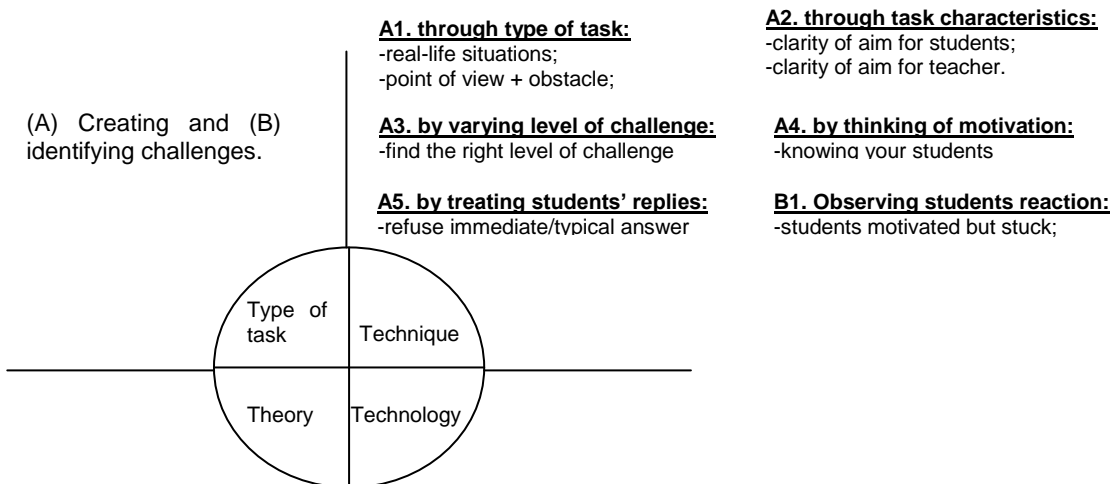


Figure 24 Praxeology of T1-iv. Type of task: creating and identifying challenges.

In addition, T1-iv also mentions that the task should allow refusing the immediate, typical answer produced by students. If the result students produce is acceptable, there is no room for cognitive conflict to appear in their minds. T3-sg adds that a teacher can understand that a challenge is accepted by students if students agree that the result they produced is poor or not qualitative enough:

“or they might think they know how to do it, but through feedback become aware they need to be able to do it better or in a different way. If it’s easy and they do it at once and ‘correctly’, it’s not, of course, a challenge.”

(T3-sg; Q1b: by observing students’ reaction. Sub-category: students agree their solution is poor/wrong)

Moreover, both teachers mention that the aim of the task should be both explicit for learners and very clear for teachers who should have a vision of why they create this challenge, what exactly they want their students to learn:

“I think what’s similar in creating these challenges is that whether it’s a game or a written piece of work or whatever, the aim has to be very clear.”

(T3-sg; Q1a: through characteristics of a task itself. Sub-category: clarity of aim for students)

“Speaking about creating the challenge, I think we need to understand why we need the challenge, what its function is. In my view it goes beyond just motivating the students. I think there can be 2 groups of creating challenges, from the teacher’s perspective and from the student’s perspective. The first is a system of challenges the teacher foresees or/and plans in the course of working within one theme or several themes. It is based on the teacher’s aims, results they want to achieve, student’s skills to be developed. I find this wider vision of ‘challenges or a system of challenges’ very useful to more clearly understand where we are with the pupils at a particular moment and where we are moving to. This system will also help us change or vary the levels of the difficulty of the challenge at different stages with different students [...]”

(T1-iv; Q1a: through characteristics of a task itself. Sub-category: clarity of aim for teacher)

To sum up, the praxeological equipment of T1-iv and T3-sg for the type of task “creating and identifying challenge” is rich and depicts a clear detailed picture of teachers’ vision of how cognitive conflict can be created in the minds of learners. If we combine both visions, then we get a complete picture:

A challenge can be created if a teacher offers a task, which has certain limitations/obstacles. In other words, students should either fail to produce the result or the result they produce should be of a poor quality. We can consider it to be achieved if we observe a certain students’ reaction: they want to do the task but do not know how to do it or they agree that what they produced is of a poor quality and has to be improved. Certain types of task have more potential to reach this result: a game/competition, point-of-view task, a task which requires sorting objects in groups or changing a text from A to B, etc. In any way, in all these cases, introducing certain limitation in a task is the key. If the task is contextualised or presented as a real-life situation, it has more potential to motivate students and thus, make them accept the challenge. One more essential aspect is that the aim of doing the task should be explicit for learners, they should be aware of what kind of a learning problem they are going to solve by doing the task, what they are going to learn, which competences develop. The same holds true for the teacher, it is essential that a teacher links the task to learning aims and objectives on different levels.

Let me now look at the praxeological equipment of two other teachers (Figures 25, 26) – t11-au and t12-gj - who provided enough information to build their more or less full profile. The two teachers share some categories with the previous teachers on how cognitive conflict can be created. These, for instance, include A1.and A2.categories: through type of task and through task characteristics. However, only t12-gj mentions the need of obstacle and speaks about the need to refuse typical answer (A3.category). The t11-au teacher merely lists different tasks without giving a clear idea on how they can create a cognitive conflict. Moreover, t11-au mentions that a challenging task should be open-ended (with more than one possible answer).

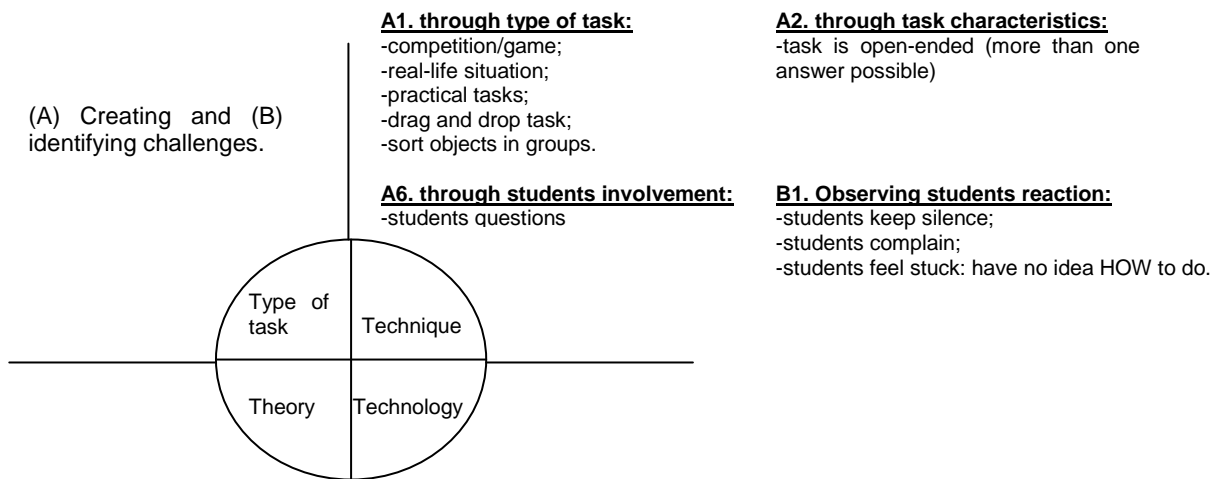


Figure 25 Praxeology of t11-au. Type of task: creating and identifying challenges.

Without denying that a challenging task can have more than one possible answer, it is unclear how an open-ended task can create a cognitive conflict:

“In general, it is best to give an assignment that will not have an exact answer and in which we would teach continuity.”

(t11-au; Q1a: through characteristics of a task itself. Sub-category: task is open-ended)

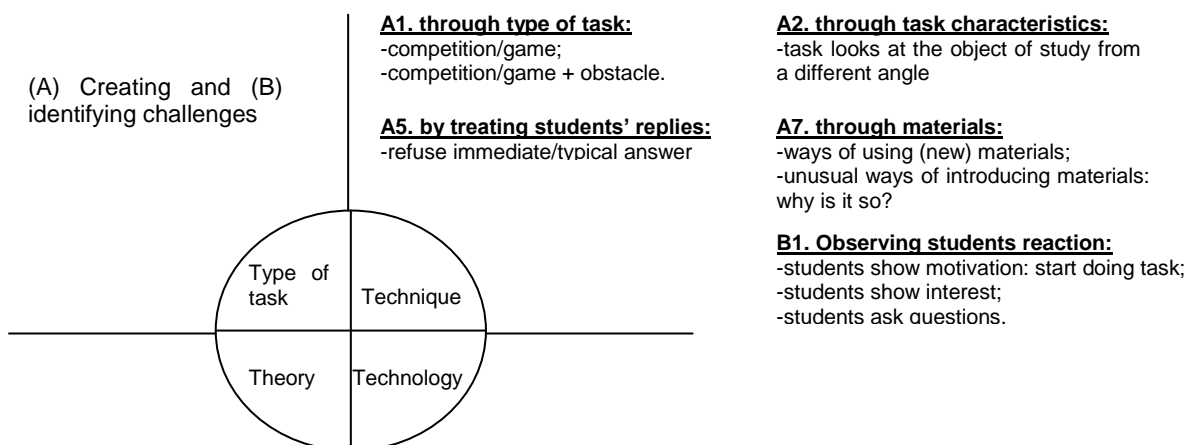


Figure 26 Praxeology of t12-gj. Type of task: creating and identifying challenges.

One more sub-category identified for t11-au, claims that a cognitive conflict can be created if a teacher uses students questions (A6.). Just as with the previous example, it does not provide explanation of how exactly it could be done. As a result, we can sum up the technique of t11-au in the following way: in order to create a cognitive conflict a teacher should offer a certain type of a task, such as a sorting task, a drag and drop task, a game or a competition or any open-ended task. If the task is connected to a real-life problem or includes a practical activity, it can be more motivating for students. As we can see from the given summary, the essential elements which truly lead to cognitive conflict are absent from the teacher's praxeology.

As mentioned above, the praxeology of t12-gj includes the need of obstacle and the need to refuse typical answer. Apart from that, she mentions that a task which allows looking at the object of study from a different perspective has more potential to create cognitive conflict. In addition, bringing new materials and introducing them in an unusual way can also increase that potential. So we can see that some elements that can lead to cognitive conflict are present, while others connected to the aim of the task are still absent.

Taking into account that the notion of the aim is absent from the both teacher's reflections we can assume that both of them begin their planning from the types of a task (t11-au) or from materials (t12-gj) rather than students' learning. As reported by some scholars (Peterson and Clark, 1986 in Anderson, 2004, p. 47) there is ample research evidence that a large number of teachers begin their planning with what they want their students to do (classroom activities) rather than with defining what they want their students to know (aims, competences, standards). That might also be the case for t11-au and t12-gj.

The next type of task for which teachers' praxeologies could be constructed is 'getting students accept challenge'. It can be interpreted in several ways, such as how do you keep students motivated to do the task in general (because it may seem

difficult to them), how do you make students agree the result they produce is poor, or how do you motivate students to build the strategy in order to cope with the task.

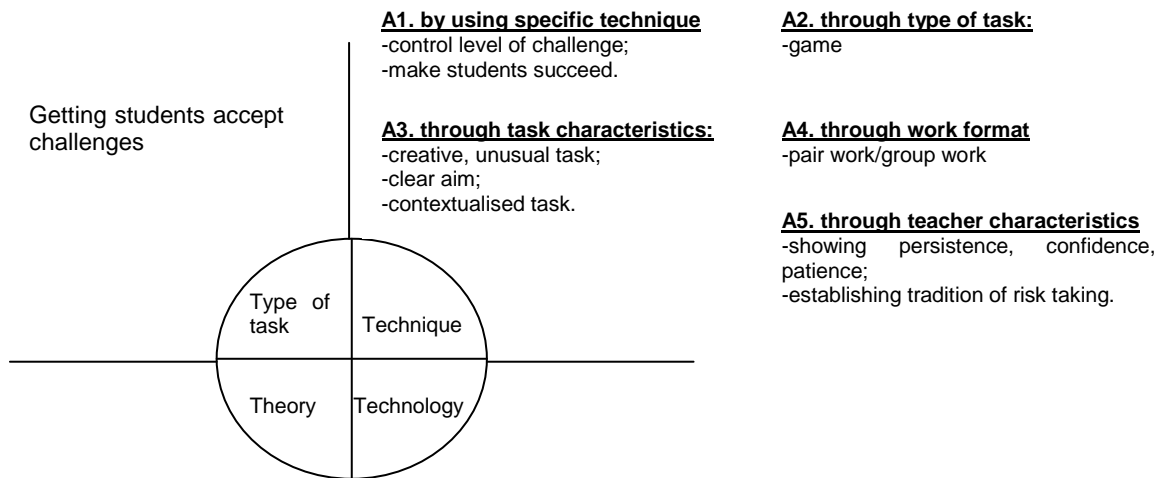


Figure 27 Praxeology of T3-sg. Type of task: getting students accept challenges.

Just as with the first type of task, the richest praxeological equipment was identified for T3-sg teacher (Figure 27), followed by t12-gj (Figure 28) and t11-au (Figure 29). Only one technique was identified for teacher T1-iv.

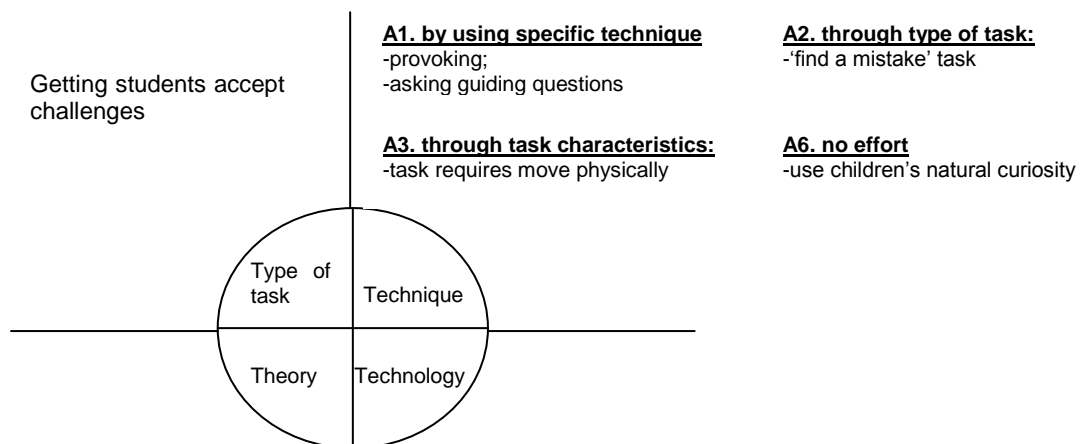


Figure 28 Praxeology of t12-gj. Type of task: getting students accept challenges.

T3-sg again evokes the idea of aim being clear for students if we want them to accept the challenge. Moreover, she adds that students will be motivated if a teacher helps them to feel they succeed with the task, despite the initial experienced difficulty:

“They have to gradually build successful experiences and have a feeling that they know they’ll be learning and moving on.”

(T3-sg; Q2: by using specific technique; Sub-category: make students succeed)

This is important since the cognitive conflict has to be positively resolved and students should feel that both strategy building and meta-tools they use are meaningful and truly help them improve their learning. In the opposite case the tasks will feel meaningless and the motivation will be lost.

Among other aspects, T3-sg also evokes the importance of a teacher showing certain character traits and establishing a certain classroom tradition which allows getting students accept challenges and be eager to solve them.

“It helps if there’s an atmosphere of ‘trying’ in the classroom, of being willing to try things out and take risks. I think this can be encouraged and fostered, but it’s not easy at first if the pupils are used to being ‘spoon-fed’ and learning is directly related to tests. I’ve noticed that pupils love their old routines and are happy to settle for less (thinking!). They do feel proud when they’ve done a hard task though, so the first tasks maybe need to be manageable.”

(T3-sg; Q2: through teacher characteristic; Sub-category: establishing tradition of risk taking)

T1-iv is the one who also mentions the technique of teacher characteristics being important for making students accept challenges. Together with S3-sg she speaks about the importance of a teacher being confident, patient and persistent. However, T1-iv also adds that persistence alone is not enough and “[...] *should be backed up with other motivations, otherwise it won’t work for long especially with 6 grades [...]*” (T1-iv. Q2: through T characteristics; Sub-category: showing persistence, confidence, patience).

As seen from Figure 28, the techniques mentioned by t12-gj include provocations, making students move physically and offering specific types of task. What is remarkable is that t12-gj claims that sometimes it is not difficult to challenge pre-school students since they possess natural curiosity and are motivated to follow the task as long as it is presented as a problem:

“Sometimes it is not difficult to deal with challenges (for preschool kids sometimes problems looks the motivation factor because they are curios and they want to find the answer).”

(t12-gj; Q2: no special effort; Sub-category: use natural curiosity)

This kind of a comment can be alarming. On the one hand, it is true that pre-school children just as young learners have natural curiosity so it may facilitate teacher’s task of motivating students to work within the problem-centred framework. At the same time, it can be a risk for a teacher leading her to think that any task she offers is good enough for creating cognitive conflict and making students accept it. The question is always which task is more effective and would lead to the development of problem solving competence and which one would be of a lesser efficiency. In the case of t12-gj it would be worth asking a teacher what would be a difference between her usual tasks and new problem tasks which are advocated by the problem-centred education.

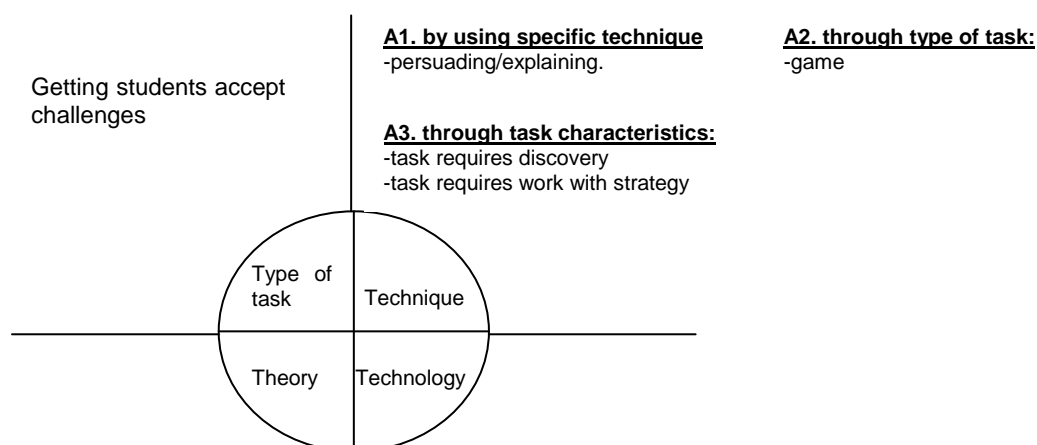


Figure 29 Praxeology of t11-au. Type of task: getting students accept challenges.

The last praxeological equipment to look at is that one of t11-au (Figure 29). As seen from the obtained responses, the teacher believes it is enough to offer a game or a task with some characteristics in order to make students accept the challenge. Explanations and attempts to persuade are also among the options. Without denying that these techniques may work, we can doubt if they are enough for reaching effectively the objective of keeping students motivated to do the challenging tasks.

The last type of task for which praxeologies could be constructed can be named 'moving from step to step in the problem-centred instruction'. As discussed in the sub-chapter above, two main categories were discovered in teachers' replies. The first one regroups different transition means from step to step and the second one merely mentions the sequence of steps. So basically the second category does not provide a lot of meaningful information on HOW the transition is done, but merely lists the sequence. All four teachers for whom the praxeology is being constructed provided some information on the question but only three of them – T1-iv, T3-sg and t12-gj – were speaking about the real transition means, while t11-au merely listed different sequences of steps.

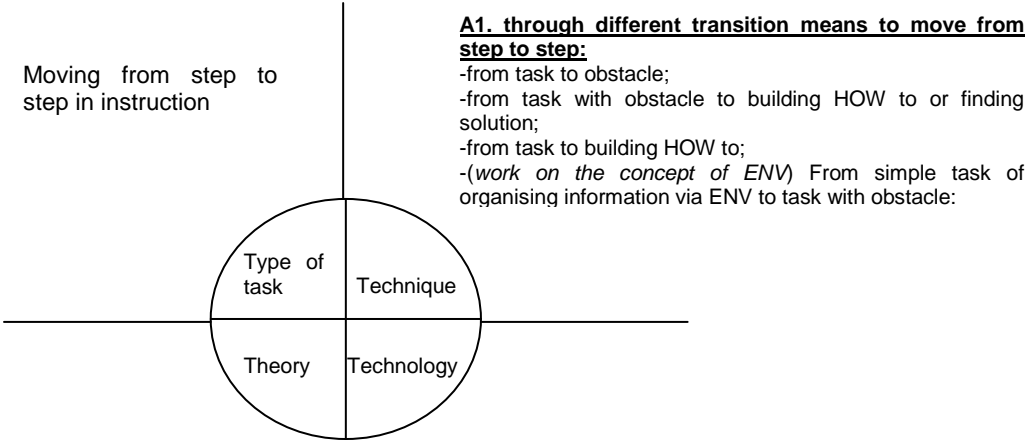


Figure 30 Praxeology of T3-sg. Type of task: moving from step to step in instruction.

Just as in the two previous cases the praxeology of T3-sg was the richest one (Figure 30). She listed four different transition means. There can be a task which leads to obstacle, there can be a task directly with the obstacle and there can be a task which

avoids obstacle and moves to building the strategy. The last category, namely, from simple task of organising information via ENV to task with obstacle, T3-sg shares with T1-iv (which is the only technique identified for T1-iv):

“I would agree with those who think that there is needed a step before step 1, when we work with the elements of ENV for example, not doing a more complex challenging tasks of step 1. At least that is what I find useful. I am not sure if it is right, maybe I need it because I just can't properly and naturally integrate the tools(e.g. ENV) into the procedures of doing the task but referring to these activities later when doing more complex task is easier, if the pupils have had this practice. What I mean is doing several simple tasks on comparing things like objects in the classroom, people in the classroom helps pupils understand the idea better, because very often it is really difficult for kids to do this, making a proper comparison, even in senior grades.”

(T1-iv. Q3: different transition means to move from step to step; Sub-category: from simple task of organising information via ENV to task with obstacle)

So we can say that T3-sg shows awareness of different transition means, while T1-iv mentions only one, t11-au speaks only about sequence of steps without giving details on how this transition can be done and t12-gj has only one technique in her equipment, that one of 'from task to obstacle'. And to complete the picture, if we look at the problems which the teachers evoked in their reflections then we will see that nothing was identified for t11-au, t12-gj mentioned difficulty connected to motivating mixed ability classrooms and both T1-iv and T3-sg evoked a number of problems:

T1-iv	Students accepting challenge	<ul style="list-style-type: none"> • controlling degree of challenge • making students succeed • creating cognitive conflict
	Treating students results	<ul style="list-style-type: none"> • when and how to deal with answers
	Organisational issues	<ul style="list-style-type: none"> • organising students' conclusions
T3-sg	Motivation	<ul style="list-style-type: none"> • for mixed ability classrooms • due to age peculiarities
	Students accepting challenge	<ul style="list-style-type: none"> • controlling degree of challenge • creating cognitive conflict
	Students developing strategies	<ul style="list-style-type: none"> • language difficulty
	Final result to aim at	<ul style="list-style-type: none"> • short-term final result for teacher • long-term final result for teacher

Expressing concerns is not a negative sign. On the contrary, it shows that teachers are aware of the difficulties and are thinking of how to take certain constraint into account while planning and running their lessons. Awareness of the problem is the first step on the way to finding a solution.

After reviewing in details teaching praxeologies of four teachers and having the analysis of all other teacher's reflections I can tentatively make some conclusions:

1. While speaking about creating cognitive conflict, some teachers seem to believe that certain types of tasks are able to do the job and create a cognitive conflict themselves. They seem not to be aware of one of the essential components that unifies those types of tasks, that is **limitation or obstacle**. A limitation can be that of time, number of objects and their characteristics (parameters and values), certain level of quality shaped by context, etc. This component is not mentioned in reflections of some teachers who focus on enumerating types of tasks which as they claim help them to develop cognitive conflict. For instance, it was seen in the praxeology of the teacher t11-au. Among those teachers whose praxeology was not discussed in details, this is also the case for the teacher t10-kg. For all other teachers an obstacle was either evoked at least once or the teacher did not provide any response for that question at all.
2. The component of **aim** behind any task is also one of the components which may be an indicator of a better teacher's awareness of how cognitive conflict can be created. It shows that a teacher is not planning her lessons from tasks but has a more systemic planning and is inclined to think of the aims of learning and to link them with the tasks which serve to reach those aims. It is also worth mentioning that planning from the aim is not relevant only for the problem-centred education. This is the competency which any teacher should normally have. So we can assume that if a teacher has the idea of planning for the aim in his/her praxeological equipment for organising a teaching-learning process, then she will be more successful in developing tasks which could cause cognitive conflict in learners' minds. Among the praxeologies which were described in details, both the praxeology of T1-iv and T3-sg evoke the

idea of aim being important element of a problem task which has the potential to create cognitive conflict. Among those praxeologies which were not analysed in details only T6-as evokes this idea, while other teachers either simply do not mention it or did not provide any information on the question at all.

3. One more conclusion concerns the way of moving from step to step of the Thinking Task Framework, which in fact reflects how exactly a teacher's instruction unfolds. Basically, we can assume that if a teacher is not capable of describing how (s)he moves from step to step, we can say that (s)he does not visualise what exactly happens in the classroom and how the tasks will unfold. A teacher may succeed in creating a cognitive conflict, however, if what follows after is unclear for the teacher, the instruction will be definitely deemed to fail. This competency has a direct connection to the instruction related to the problem-centred education since it requires visualising the entire process with important elements of the problem-centred education - from giving students a task, to dealing with creating cognitive conflict, and moving to building a strategy with the help of a meta-tool incorporating reflections on different stages of the process. The analysis revealed that t11-au does not provide any explanations on how the transition can be effectuated apart from listing a sequence of steps. While T1-iv and t12-gj give one way of making this transition, this is T3-sg who gives four options. One of those teachers – T8-dj - whose praxeology was not described in details mentions at least three ways of moving from step-to-step, which in some cases correspond to those mentioned by T3-sg. The transitions described being meaningful, we can assume that the teaching-learning process she organises for her students may have important features of the problem-centred education (PCE). Unfortunately, T8-dj did not provide any information for any other question teachers that were asked, which restrains us from making more definite conclusions on her praxeology in the domain of the PCE.
4. The results of my analysis show that this is T3-sg who was identified to have the richest praxeology which combines all the components essential for the

problem-centred education (all those which could be identified from the questions teachers were asked). However, the analysis showed that the teacher is also aware of other important components which are not exclusive for the PCE but belong to the general domain of effective teaching. For example, the importance of the aim and its clarity for students, as well as the need to create a classroom atmosphere which would be open for risk-taking and problem solving as such. These were not included explicitly in the Thinking Task Framework and were not touched during the seminars the teachers participated in. Therefore we can claim that they were present in the teacher's repertoire beforehand. We may assume, thus, that having these competences may play an important role in helping a teacher easier integrate specific components of the problem-centred education into his/her instruction. Moreover, they may not only help to integrate something superficially but rather build a new system out of old and new components. This, however, remains only a hypothesis so far.

After interpreting and discussing the results, it is important to mention some limitations of this study and the presented conclusions.

First of all, the three respondents – T6-as, t14-el and to some extent T1-iv – were having the roles of teacher trainers and did not have the task of answering all the questions but rather had to ask additional questions or provide their additional comments on other participants' replies. This can explain why a lot of information was not collected on their praxeologies. We may have revealed more on, for instance, praxeological equipment of T1-iv if she was asked to fully participate in the reflective written session.

Secondly, the teachers were free to respond to those questions which seemed clearer for them and that they wanted to discuss their understanding on. Therefore, if information was absent for some questions we may not assert that the teacher has no understanding of that aspect. It may be the case that the teacher merely did not share his/her understanding. At the same time, if the response was provided and lacked essential elements, we may assume that this is not merely due to

forgetfulness but rather due to the fact that a certain component is absent from that teacher's praxeology.

And the last limitation we have to take into account is related to the nature of the study. We have taken a qualitative approach to data analysis and would need to collect more data in order to support our first conclusions on teaching praxeologies of teachers. Otherwise, the tempted conclusions are based on too few facts. Despite this need, the first analysis allows us to make first hypothetical conclusions leading towards a deeper understanding of the question of teaching praxeologies for the problem-centred education as well as towards new study and new data which can complete our first conclusions or shed light on new aspects that I failed to consider in the first study.

3.3. Study 2: Analysis of Instructional Patterns of Experienced Teachers

The second study deals with the analysis of how teachers put in practice the three-step lesson structure depicted in the Thinking Task Framework (TTF). In other words, this is the analysis of teachers' classroom behaviour or otherwise called classroom instruction.

3.3.1. Aim of the Study and Data Collection Method

After dealing with teachers' understanding, it was important to pay attention to the real teachers' practice and see how certain understanding manifests itself in the true classroom situations. For this purpose, the study of teachers-in-action was undertaken.

The aim of the study was to identify instructional patterns of experienced teachers who build their instruction through three steps (problem task – building solution –

reflection) within the framework of the problem-centred teaching-learning process and to compare it to the instructional patterns of other less experienced teachers.

The question guiding the study question was the same as in the first study: What are teachers' praxeologies in respect to the three steps of classroom instruction?

Participants of the study were three teachers who have more experience in organising the problem-centred teaching-learning process and two teachers who at the moment of the study had less experience in the matter.

The more detailed information on the experienced teachers and the reasons for labelling them as experienced is presented below:

- T1-iv is an English as a foreign language (EFL) teacher, the head of the English language department in the secondary school in Latvia (Daugavpils). She had more than 10 years of teaching for thinking experience working with the problem-centred education. Results of her expertise were supported by the research.¹¹⁹
- T2-nk is a Russian as a mother tongue teacher, the head of the Russian language department in the secondary school in Latvia (Daugavpils). In 1997 she received the title of the best teacher of Russian as a mother tongue. She had more than 3 years of experience of working with the problem-centred education. In addition, she had more than 10 years of experience of working with the Developmental Education¹²⁰.

¹¹⁹ Refer to the following article for more details on the results: Sokol A., Oget D., Sonntag M., Khomenko N. (2008). The development of inventive thinking skills in the upper secondary language classroom. *Thinking Skills and Creativity* 3 (2008). ELSEVIER. 34-46.

¹²⁰ For references on Developmental Education (from Russian, Развивающее обучение), check the following authors Leont'ev A., Davidov V., Elkonin D., Repkin V. (from Russian, Леонтьев А., Давыдов В., Эльконин Д., Репкин В.).

- T6-as is an EFL teacher in a secondary school in Latvia (Riga) with more than 10 years of teaching for thinking experience working with the problem-centred education. Results of his expertise were supported by the research.¹²¹

The non-experienced teachers are those who have no strong background in any thinking-related education and no data is available to support their expertise.

- One teacher is an EFL teacher in Daugavpils (Latvia) who worked with basic school students (Form 5, 11-12 year olds) and had only one year of teaching for thinking experience (T4-os) at the moment of the study.
- Another teacher is EFL teacher in Eura (Finland) who worked with primary school students (Form 3, 9-10 year olds). This teacher (T3-sg) was selected for the study since the results of my previous study described in Chapter 3.2 showed that she had the richest praxeology which combines all the components essential for the problem-centred education (all those which could be identified from the questions teachers were asked). She was relatively new to the approach but has already showed some positive progress so it was interesting to see the similarities and differences between her real classroom instruction and that one of more experienced teachers. Moreover, lesson filming being a difficult endeavour in educational research, I benefited from the possibility of having her lesson filmed and available for the analysis.

Data collection method

- First of all, I obtained the permission from T1-iv and T2-nk for observing and filming their lessons during which they were purposefully working through the three steps of the Thinking Task Framework organising the problem-centred teaching-learning process.

During one month, from Sep 2013 to October 2013, I was attending and filming the lessons of these teachers, occasionally recording their comments on their own lessons. As a result 25 lessons (40 minutes each) were filmed for T1-iv. These were lessons with forms nine (one group) and 11 (two separate

¹²¹ Refer to the following article for more details on the results: Sokol A., Oget D., Sonntag M., Khomenko N. (2008). The development of inventive thinking skills in the upper secondary language classroom. *Thinking Skills and Creativity* 3 (2008). ELSEVIER. 34-46.

groups). As for T2-nk, I managed to film 16 lessons (40 minutes each) with forms eight (two groups) and nine (two groups). The information about the recorded lessons was summarised in a form of a table with details that would allow me to track the data (see Appendix 7).

- The permission was obtained from T3-as to use the video recordings of his lessons, which the teacher filmed himself when he was working with his secondary school students in 2009 in a secondary school in Latvia (Riga). These lessons were organised within the framework of the problem-centred education.

As a result, three lessons (40 minutes each) were received in video files. All the three lessons are with forms 11, two lessons with the same group and one lesson with the second group. Moreover, one more video was obtained from T3-as lesson held with form nine in November 2013 in a secondary school in Latvia (Daugavpils).

- As what concerns non-experienced teachers, the lessons of T4-os were filmed during the visits of the researcher to the school. T1-iv, T2-nk and T4-os work in the same school and were open to collaborate in the framework of the project they were involved in which facilitated the access to their lessons for the researcher. This was also one of the reasons why T4-os lessons were selected for the analysis. As it is known, it is always difficult to get access to real classrooms due to many reasons. Moreover, T4-os was a true novice in working with the Thinking Task Framework so she fitted the criteria of being a non-experienced teacher that could be compared to her more experienced colleagues.
- The permission was obtained from T3-sg to use video recordings of her lessons, when she was working with her class trying to implement the principles of the problem-centred education.

Data selection logic

In order to select the data for the analysis, the following logic was followed:

1. Four consecutive lessons of T1-iv held with the same group of form 11 were selected for the analysis. These were the lessons where the teacher started and continued working with the system of tasks to the text. Moreover, non-structured interviews of the teacher on her own lesson were recorded.
2. Two consecutive lessons of T2-nk were selected for the analysis since the teacher introduced a new grammar topic. Non-structured interviews of the teacher on her own lesson were recorded. The next four consecutive lessons were selected since these were held with the same group of students of form and teacher continued working with the same grammar topic. Non-structured interview of the teacher on her pre-last lesson was recorded.
3. Out of four available lesson videos of T3-as, I selected three since these were held during one year and in one school (Riga, Daugavpils) with the same age group of students (form 11).
4. It is worth highlighting again that during all the selected lessons teachers were purposefully working on organising their instruction through the three steps: problem task – solution building – reflection.
5. As for the non-expert teachers, during all the selected lessons the teachers worked on implementing the problem-centred teaching-learning process. T4-os also worked on introducing a new topic, therefore the lessons were considered to be relevant for the analysis. Non-structured interview of the teacher before and after one of the lessons was recorded. As for T4-sg, the choice was based on availability of the video material more than on whether it was an introduction to a new topic or not.

As a result, 13 lessons of experienced teachers were selected for the analysis and three lessons of non-experienced teachers (see Table 33 for details).

Table 33 Summary of data used for the study of teachers' instructional patterns

Teacher	Date	Form	Lesson	Additional data
T1-iv	September 17, 2013	Form 11 (group 1)	40 minutes (part 1)	Non-structured interview with T1-iv before the lesson (Appendix 8)
			40 minutes (part 2)	Non-structured interview with T1-iv after the lesson (Appendix 9)
	September 24, 2013	Form 11 (group 1)	40 minutes (part 1)	
			40 minutes (part 2)	

T2-nk	September 25, 2013	Form 8 (group 2)	40 minutes (part 1)	Non-structured interview with T2-nk after the lesson. T1-iv also participating in the talk. (Appendix10)
			40 minutes (part 2)	
	October 16, 2013	Form 8 (group 2)	40 minutes (part 1)	
			40 minutes (part 1)	
October 23, 2013	Form 8 (group 2)	40 minutes (part 1)	Non-structured interview with T2-nk after the lesson. (Appendix 11)	
		40 minutes (part 2)		
T3-as	2009	Form 11 (group 1)	40 minutes (part 1)	
			40 minutes (part 2)	
	2009	Form 11 (group 2)	40 minutes	
T4-os	September 09, 2013	Form 5 (group 1)	40 minutes	Non-structured interview with T4-os before and after the lesson (Appendix 23).
	November 27, 2013	Form 5 (group 2)	40 minutes	
T3-sg	May 22, 2014	Form 3 (group 1)	40 minutes	Teacher's description of the lesson and her reflections on it (Appendix 22).

3.3.2. Data Analysis Method and Procedure

In order to identify instructional patterns, the study employed the analytic approach to modelling the teaching process developed by Teacher Model Group at the University of California at Berkeley, Graduate School of Education (Schoenfeld, 1998a, 1998b, 2000, 2011). The Teacher Model Group developed the model of classroom teaching (teacher-in-action).

The core components of the model are based on the assumption that the teacher “has” knowledge, goals and beliefs, makes decisions and takes actions. The model of the teacher, thus, contains representations of knowledge, goals and beliefs attributed to the teacher, and the decision-making mechanism that suggests what actions the teacher is likely to take (Schoenfeld, 2000, p. 249). The model has a descriptive nature and can be used to characterize, in extremely fine-grained detail, what happens in a given teaching session and used for making predictions about teacher’s classroom instruction in various circumstances. The modelling has the following procedure (Schoenfeld, 2000, p. 253):

1. A transcribed lesson is parsed into large units delineating large-scale action sequences;
2. Each action sequence is in turn parsed into smaller units/action sequences (corresponding to smaller-scale action sequences), and so on down to the

level of relatively small linguistic units ("simple talk") on the order of a line or two of transcript.

3. Each action sequence contains the following information:
 - a. Triggering event;
 - b. Beliefs which were activated at this point;
 - c. Goal;
 - d. Type of action sequence (a routine, a scrip, an improvisation, etc.);
 - e. Kinds of knowledge the action sequence depends on;
 - f. Part of the lesson image to which the action sequence corresponds;
 - g. Terminating even (if any).
4. At least one goal corresponds to each action sequence.
5. A decomposition of the lesson into episodes is done with the methodology of competitive argumentation (VanLehn et al., 1984). The general idea of competitive argumentation is that "*it's the investigator's responsibility to consider all possible explanations of the situation being examined, and then look at the pro- and con- evidence for each. If every explanation but one is discredited, and that one is credible, then it's the best explanation*" (from the personal email correspondence with Alan Schoenfeld, January 01, 2014). The first parsing is then refined through multiple iterations.

The study of experienced teachers – T1-iv, T2-nk, and T6-as - followed the following procedure:

1. The researcher first transcribed all the six lessons of T2-nk;
2. The first two consecutive lessons (September 25, 2013) were then analysed together since they constituted one unit. The same was further done for two other lessons (October 16, 2013) and then, two remaining lessons (October 23, 2013).
3. The first lesson was divided into 6 episodes and the second lesson into 8 episodes (large action sequences) each containing brief summary of the content of that episode.

- Each episode (large action sequence) was then parsed into smaller action sequences going down to the level of 'simple talk' (see Figure 31 for an example of a parsed lesson). Each action sequence was characterized by triggering and terminating event, as well as beliefs, goals, and knowledge attributed to the teacher (see Appendices 12, 13, and 14 for parsed lessons of T2-nk).

First level parsing	Second level parsing	Third level parsing	Fourth level parsing
<p>[1.1] (1-13)</p> <p><u>Solve organisational issues</u></p> <p>Triggering event:</p> <p>Several students were not ready with their homework.</p> <p>Beliefs</p> <p>responsibilities should be clear and explicit to students</p> <p>Doing homework is important and</p>	<p>[1.1.1] (1-7)</p> <p><u>Solve problem of excuses for not doing homework</u></p>	<p>[1.1.1.1] (1)</p> <p><u>Introduce the issue</u></p> <p>[1.1.1.2] (2-3)</p> <p><u>Unexpected interruption. Solve issue with putting affairs in order.</u></p> <p>Emergent goal: Keep work space in order</p> <p>[1.1.1.3] (4-7)</p>	<p>[1.1.1.1.1]</p>

Figure 31 Extract of one example of a parsed lesson

- The discussion on the parsing was held with the peer following the principles of competitive argumentation. (VanLehn et al., 1984).
- After all the lessons were parsed, the researcher proceeded to identifying the action sequences where the teacher organised learners' work with the system of tasks (a problem task and sub-tasks) following the instruction defined by the Thinking Task Framework. The guiding question was to identify whether there is a specific pattern (routine) how the teacher worked through these tasks. After several modelling attempts, I managed to identify a certain pattern of how T2-nk works through the system of problem tasks. A draft model of this pattern was drawn.
- After that, I did the same type of a meticulous analysis for two other teachers' lessons - T1-iv and T6-as (see Appendices 15 and 16). This time the

identification of a pattern was easier, since I had the T2-nk draft model in mind and had a better understanding what to pay attention to.

8. After all the lessons of all three teachers were parsed and analysed, I could compare the patterns of all three experienced teachers. It appeared that they share a very similar pattern.
9. Having a clear pattern in mind, I proceeded towards the analysis of the lessons of non-experienced teachers. This time, the analysis was not so meticulous since I have already had the idea of what to look at so I merely had to identify if non-experienced teachers' actions followed the same line as those of experienced teachers.

The chapter below presents the results of this study.

3.3.3. Results of the Study

As mentioned above, a similar pattern was identified for three experienced teachers – T1-iv, T2-nk and T6-as – on how they move through a problem task following the Thinking Task Framework. The identified pattern can schematically be shown as in Figure 32 below. I refer to this pattern as a loop instruction.

As can be seen, the teacher starts with offering students the main problem task, which involves students in the first learning activity in the form of an individual work, pair work or group work. As a result of this activity, students produce their first result, which is then discussed in a plenary session during the teacher-student interaction. This is specifically during the first teacher-students' interaction that students should normally experience cognitive conflict and have to be offered or reminded of the meta-subject tools which have to help them build their model or strategy. The result of this interaction is involvement of students into the second learning activity during which they work on improving their first result taking into account the conclusions of the plenary session. This is specifically during the second learning activity that the real learning is taking place since students apply new understandings gained during the stage of the social construction of the meaning to the problem task. Students never start doing any other task before they work on the improvement of their first

result. The given loop instruction may be repeated several times in the framework of doing one task.

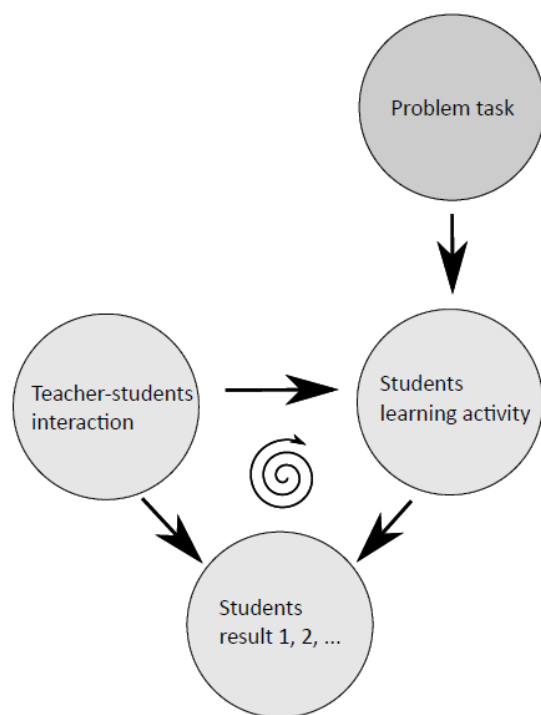


Figure 32 Experienced teachers' (T1-iv, T2-nk, and T6-as) instructional pattern for working through a system of problem tasks following the Thinking Task Framework in the framework of the problem-centred teaching-learning process.

Specific examples of teachers' lessons (see summaries in Appendices 17, 18, and 19) may better illustrate the loop instruction.

If we look at the first two lessons of T2-nk, then we notice several loops, which in addition are supplemented by the discussion on the aim of the task or the aim of the lesson. The flow of the first task is demonstrated in Table 34 below. Since this was lesson of Russian as a mother tongue, the translation of teacher questions is provided in the last column.

Table 34 Extract from T1-nk lesson (September 25, 2013. Form 8ii. Lesson 3/4).

WHAT was done	Lesson questions (original version in Russian)	Lesson questions (translated in English)
T. gives a task to Ss	<i>На прошлом уроке ваши одноклассники, [...] Задали вопрос после урока, который был на прошлой неделе. Вот вопросы, которые ребята задавали. [...]</i>	<i>At the end of their last lesson your classmates asked some questions. These are the questions which they asked, nine</i>

	<i>сформировалось 9 вопросов, которые задали ваши одноклассники. Ваши вопросы распределила на группы. Зачем?</i>	<i>questions all together. I sorted these questions into two groups. What is the sorting criterion which was used and why was the sorting done?</i>
T. sets working time	<i>Хорошо, я вам даю три минуты на выполнение этого задания.</i>	<i>I give you three minutes to do the task.</i>
Ss work individually		
Ss produce result 1: partly correct		
T. asks guiding question to help Ss get out of difficulty.	<i>Хорошо, ребята, я посмотрела как вы выполняли задание. Я увидела...обобщаю работу. [...] Вы отметили, что все вопросы распределены на основании смысла или содержания вопросов. А вот в отношении цели, у нас цели разные. Скажите мне, пожалуйста, чью цель вы там должны написать?</i>	<i>Ok, I have had a look at how you did the task. To sum up, you have noticed that all questions are sorted according to the sense of content of the questions. At the same time, you have different result in terms of aims. Please tell me whose aim you have to define?</i>
Ss offer ideas		
T. sets time to improve result 1	<i>Нужно время для корректировки цели? давайте дам одну минуту.</i>	<i>Do you need time to introduce corrections? I give you one minute.</i>
Ss work individually		
Ss produce result 2		
Ss share result 2: S1, S2, etc.		

As we can see, students work on the task and produce the first result which is partly correct. Since teacher was monitoring students' work it allowed her to notice the problem, stop the learning activity and discuss the problem, which allowed students to proceed in the right direction. It is worth noticing that during the social construction stage, the teacher did not offer any meta-tools and it is even difficult to say whether students experienced any cognitive conflict. The question some students struggled with was why the teacher did the sorting. So this is what can be called an open question, which may have several answers and hence would allow any guesses students might have. It is also the question which makes students think of the aims of any tasks they are offered. Nevertheless, this cycle shows a clear loop presented in Figure 32 above and we can observe a certain improvement of the result one after every social construction stage. We can identify two loops in each lesson pair, sometimes with the second stage involving the work on the strategy and sometimes merely including a small push towards making students get out of difficulty.

T6-as lessons also include very clear loop instruction. Table 35 shows an extract from one of them.

Table 35 Extract from T6-as lesson (2009. Form 11i. Lesson 1/2)

WHAT was done	Lesson questions
T. gives Ss time to read task 1	<i>And this is, if you look at the tasks, this is task 4.4. [...] Can you read it for yourself</i>
Ss read task individually	
T. broadens the task	<i>Can we make it broader? Let's not limit the problems to the narrator. So let's look for all possible problems you can notice in the text.</i>
T. sets time limit for Ss to work	<i>I'll give you now about 5 minutes. I suggest that you work individually.</i>
Ss work individually	
Ss come to result 1	
T. invites Ss to share result 1 in groups	<i>Ok, I am giving you a few minutes now to show each other what you found and probably discuss what you think</i>
Ss share results in groups	
T. invites Ss to share result 1	<i>Ok, can we try to summarise. Can you...can you tell me what you found as a possible problem.</i>
Ss share problems, T. writes them down	
T. challenges result 1 [step 1]	<i>Now, a more difficult question. How do you know that these are the problems?</i>
Ss share their ideas. T. challenges some of them	
T. makes first conclusion	<i>So I think that basically when we have a problem would you agree that it is usually somebody's problem? To say that something is a problem, there must be somebody who has this problem, would you agree?</i>
T. asks to apply first rule and check result 1	<i>Let's start with simple things. Can we look at this list [referring to the list on the board] and start with WHO [is writing 'who' on the board] - who faces this problem</i>
Ss improve result 1 together with T.	
T. challenges result 1 [step 2]	<i>What else is necessary to be able to speak about a problem? So when does a problem appear?</i>

In this case, we notice that the task was to find problems in the text. However, the difficulty is that students have no clear criteria on what a problem is and just use their common understanding on what a problem is. So after collecting some results produced by students, the teacher challenges them asking to develop criteria on assessing whether a problem found is really a problem and improve the result 1 according to the agreed rule. In terms of a cognitive conflict, we can assume that students do not experience it up to the point when a teacher asks them to prove that what they have found is really a problem. In terms of meta-tools, the teacher is offering a meta tool of problem definition as defined in TRIZ which claims that in order to define a problem one has to define (1) point of view or who faces the problem, (2) what the wish of that person is and (3) what the obstacle is which prevents a person from reaching his wish. It is worth noticing that both T2-nk and T6-as set clear time limit for students for doing the tasks. Compared to T2-nk, T6-as does not discuss lesson or task aims with students. However, what is typical for the four analysed lessons is that T6-as works a lot of criteria development.

As what concern T1-iv, the loop may be less evident (Table 36); however, I would claim it is still present in teachers' instruction. If we look at the extract from T1-iv lesson we will see that the first result students produce is not only their home task but also their reflections on how they approached it. The point of cognitive conflict and the social construction stage come when the teacher asks to assess the approaches students followed to come up with the result. Once students voice their opinion the teacher refers to the tool that they discussed on the previous lesson, which may help to define whether any approach is effective or not, which is linking approach to the aim.

Table 36 Extract from T1-iv lesson (September 17, 2013. Form 11i. Lesson 3/4)

WHAT was done	Lesson questions
T. asks what was Ss home task	<i>Who can you tell me what was your home task?</i>
Ss respond: S1, S2	
T. invites Ss to share result 1	<i>So just at the moment I just want to collect all your ideas you came up at home about two enemies.</i>
Ss share result 1: respond S1, S2, etc.	
T. invites to share HOW Ss did the task	<i>My second question is how did you come to these conclusions? [...] How did you come to the idea?</i>
Ss share HOW to: respond S1, S2, etc.	
T. invites to assess the first HOW to	<i>Before coming to the first list, let's speak about this. Thinking about myself as an object to do a task. Is it a good idea or not a good idea? To chose yourself as an example to do the task. [...] Plus explanation why, why do you think that yes it is a good idea because... No it is not a good idea because...</i>
Ss share their response: S1, S2, etc.	
T. invites to check conclusions of the previous lessons	<i>If we come back to our yesterday's lesson. And we discussed with you what is a good item for your bank, what is not a good item. How... What did we decide? What conclusion did we make? About how to decide what is a good one idea, what is not a good idea?</i>
S1 responds	
T. invites to apply the conclusion to assess the first HOW to: invites to discuss the aim, the definition	<i>It depends on the aim. Ok. So, let's try to check if... You think this criteria, like the aim. And let us check from this point of view. I... thank you Darya that you have explained your position here, but now let's try to use our tool. So what is the aim?... In fact. What were you doing? What was the aim?</i>
Ss share their ideas: respond S1, S2, etc.	
T. invites to apply conclusions to assess the first HOW to	<i>Do you think it was a good choice [referring to one of the typed answers]. After discussing all this, do you think it was a good choice? ...To build your choice of enemies on your own example? Was it a good choice? If yes, why? If no, why?</i>
Ss share their ideas: respond S1, S2, etc.	
T. invites Ss to write conclusions/reflections they made after discussion	<i>I want you to go back at what we have done and discussed, to go back to the task, how you did it and to put down advice for yourself so that they helped you to avoid mistakes which you have done so far when you do the task...another task.</i>
Ss work individually	

Students are then invited to assess their approaches through the prism of the aim of the task. After the discussion, the teacher asks students to write down conclusions they made for themselves after the social construction stage. These conclusions serve as a kind of a strategy that students build for themselves on how to approach doing a text-related task. More specifically, how to work on a preparation part before doing a text-related task. The stage of writing conclusions is very much present during all four lessons and we can treat it as a strategy building stage. So the ideas discussed in class are not applied immediately to correct the first students' result but are rather accumulated throughout a series of reflections and conclusions, which students also share with each other and apply either later on (during lesson 3/4 in September 17, 2017 students had to apply the conclusions at home to improve their result) or for a new task. In any case, the loop of (1) task – (2) result one – (3) plenary discussion – (4) improvement of result one is present in T1-iv's instruction.

Having this loop instruction pattern in mind, I proceeded to observing some non-experienced teachers' lessons in order to identify whether they follow the same instruction or not.

The first teacher whose lesson was studied was T4-os. Two lessons of T4-os were analysed: September 09, 2013 and November 27, 2013 when T4-os was working with her class of form 5 (10-11 year old students), two different groups. Appendix 20 gives a brief summary of these lessons. A similar pattern was identified for both of these lessons, which is different from that one of experienced teachers presented in Figure 32. This pattern is schematically presented in Figure 33. The Table 37 below gives an excerpt which should allow us to have an example to better see the pattern of how T4-os builds her instruction following the Thinking Task Framework.

As we can see, the teacher starts the lesson with a big task (students have to write an email to the American friend) but students are not given the chance to produce any result. Instead, the teacher is splitting the big task into small sub-tasks (1.1) write seven peculiarities of our birthday parties, (1.2) read the text about American birthday parties and write down their peculiarities, (1.3) identify what you still don't know about

American birthday parties, (1.4) prepare questions for your American friend and only the last task will be to combine all the information together and finally write the email.

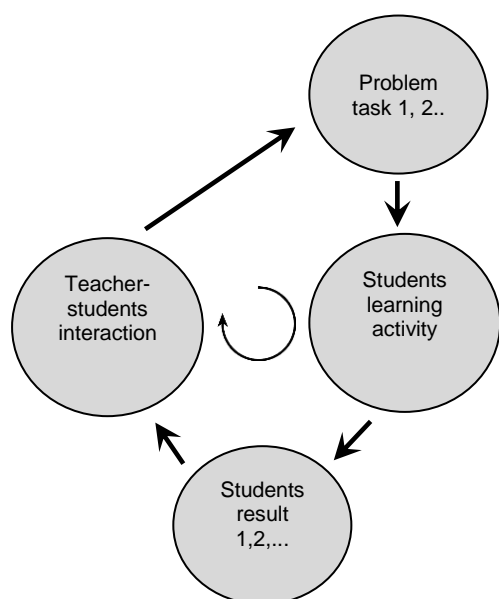


Figure 33 Non-experienced teacher's (T4-os) instructional pattern for working through a system of problem tasks following the Thinking Task Framework in the framework of the problem-centred teaching-learning process.

The teacher is asking guiding questions to make students agree that they have to follow these sub-steps: “*What else do we need [in order to write an email]?*”, “*So my question is, do you have information in column one, which is not given in column two or in the text?*”, etc. Sometimes, students offer other ideas. For instance, if they don't know everything about American parties they offer to look the information up on the internet or in a book. These options are denied by the teacher who says they have neither books nor internet. The teacher has pre-defined the steps and pushes students to agree to follow them. There are also some vocabulary activities in-between to make sure students understand new words and are able to use them.

Table 37 Extract from T4-os lesson (November 27, 2013. Form 5. Lesson 1)¹²²

WHAT was done	Lesson questions
[...]	[...]
T. announces lesson plan	<i>Today we have a special lesson with you. And we will write with you an email to a friend.</i>
T. invites Ss to have a look at the task	<i>Please take a look at the lesson task while I am distributing these</i>

¹²² The shaded rows mean some not essential parts of the lesson were missed out in this excerpt to make sure the identified pattern is more visible for the reader.

(on worksheets)	worksheets. <i>[Task: You invited Russel Cooper, American 12 year-old boy to your birthday party. Write an email and tell him how your birthday party differs from traditional American Birthday parties. And write about peculiarities of your birthday party so that he feels relaxed at your party. Ask Russel three questions. Write about sixty words.]</i>
[...]	
T. invites Ss to read task 1.1.	Now let's start with task 1. David could you please read it? <i>[Task: Write down seven peculiarities of your birthday party]</i>
S1 reads the task out loud	
T. sets time limit for doing the task	You have five minutes for this task.
Ss work individually. Ask T. for words they don't know.	
T. asks for further steps	What else do we need [in order to write an email]?
Ss respond: S1, S2	
[...]	
T. offers support: gives task 1.2	That is why I prepared this small text for you "How American children celebrate their birthday parties". Your task now is to read this text and to underline the traditions or peculiarities of their birthday parties.
T. sets time limit	You have 5 minutes for this task
Ss read the text individually and do the task	
T. invites to write down in Worksheets information Ss found in the text	Here write down all the information that you underlined in your texts
T. sets time limit	You have five minutes for this task
Ss work individually	
T. asks if Ss found similar peculiarities	Do you have something similar? Connect it with a line
Ss respond: S1, S2	
T. gives task 1.3	Now look through your information and try to connect it with the American traditions with a line.
T. sets time limit	So some two minutes for you
Ss work individually	
S produce result 1	
T. asks tries to challenge Ss	So my question is, do you have information in column one, which is not given in column two or in the text?
Ss respond	
T. asks tries to challenge Ss [continuation]	So you don't know this information about Americans. Is it true? What can we do with this if we don't know it?
Ss respond: S1, S2, S3	
T. gives asks guiding questions to lead Ss to the answer	Whom can you ask? ...yes to ask Russel about it.
T. gives task 1.4 and makes sure Ss understand all vocabulary and the task	Let's continue with task two. Vitols, please read task two. <i>[Task: Write down questions that you ask Russel and explain why you think these questions are important.]</i>
T. sets time limit	So please start, five minutes for you
Ss work individually	
Students have to write an email at home.	

In contrast to the experienced teachers' pattern, there is no stage when students would be improving their first result. Instead, we have students learning activity, their result, teacher-student interaction where the teacher is asking students to define the next step and a new sub-task offered to them. The circle continues until students have done all the sub-steps, which allow them to finally proceed towards doing the

main task they were given. The aim of the teacher-student interaction is different in this pattern. It is not used to make students aware of potential problems they have made while producing their result leading towards the students' attempt to improve it. The aim is rather to make students agree on the next steps they have to follow. So we can assume, that the stage when the 'true thinking and learning' has to take place is absent from the instruction. There is no true stage of cognitive conflict since the only difficulty they are faced with is the absence of information (in the first lesson of T4-os absence of information which food is better for which astrological sign and in the second lesson, peculiarities of American birthday parties) rather than the question of HOW to do something, HOW to improve the quality of our strategies and results. We can also notice that neither the aim nor the reflection which we observed in experienced teachers' instructions appears on the lessons of the non-experienced teacher.

What concerns the results for T3-sg, the analysis showed that the teacher is very close in her instruction to that of experienced teachers. Appendix 21 summaries the mains steps of the T3-sg lesson, Appendix 22 includes teacher's reflections and the Table 38 below gives an excerpt from the filmed lesson.

Table 38 Extract from T3-sg lesson (May 22, 2014. Form 3. Lesson 1)¹²³

WHAT was done	Lesson questions
T. reminds Ss about the topic	<i>We were talking about how we can describe foods in English.</i>
[...]	
T. gives task 1 to Ss (in a form of a game)	<i>Now can somebody describe a food? The others guess.</i>
S1 responds: describes a food. After giving two features he gets stuck	
T. reminds S1 about the tool	<i>Can you tell us more? Do you remember we had these things before? [showing on a chart which synthesises some information on how to describe foods: size, shape, colour, type]</i>
S1 looks at the chart and gives more description. Classmates guess the food.	
T. invites Ss to reflect.	<i>Here we have five different sentences. [...] What helped you, when did you know?</i>
Ss give their ideas: S1, S2, etc.	
[...]	

¹²³ The shaded rows mean some not essential parts of the lesson were missed out in this excerpt to make sure the identified pattern is more visible for the reader.

T. asks if anything can be added to the parameter 'type of food'.	
S1 replies [meat is a new type of food]	
[...]	
T. introduces a task	<i>Ok, very good and now we have a new person – Whiz – going to a shop. And Whiz he doesn't know foods. [...] He doesn't know the names of the foods. So when Whiz goes to the shop this is what happens [T. replaces a part in a dialogue where Whiz asks for a food and says 'chump' since he doesn't know the names of foods so he has to describe it in order to get it from a shopkeeper].</i>
[...]	
T. invites Ss to role play the conversation	<i>Let's try. Who can try to be Whiz?</i>
S1 comes in front of the class and role plays the conversation together with the teacher	
T. invites Ss to practice the role play in pairs	<i>And now let's try. You have partners. One is in a kiosk, one is Whiz. [...] If it's difficult, ask me words.</i>
Ss work in pairs	

The teacher was working on the topic of how to describe foods in English. The given lesson is not the first one in the series of lessons but is a continuation of some work done by class before. During this lesson, the clearest part where the loop instruction was observed is in the following. After revising names of foods in English, a teacher invites a student (stage 0: give a task) to think of a food and describe it to his classmates so that they could guess (stage 1: student is involved in a learning activity), after giving two sentences, which do not help his classmates to guess his food a student gets stuck (stage 2: student produces certain result 1). The teacher has then to remind a student that during the previous lessons they developed a chart which summarises some information on how one can describe foods (stage 3: teacher-student interaction). The student looks at that chart and comes up with three more sentences about a food he thought of (back to stage 1: student's learning activity) allowing his classmates to guess it. After that a teacher holds a brief reflection on which sentences were the most helpful. The given instruction goes as a loop even if this is only one student who was its real active participant.

The second part is less clearly visible on the video; however, it was identified as being close to a loop instruction when the researcher read teacher's reflections on the lesson. After practicing a dialogue where students had to buy some foods in a kiosk, a teacher introduced a new character – Whiz – who didn't know the names of foods in English so he had to describe a food he wants to the shopkeeper in order to get it (stage 0: give a task). Students then worked in pairs (stage 1: students learning activity) and had to play roles of a shopkeeper and Whiz and describe and guess a

food he wanted to buy (stage 2: students produce result 1). The recorded video did not show any difficulties of students to do this task. However, as mentioned above, the teacher shared the following reflection about this task:

“It was surprising how much more difficult it was for them to describe the foods in this situation as the task was basically the same as at the beginning of the lesson. As shopkeepers they were quick to say that they didn’t understand, so ‘Whiz’ had to think of more and different ways of describing the food. In many cases they seemed to be stuck.

STEP 2: Building the stairs

Everyone agreed it had been more difficult now, so we looked back at our ‘Food gadgets’ to see if they could help.”

(T3-sg; Description of lesson 1 with form 3 and reflection on the lesson)

As it can be seen from the reflection, students got stuck while doing the task and a teacher had to remind them about the chart (stage 3: teacher-students interaction) so that they could proceed with doing the task (stage 1 back again: students learning activity). The teacher was working with several groups on the same lesson so this description may either belong to the lesson with another group or belong to that part of the analysed lesson which was not recorded. In any case, it clearly shows that there is again a certain loop when students get stuck and are reminded of the tool in order to improve their first result. Moreover, teachers’ reflections show that more loops instructions are planned for the upcoming lesson:

“STEP 1: New context and challenge

Whiz comes to the kiosk, but the shopkeeper has just put up the Closed sign. [...] Anyway, the shopkeeper is keen to go home, and now along comes Whiz asking for his chump, so the shopkeeper is a bit impatient and says, ‘Quick!’, and , ‘Sorry, I STILL don’t understand!’, and generally makes impatient noises, so Whiz really has to think about how he can describe the food in as few sentences as possible, having to find the defining feature of each food as quickly as possible.”

(T3-sg; Description of lesson 1 with form 3 and reflection on the lesson)

Therefore, we can make a conclusion from what was observed on the lesson combined with T3-sg teacher's reflections and further plans, that her instruction resembles the loop instruction identified for experienced teachers.

Since the T3-sg teacher is working with young learners it is inevitable that just as her T4-os colleague she also offers vocabulary practice (e.g. practice of a dialogue in a kiosk with your partner before Whiz character was introduced to create challenge) which does not necessarily require loop instruction. However, the general line is towards building a strategy on how to describe foods in English so in a long-term basis students are involved in building a strategy with the help of an ENV tool. Even though students are not yet aware of the meta-tool as such, the teacher has it in mind to formalise it at later stages:

“The lesson ended here, and I don't really have any more time with this class. However my plan was that they would try out the chump conversation again, using their new passports to help them, and we'd discuss if there was still something missing, thus taking us to Step 3, reflecting on the model. I'm thinking that at this point I could even introduce the word 'parameter', as it would make it so much easier to talk about the model. We would then test the model with a new challenge.”

(T3-sg; Description of lesson 1 with form 3 and reflection on the lesson)

As mentioned in the section on data collection methods, in addition to filling and analysing lessons, the researcher also managed to record some interviews with some teachers – T1-iv, T2-nk and T4-os – either before or after their lessons. This provided some supplementary information on how teachers plan their instruction and what they think about it.

The following supplementary information was obtained from the interviews after T2-nk lessons.

Two non-structured interviews were taken with T2-nk. One after the first pair of lessons in September 25 (Appendix 10) and the second after the first lesson in October 23 (Appendix 11).

The first interview was the discussion of the researcher, T1-iv and T2-nk after her lesson pair. The given interview gave us the following additional information.

- The teacher held eight lessons since the beginning of the school year. September lessons observed were the third lesson when T2-nk was introducing the problem-centred approach through the Thinking Task Framework. It is also worth mentioning that this is the first year the teacher works with these eighth-form students.
- T2-nk remarks that before starting working with the problem-centred approach it was essential to have a lesson where she would deal with some organisational issues and classroom culture. During one lesson teacher worked on discussing with students why the answer “*I don't know*” cannot be accepted on the lesson. T2-nk openly shared with students that she interprets it as a kind of an insult where a student is trying to say ‘*I am not interested, don't bother me*’ even if a student does not mean it. If one is not sure about the answer, it would be better to say ‘*I am not sure but it seems to me that...*’, ‘*I may be wrong but...*’, rather than saying ‘*I don't know*’:

“когда я сказала своё отношение к слову не знаю. Что я под этим понимаю, и что я чувствую – отстань, иди ка ты куда подальше - открытым текстом. Я не слушал, мне не интересно и вообще думать не хочу. Всё. Слово не знаю...что ученик подразумевает. Он может искренне говорить «не знаю». И я предполагаю, что искренне. Но ... просто... ты говори то, что ты думаешь, и ты говоришь «я сомневаюсь, но мне кажется, что», «я не уверен, но мне кажется, что»¹²⁴”

(T2-nk, interview after lesson 4, September 25, 2013)

The teacher added that if this dialogue had not been held during one the introductory lessons, then during today's lesson when a teacher was

¹²⁴ “I openly explained my attitude towards the phrase “*I don't know*”, what I feel when I hear it and how I interpret it - “*get lost*”, “*leave me alone*”, “*I did not listen to you*”, “*I am not interested and I don't even want to think*”. What may a student mean under this phrase. Maybe he really means he doesn't know. And I am pretty sure he does mean exactly this. However, it is better you explain what you

introducing a new type of task and a new way of working for students, they would have constantly been saying ‘*I don’t know*’ for every question asked by a teacher and it would be hard to make students accept the challenges:

*“Если бы это не было проведено, мы бы сегодня на уроке услышали, вот там где поднимаешь планку «не знаю». И делай с этим что хочешь. А это идёт как болезнь. Здесь не знаю, здесь не знаю, здесь не знаю”.*¹²⁵

(T2-nk, interview after lesson 4, September 25, 2013)

Both T1-iv and T2-nk remark that many students, not only from this class, are pretty reserved and are afraid of voicing their opinion and it is difficult to change their attitude towards ‘wrong’ answer and make them see it as a starting point of learning rather than a fatal mistake.

*“И за год так и не получилось у них убрать, что это неправильный ответ это не ошибка неправильный ответ это хорошо, неправильный ответ это повод для обсуждения почему. Зажаты, зажаты так, что...даже по-русски говорят боятся высказываться. Вообще боятся высказываться”.*¹²⁶

(T1-iv, from T2-nk interview after lesson 4, September 25, 2013)

- Since these were one of the first lessons implemented following the problem-centred approach, a teacher introduced a new type of task - a sorting task (sort objects in groups). As the main aim of the observed September lessons the teacher saw the development of students’ understanding that any task they do (including sorting) has an aim. In other words, every time they do sorting, they should ask themselves why they do it, which problem they are trying to solve while doing this task. Every task, sorting task including, should

think, for instance “I doubt but it seems to me that”, “I am not sure but it seems to me that”. (Translated by RJ)

¹²⁵ *“If I hadn’t previously discussed it with students, then today on the lesson we would hear ‘I don’t know’ every time they faced a challenge. And do whatever you want with it. It’s like a disease, ‘I don’t know’ once, ‘I don’t know’ twice, ‘I don’t know’ every time.”* (Translated by RJ)

¹²⁶ *“One year was not enough to make them understand that a wrong answer is not a mistake, that on the contrary, it is good, it is the chance to discuss why-s. Students are so blocked that can’t even express their opinion in Russian. They are afraid to voice their ideas in general.”* (Translated by RJ)

be meaningful for a student and they should be aware of what is being described with the help of a sorting task and how it is being done:

“Но основная цель, да, у меня была решить вопрос с сортировкой именно с точки зрения...чтобы они обращали внимание на то, что мы описываем (но я назвала исследуем, потом скорректируем). И с помощью чего мы это можем описать. То есть на основании чего выполняем именно задание сортировку”
(T2-nk, interview after lesson 4, September 25, 2013. Part 2)¹²⁷

The second aim for the teacher was to introduce the ENV meta-model and terminology connected to it: element, name of feature, value of feature. This should have been done through students' activity being as meaningful to them as possible.

- T2-nk remarked that it was still difficult for her to see clearly the steps of the Thinking Task Framework when planning the lesson. If looking back at the lesson T2-nk could retrospectively identify the following steps. As the first step (increasing challenge) the teacher saw the task of identifying the aims. The first aim students had to become aware of was why they had to do the sorting task at home. The second one – why the teacher did the sorting which they had to analyse. As mentioned by T2-nk, at this level, identifying and thinking about the aims is already a challenge for students. Regarding step two, T2-nk assumes that students were building steps because they were doing the tasks with the help of her guiding questions:

“Шаги наверное выстраивались, потому что задания как-то выполнялись. Это так я для себя определяю. Они выполнялись шаги. ...Если так проанализировать так подробно как по ходу урока, то шаги можно, как мне кажется, выстраивать на основании каких то наводящих вопросов или на основании того. Вот ты проходишь, просматриваешь, ты уже видишь, куда

¹²⁷ “My primary aim was to deal with sorting, to make them pay attention to what exactly we describe (during the lesson I formulated it as ‘what we study’ but I will correct it later), and how we can describe it. What is the basis for doing the sorting task.” (Translated by RJ)

двигаются они. И где в чём помочь. Но опять оно идёт подспудно через вопросы»¹²⁸

(T2-nk, interview after lesson 4, September 25, 2013. Part 2)

Regarding the reflection step, T2-nk found it to be the most difficult to organise. She identified one attempt at making students reflect on the process (RJ: during the analysis, it was not very evident from an interview which exactly moment the teacher was talking about).

- T1-iv remarks that since the approach is new to students, they experience a new way of working which in addition to new terminology being introduced may make them feel a little bit lost. T1-iv has also been experiencing the same difficulty on her lessons. Clarification is normally expected to come later, when students will connect all the bits and pieces of information together into a system. These scattered bits and pieces include: new way of interacting (expectation to express opinion), new types of tasks introduced (e.g. sorting), new meta-tools and terminology (e.g. ENV), connection of meta-tools and strategy building to the content of the subject (ENV and how it helps to learn about punctuation marks in Russian), etc.

«Моя проблемы, как всё это начинать. То есть потом разгребать, уже как бы не трудно. То есть, когда вот этого всего насобирали, потом начинать потихоньку это всё как бы организовывать. Но как избежать вот этого вот... ну хаос, не хаос, сложность не сложность, много...много...много информации на самом начальном этапе.»¹²⁹

(T1-iv in T2-nk, interview after lesson 4, September 25, 2013. Part 1)

- T1-iv and T2-nk pointed out at the lack of clear logical conclusion at the end of the lesson. This was due to a too prolonged discussion over one question

¹²⁸ "I think there was the stage of building steps because students were somehow doing the task. That's how I see it. Steps were followed. If we have to analyse in more details, then I think we can build the steps based on guiding questions. Or as a teacher you walk around and you see already where students are heading and how you can help them. But again, this is done through questions". (Translated by RJ)

¹²⁹ My problem is how to start it because once started, it is not so difficult to deal with it. Once everything is put on the table, you can gradually start organising it. The question is how to avoid this

where students experienced a difficulty. At the same time, this lesson is only part of a series of lessons, so a clear logical conclusion may be drawn at later stages.

- T2-nk remarked that the work with the problem-centred approach gives her the possibility to make students work on their individual problems, rather than having one problem for all students and working on it:

“[...] Что без ТА у меня не было лично-ориентированного. У меня шла дискуссия одиночных ответов. [...] проблемы, которые решались, то есть, на уровне гипотез учеников, что от ученика В. Я развожу. А здесь от ученика А. Для меня это две больших разницы: от ученика В, как от всей группы или от ученика А. Вот для меня большая разница то что идёшь...ну от большего количества учеников. Потому что я раньше получала проблему общую для всего класса. А теперь я вижу эти проблемки они у меня есть как какая-то общая, но есть ещё какие-то другие, понимаешь. Идёшь в большей степени от учеников.”¹³⁰

(T2-nk, interview after lesson 4, September 25, 2013. Part 1)

- Since the researcher was observing the lessons of T1-iv for a month already and it was the first lesson of T2-nk that she attended, she had the possibility to notice the immediate differences and similarities between the two ways of working. The interview revealed that the researcher pointed out at two main characteristics. The lessons of T1-iv seemed less structured with the flow of the lesson depending almost entirely on the students', sometimes giving them the mandate to decide what to do next. In addition, teacher-classroom interaction was taking a lot of space with students writing conclusions after

chaos or difficulty. There is really a lot of new information at the very beginning of this process”.
(Translated by RJ)

¹³⁰ *“When I was not implementing the Thinking Approach I could not organise a true learner-centred education. I had a discussion of separate answers. [...]we solved problems and dealt with the hypothesis of students, not a student, as I do now. For me there is a huge difference between students as a group and an individual student. For me there is a difference whether you work with the majority of students... Previously I would have one hypothesis common for the group. But now, I see*

them. T2-nk lessons were identified to be much more structured with a clear line where a teacher is leading her students to and more tasks being given to students rather than long discussions. It does not mean though that the teacher did not take into account the real circumstances of how the lesson unfolded. One of the reasons of why the lesson did not have a very clear logical conclusion is exactly due to the fact that students struggled with one question and the teacher did not drop it down for the sake of following the lesson plan, but rather pursued students' reasoning until understanding was established. Regarding similarities, both teachers were involved in a qualitative teacher-student interaction (the given hypothesis was proven during study 2.2 described further).

The second interview was a brief discussion of T2-nk and the researcher between her two lessons observed in October 23, 2013. It provided the following information:

- Speaking about lesson aims T2-nk said that there is one general aim for the series of lessons that she follows: develop students' ability to compare (finding common and different features of elements), learning to use instruments on how to compare (ENV) and to see any task in the context of an aim (why I do it? what does it give to me?). During this particular lesson the teacher focused on finding differences for the subject-topic of punctuation marks.
- Regarding following the steps of the Thinking Task Framework, the challenge T2-nk saw in comparing punctuation marks since she noticed some students were not able to cope with the task and only discussion helped them to think of how they could do it. The teacher interprets the steps as giving a task, giving the chance to do it and then discussing what students do and what they came up with. T2-nk remarks again that she does not yet see a clear reflection on her lessons, apart from reflection on the aim, and what helped to formulate it and what helped to name the differences after students experienced difficulties and the discussion was held to help them cope with them.

these sub-problems. I see one common big problem and also some other small problems. Do you understand?" (Translated by RJ)

Two interviews were recorded for T1-iv, one before September 17, 2013 lesson and one after it (Appendices 8 and 9). **These interviews revealed the following supplementary information.**

- For September 17 lessons students' task was to read the extract from the text of Carlos Castaneda "The man of knowledge". The text stopped at the moment when it was said that the man of knowledge has four enemies on his way to learning. Students had to think of and write two enemies which they consider a man of knowledge can have.
- The general lesson aim set by the teacher was to develop students' habit and skill of doing a preparation part before producing any written assignment.

"I think that maybe, maybe writing skills, I want to focus on this what I call preparation part or it can be called the thinking part. So before they produce whatever, whatever, they should think, which they don't do. They usually produce spontaneously the first thing that comes to their mind. And I want to work with these things today. To show them that what they produce just...without any thinking or without much thinking...is not maybe the best variant of what they can produce."

(T1-iv, interview before lesson 3, September 17, 2013)

- The teacher was planning to start with the results students produced at home and make them see that these are not based on the analysis of the text and the task and just produce whatever comes to their mind. The lesson should also help them to see how to make this analysis (a preparation part), to see the need of considering the function/aim/purpose and to use the ENV meta-tool.
- The instruction the teacher identified for her lesson resembles the loop instruction identified during the analysis: *"my plan is that we will collect, I will ask their examples"* (stage 0, 1 and 2: task is given, students work individually and produce result 1). *"We will discuss their examples. I hope that I will manage to do it so that they understand that they need to use resources. At least to find resources which they have and what resources are and how to work with them."* (stage 3: teacher-students interaction). *"And then they will try to re-do."* (back to stage 1: students learning activity). *"To use, to re-do to*

reflect on how they did. What they did, what worked what didn't work. And to add or maybe to start their model or maybe to add to their model about how to do the tasks." (result of a loop instruction is students' adding some ideas to their general HOW to tool on how to do a task).

T1-iv has a **pattern** that she uses for planning her lessons: *"Give the task, they give the answers, I try to challenge their answers saying that that and that and that is not good. [...] Then we will try to discuss how to make it better. Then we'll try to make it better. And then we will reflect how we tried to make it better, like coming to these instruments. That is, that is my pattern which I have in my mind which corresponds with this [...] Thinking Task Framework."* (T1-iv, interview before lesson 3, September 17, 2013)

- At the same time, it is worth noticing that students do not have a draft-tool yet, which they would have saved from the previous lessons (or even the previous year). The teacher, however, claims they did work on some tools last year so this year she want to discuss the question of preparation part on a deeper level:

"I don't remember last year what models we started, what we didn't. I am sure we did, we write how to do the grammar models and how to write the text model. How to do the task, I am not sure. But doing the task is a part of doing whatever. I mean, writing, whichever. But I want to start with very very like small step and to go deeper this year. If last year we had maybe a wider picture but maybe more superficial. Now I want to go deeper [...]"

(T1-iv, interview before lesson 3, September 17, 2013)

- Speaking about the final result students are expected to come up with, T1-iv mentions that she does not have the final result in mind, just a vague idea and **the pattern** of how she will organise her instruction (see above). That, probably, explains why her lessons seemed less structured to the researcher in comparison to T2-nk lessons. T1-iv does not lead her students so much but rather constructs the tool together with students. It seems that T1-iv seeks challenge for herself and is not afraid to take the risk of being stuck in the middle of the lesson: *"yesterday at the middle of the lesson I didn't know what*

to do next. But that's... when you don't know where to go it keeps some space for thinking for you." (T1-iv, interview before lesson 3, September 17, 2013)

- Commenting the results of her lesson, T1-iv assumes that her aim was mostly achieved. Judging from conclusions that students wrote, the teacher assumes that the importance of doing preparatory task was accepted. However, she is less sure that they accepted it as helpful and she assumes students have to practice the tool and apply it to other tasks to see its usefulness. T1-iv says, "*I am not sure that at the moment I managed to show them that their answers are not good*" (T1-iv, interview after lesson 3, September 17, 2013), which may indicate the she feels students did not quite accept the challenge, so the cognitive conflict was not effectively created. However, the teacher assumes that the tool may be accepted in the long run: "*Still, at the moment might be very, too complicated for them and they still might not accept it. It becomes good, a good tool, an easy tool when it is practiced, mastered and when it becomes theirs. Now, after the first and even the second lesson it won't still become.*" (T1-iv, interview after lesson 3, September 17, 2013)
- T1-iv also noticed that at least some students saw the list of conclusions as a HOW to tool: "*how to work with the task, how to deal with the task, how to analyse the task and how the task can help.*" (T1-iv, interview before lesson 3, September 17, 2013). The teacher is not sure whether she should have worked more properly on the HOW to list but she plans to keep working on it during the upcoming lessons.

What concerns the **non-experienced teacher, T4-os, two interviews were recorded**, one before September 09, 2013 lesson and one after it (Appendix 23). It allowed revealing the following supplementary information:

- This was T4-os third year of professional experience and she has previously been using only some elements of the problem-centred approach so she can't say she worked with it. Year 2013 was her first year when she started implementing it on a more regular basis.

- The teacher has always been working with form five and that year she had a new class of fifth form students, so they were new to her.
- T4-os defined her lesson aim as to develop students' ability to compare certain types of food using the ENV meta-tool. During this one lesson the teacher believes students "*will learn that there are more parameters to compare food than just one. And probably they will learn to, actually to compare food according to different parameters.*" (T4-os, interview before lesson 3, September 09, 2013)
- Difficulties the teacher envisages students may face are firstly language difficulties, understanding of vocabulary and secondly difficulty to name parameters when asked so.
- T4-os named the following activities that students will do on the lesson: read the text, give advice on different types of food, and write a letter (most probably on the next lesson).
- We can see that T4-os aim corresponds in a way to T3-sg aim because both teachers work on describing foods in English. T3-sg formulates an aim of how to describe foods in English and offers an activity within which students would have the need to do it (you go to a kiosk and you don't know the name of a food you want so you have to describe it). She uses an imaginary character that faces this difficulty in a kiosk, which allows involving students in practicing the activity in a context meaningful for them. T4-os, on the other hand, formulates an aim of how to compare foods in English and offers an activity where students would have to write a recommendation letter. However, we can notice that there is no real need for them to compare foods. Students offer ideas on which food is better for which astrological sign, they experience no difficulty in writing the required recommendation letter without having the skill of describing foods using a number of parameters. So we can assume, that the aim might have the potential of developing certain set of inventive thinking skills, however, the means T4-os chose for reaching the aim were not appropriate.
- When commenting on the flow and the outcome of the lesson after it was conducted, T4-os acknowledges that she did not achieve her aim because of

the lack of time, students did not manage to start doing the task where they would be required to compare dishes: *“Actually I haven’t achieved my aim because we didn’t even get to that task, task 3 where their task would be to [...] analyse different dishes according to parameters.”* Even though the teacher acknowledges that students did not see her challenge, it seems she does not perceive it as one of the main problems why she could not reach her aim: *“When I asked them what information they needed to do the written task they had but in this case they said they need no information so they didn’t see that challenge. I didn’t manage to show them the challenge, that they can’t do the task without information and I simply had to give that information myself.”*. In fact, T4-os says students accepted the challenge *“because they just participated in the discussion of the grids we had and they didn’t keep silent”*. The teacher would name the lack of time, too many parameters for students to describe and vocabulary difficulty as the main problems which prevented her from reaching her aim. Even though these reasons might have contributed to the fact that the aim was not achieved, the true reason seems to be the failure to produce the cognitive conflict – the need and inability to compare foods in English. So there was no challenge and thus students could not accept it.

- Contrary to T2-nk who found it essential to introduce the ENV terminology to students and agree on the notions, T4-os was hesitating whether she has to give the name of the meta-tool: *“Probably, when this model is ready I’ll tell them that here we have parameters, remember. And I am not even sure whether I have to name this model as ENV model. I have no answer yet whether the name of the ENV model is necessary for them. Probably it’s enough that they see that they can analyse food according to parameters.”* (T4-os, interview before lesson 3, September 09, 2013)

Before we can make conclusions about teacher’s praxeologies based on the data obtained from both lesson observation and interviews, it is worth paying attention to one more essential aspect of teacher’s instruction, that one of the quality of teacher-student interaction, the importance of which was highlighted in the research I analysed in the first chapters of my thesis.

3.3.4. Study 2.1.: Analysis of the Quality of Teacher-Student Interaction

As identified in the literature review, one of the most important dimensions of teaching competence after Aims and Instruction is Interaction, which includes such main components as Dialogue, Questioning, Student engagement, Patterns of verbal interaction and Patterns of action (Table 13 or Figure 9). According to the research (Anderson, 2004) the quality of these competences has positive impact on student learning. Their importance is also acknowledged for the development of students' higher order thinking skills. Therefore, I decided to study this aspect in teachers' praxeologies as well.

The aim of the study 2.1 was to measure and compare the quality of teacher-student interaction of experienced and less experienced teachers.

In order to study the quality of teacher-student interaction, I intended to measure some of competences defined in Table 13. The table below (Table 39) summarises what exactly was measured and how.

Table 39 Measurement units for the quality of teacher-student interaction used for study 2.1

Dimension	WHAT measured (competences)	HOW measured (measuring unit)
1. Dialogue and Questioning	<u>1.1. Ability to pursue students reasoning:</u> Pursues students understanding why something is right, asks students to elaborate on the answer, clarify it and reason their judgement; <u>Ability to ask strong questions:</u> Raises different types of questions (i.e., process and product) at appropriate difficulty level	Identifying presence or absence and a number of: <ul style="list-style-type: none"> • 'why do you think so' questions; • 'how did you do it', 'how do you know it', etc. questions • 'what do you mean by' questions; • 'what exactly do you mean' questions
	<u>1.2. Ability to deal adequately with students incorrect, incomplete or wrong answers</u>	Identifying strategies used by teachers when a student produces incorrect, incomplete or wrong answer. Identifying the tone of the response.
	<u>1.3. Ability to give time to think:</u> Gives longer time for students to think and respond before offering a helping question, asking another student to respond or providing	Counting number of seconds given to a student to think on a question (s)he receives before the teacher attempts to provide help or ask

	a correct answer	another student.
2. Student engagement	<u>2.1. Ability to engage students in teacher-student interaction:</u> Involves all students in the lesson rather than focuses on only active/strong students.	a) Counting number of seconds a teacher gives students for showing they are ready to participate (raise their hands) after a question was asked; b) Checking whether the first student who is invited to speak is the one who raised his hand first; c) Checking whether this is all the time the same student. d) Counting number of students who are invited to voice their answer after the first student gives his opinion (which may even be very well formulated answer).

The same lessons that were used for the analysis of the instructional patterns were used for this study as well. The analysis revealed the following results.

In terms of (1) **Dialogue and Questioning**, for the **(1.1) ability to pursue students' reasoning and asking strong questions** the researcher counted the total number of questions a teacher asked. The given questions were then grouped under several categories:

- WHAT questions, included all those questions that could be answered yes or no, or one specific answer can be given. Sometimes these were not completely closed questions, and sought for students' opinion. For examples, a 'what do you think question' may also be included in this group. At the same time, it would depend on what exactly is the object of inquiry. If the question is about the aim of the task and a teacher asks for students' opinion, then the question would be rather classified in the WHY group. In general, the yes/no or WHAT questions are not considered to be strong questions since they do not require much reasoning but are rather applied to check students' knowledge.
- SPECIFY questions, included all those questions which were used by the teacher in order to specify students' opinion. These would normally start as follows: *What do you mean by...? What exactly...? Is that what you mean? Do I get it right that...?*

- CLEAR questions include two groups of questions. The first one is those questions when the teacher asks students if everything is clear. They include: *Is it clear? Who doesn't understand? Do you have any questions?* The second group includes those questions which start with WHO and seek to involve other students in expressing their opinion: *WHO can help? WHO (dis)agrees? WHO has another version? WHO wants to ask Ss a question? WHAT else can you say?*
- WHY and HOW questions ask students to specify why they think so, why they do something, how they know something is true or how they came up to the solution. These are the questions which require reasoning on behalf of students, proof of the point of view, explanation of the approach and reasons behind it.
- And the last group is OTHER questions which regroups all those questions that did not fit any group above.

I counted all the questions the teacher asked, even if the teacher repeated some questions several times. Since the lessons of experienced teachers were coupled, the questions were counted for two lessons as for one.

The analysis (Appendix 24) revealed that three experienced teachers had in general a high quality of teacher-student interaction.

As can be seen from the pie charts (Figure 34), only **37% and 31%** of all the questions for two pairs of lessons respectively asked by T1-iv are the so-called closed or yes/no questions. These are questions where a student is expected to answer 'yes' or 'no' or where only one answer is possible. So these types of questions are not considered to contribute a lot to the development of students' reasoning abilities. For instance, some of the WHAT questions asked by T1-iv are (September 24, 2013):

- *Ok, how many enemies did we come up with during the previous lesson?*
- *Are you ready? Do you want? My question is do you want to deal with these difficulties or you don't?*

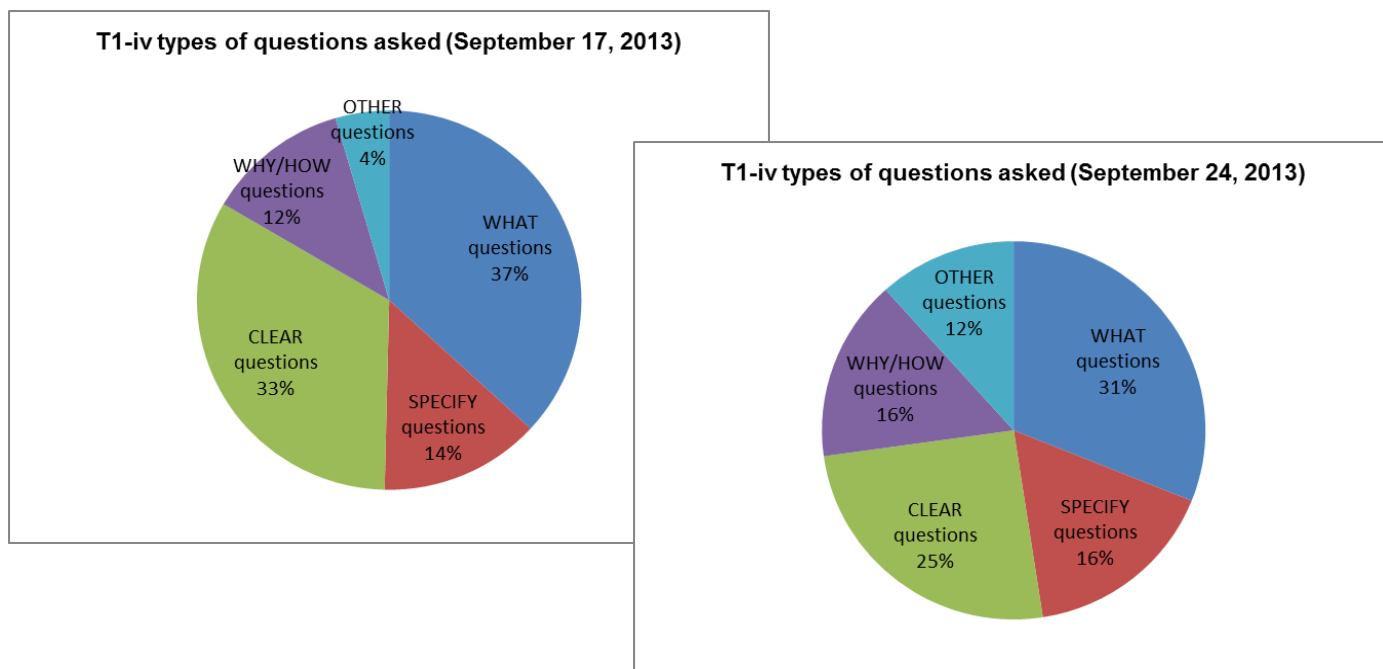


Figure 34 Percentage of the types of questions asked by T1-iv on her lessons (September 17 and September 24, 2013)

Those questions where the teacher asked students to specify their opinion or was making sure she understood a student correctly constitute as many as **14% and 16%** of all the questions asked. This may show that a teacher is genuinely listening to her students and makes sure they express their opinions clearly. For instance, such questions of T1-iv (September 17, 2013) as

- *So, here, here the idea of definition, right? The definition. By definition you mean...?*
- *Am I right? Am I right to understand you...? Was it what you meant?*

Since **33% and 25%** of questions are of the CLEAR type, we can also assume that a teacher makes sure her students follow the discussion and have the possibility to ask a question if something is not clear. It can also indicate that a teacher engages more than one student in a discussion (T1-iv, September 17, 2013):

- *Can you see the difference or you don't see the difference?*
- *Enemies. Is it clear?*

Moreover, **12% and 16%** of questions are WHY and HOW questions where students are expected to develop their reasoning. For instance, these questions asked by T1-iv (September 17, 2013) include:

- *Ok, I think it is important. Why? Why is it important? Why formidable, that is very horrible, why is it important?*
- *Yes, it specifies the aim. What does it give us to the task? Please think about what does this putting not any person but a man of knowledge would... How would it change your approach to doing the task?*

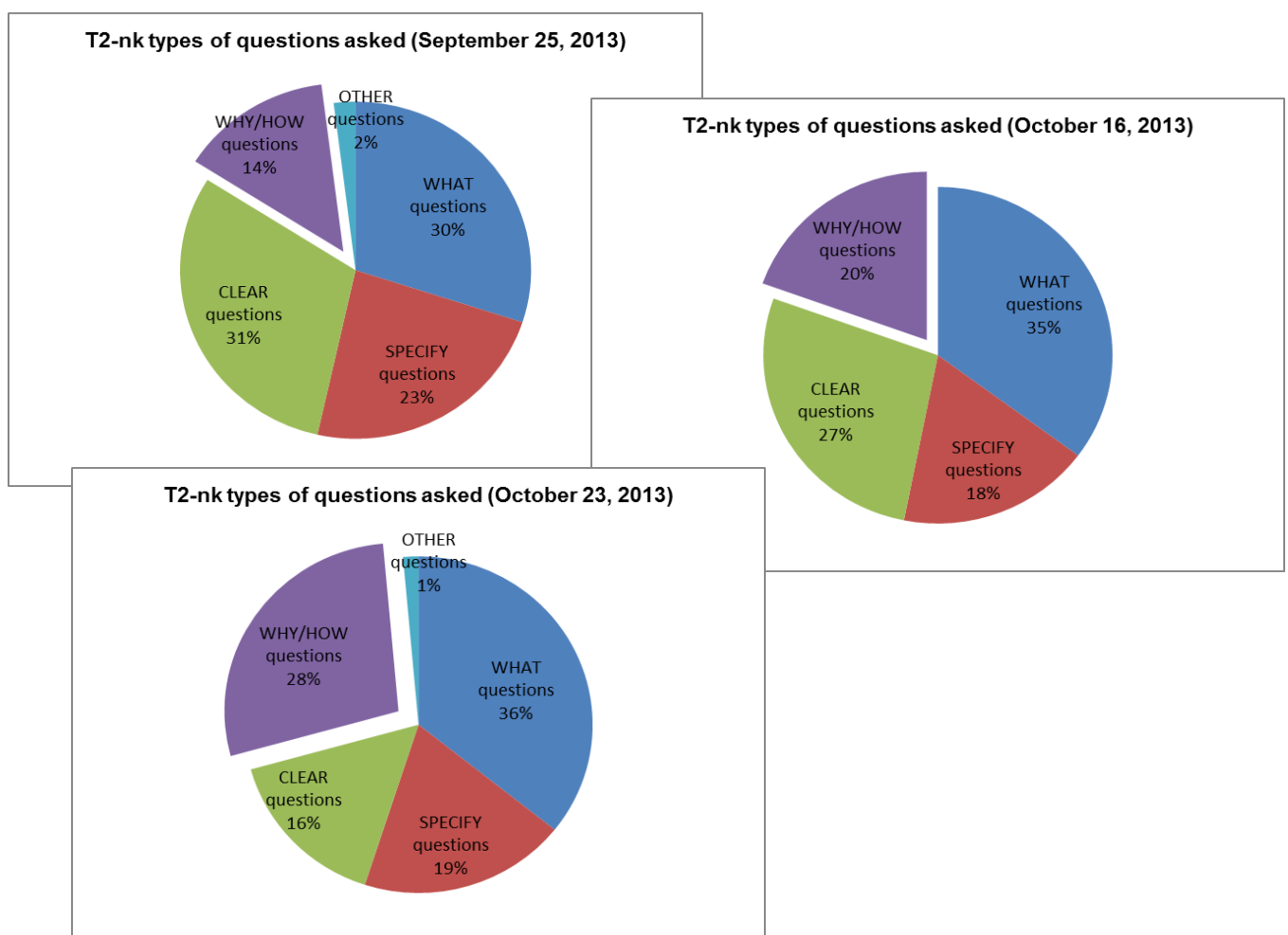


Figure 35 Percentage of the types of questions asked by T2-nk on her lessons (September 25, October 16 and October 23, 2013)

In comparison to T1-iv, T2-nk has almost identical percentage of WHAT questions, as well as CLEAR questions (Figure 35) and slightly more questions of the SPECIFY type. The examples of the questions would include (examples from September 25, 2013 lesson):

- WHAT question: “*Что нужно распределить?*” (What do you have to sort in groups?”);
- CLEAR question: “*Кому не понятно?*” (“Who doesn’t understand?”)
- SPECIFY question: “*Что именно делали на уроке?*” (What exactly did you do on the lesson?”)

However, the number of WHY and HOW questions T2-nk asked is relatively higher with **14%**, **20%** and **28%** for three lessons respectively. The examples (from September 25, 2013 lesson) include:

- “*Почему появилась причина?*” (“Why was the reason added?”)
- “*На основании чего ты уверен в правильности выполнения задания?*” (“What makes you think that you did the task correctly?”)

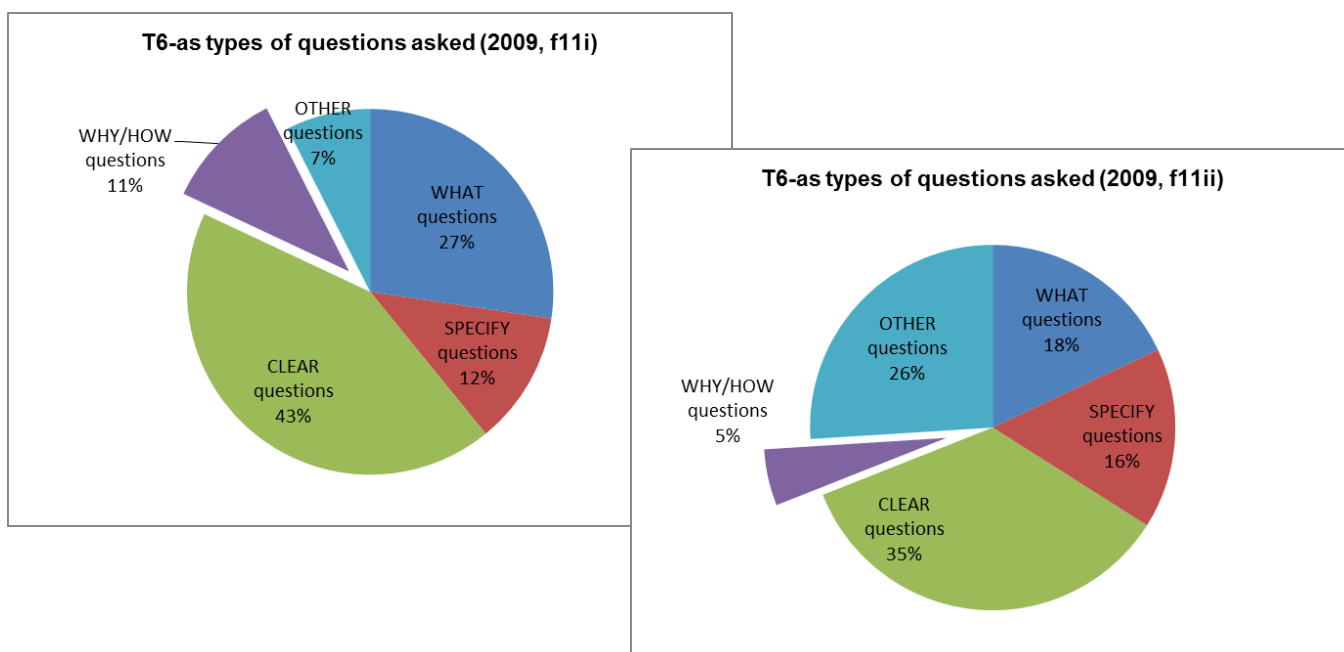


Figure 36 Percentage of the types of questions asked by T6-as on his lessons (2009, group 11i and 11ii)

At the same time, it is worth noticing that T2-nk has the tendency to repeat one question several times since she is seeking to hear as many students as possible. In any case, both teachers have asked a good variety of questions with closed questions being in minority in comparison to more qualitative questions which deal with students' reasoning and understanding.

As can be seen from the pie charts (Figure 36), T6-as also asked a variety of different questions. If the number of WHAT questions is less for T6-as, then we can see that the number of HOW and WHY questions is relatively small, especially for the second lesson: **11% and 5%**.

The examples of HOW/WHY questions asked by T6-as include (2009, f11i):

- *Can you answer the question, why is the problem clear?*
- *How can it help you? So we have quite a few people here working on task 8.1. How can this demand help you...do this task well? If it can.*

Nevertheless, the variety of questions remains high with closed questions being in minority.

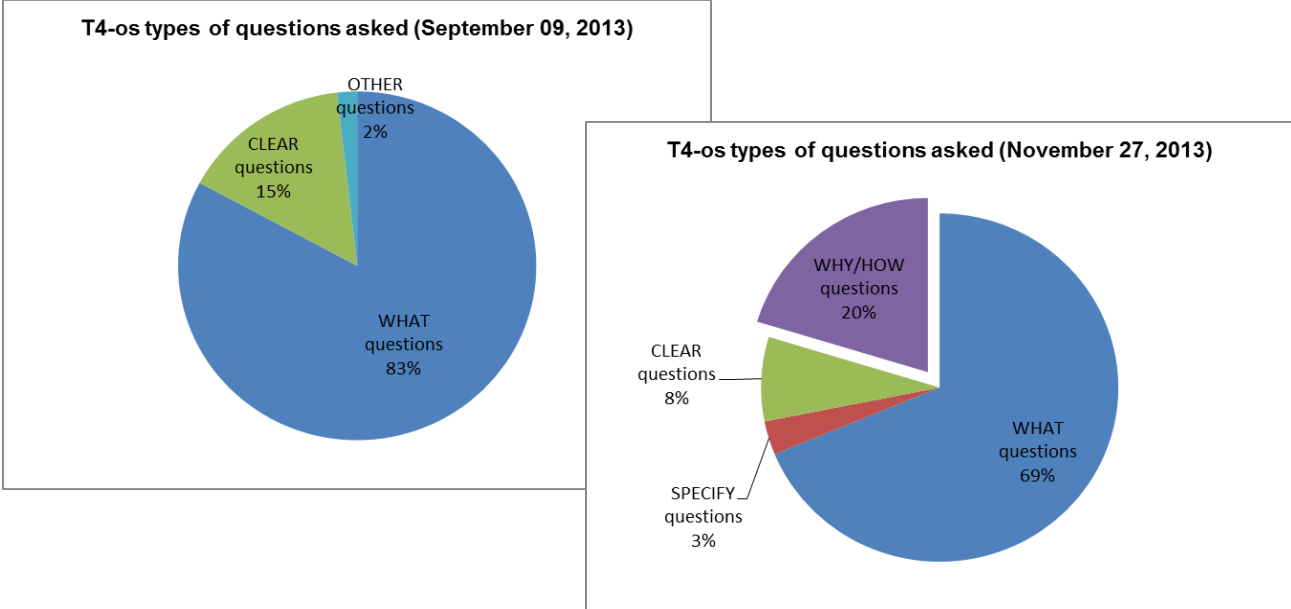


Figure 37 Percentage of the types of questions asked by T4-os on her lessons (September 09, 2013 and November 27, 2013)

A different situation can be observed with the types of questions of non-experienced teachers. The first observation which can be made after looking at the pie charts showing the percentage of questions asked by non-experienced teachers (Figure 37, Figure 38), is that the WHAT questions make 50% and more percent of the total number of questions they asked, while the SPECIFY questions are either absent (T4-os) or are at a dire level.

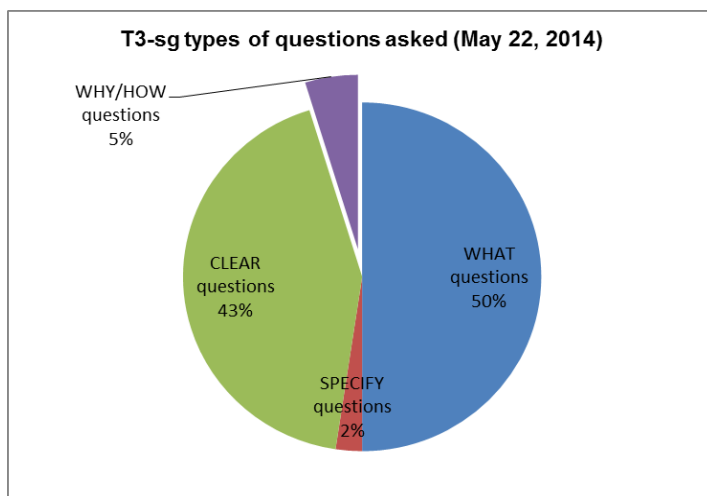


Figure 38 Percentage of the types of questions asked by T3-sg on her lesson (May 22, 2014)

The majority of WHAT questions asked by T4-os are aimed at checking students' vocabulary comprehension. These questions would include (T4-os, September 09, 2013):

- *What is it 'question formulas'?*
- *What is it 'tenses'?*

Since the number of open questions is low (for instance, we can see that T4-os September lesson did not have any WHY/HOW question asked), there is no specific need to specify students' opinion, which may explain why the number of SPECIFY questions is so low.

There are certain limitations of this part of the study. First of all, some teachers repeated one question several times (for example, asking one student and then some more the same question). Every time, the question was counted. So it is

possible that some teachers have more questions asked merely because they repeated the same question several times. In addition, the age group of students and the nature of the subject may influence the number and type of questions asked. For instance, young learners may require more work on vocabulary when they deal with a foreign language, which may influence the number of questions of a certain type. Even though, this one aspect of types of questions asked cannot be used as a measure of the quality of the lessons in general, especially taking into account all the limitations listed above, it can give a general idea of how much thinking (i.e. problem solving) students were involved in on the lesson and may allow us to make certain assumptions on the quality of dialogue and questioning happening in the classroom.

The second aspect of the **(1) Dialogue and Questioning** which was measured in the study is the **(1.3) ability to give students time to think**. The researcher counted the number of seconds that a teacher gave students to think on a question before (s)he provided any help or asked another student to reply.

The longest waiting time identified belongs to T2-nk. Out of the 20 'waiting' instances identified during September 25 lessons, 11 (or 55%) of them last six seconds and more. The second pair of lessons counts seven waiting instances with two of them being equal to or lasting longer than six seconds. As for the third pair of lessons, eight waiting instances (or 62%) out of 13 are of six and more seconds. The longest waiting time identified for T2-nk is 12 seconds. Sometimes a teacher asked a question and then repeated it after a student kept silence and gave more time to think. That is why some waiting times are as long as 11 and 12 seconds.

T2-iv and T6-as are less patient with the average waiting time of three seconds for T1-iv and two seconds of waiting time for T6-as.

What concerns non-experienced teachers, it was difficult to count waiting time for T4-os because it seems that the teacher does not have a habit of working with individual students and pursuing their reasoning. Since the majority of questions asked were WHAT questions, one specific answer was expected and if a student was not able to provide it a teacher picked up very quickly another student who was ready to help. The waiting time was rather inexistent. A similar situation was identified for T3-sg with

probably only one situation where a teacher talked to one student. If we look at that dialogue (Table 40) we can make some assumptions.

Table 40 Extract of a dialogue from T3-sg lesson (May 22, 2014)

Time	Text
	Task: Can someone describe a food? What can you say about a food? The others guess.
04:04 - 04:13	S: It have cheese and it can have anything in it...that food. [T.is writing sentence on board.]
04:19-04:20	T: can you tell us more?
04:21	Now, do you remember we had these things before? Maybe this can help. Do you remember? We had this? Do you remember it, in your notebooks? And these things on the wall can help. Have a look. Can you help? Can you say more? You can think about these ones.
04:45 - 04:56	[S is thinking] [T. Is pronouncing a text] because I think everybody doesn't understand [incomprehensible]. You have to say more. They are good clues but I think not everyone knows. What else can you tell us?
04:57	T: What size, what shape, what colour?
05:00 - 05:02	[Ss is thinking]
05:03	Can you tell us more?
05:05	S: it's round [T.is writing on board.]
05:12	Anything else?
05:13 - 05:18	[Ss is thinking]
05:19	T: You can ask if somebody knows
05:20	S: It's junk food [T.is writing on board.]
05:37-05:49	S1 is guessing: meatballs T: Is there cheese in meatballs? Maybe not.
05:50-05:52	Can you say something else about it?
05:54 - 05:58	S: It can be big and small...and medium.
05:59 - 06:09	T: Ah, so it can be any size, big, small or medium. [T.is writing on board.]
06:10 - 06:14	S: [calls a Ss] Catarina Catarina: a pizza S: that's right

We can see that when a student was stuck for the first time, the teacher did not give any time to think after prompting a student to share more features of a food he was thinking about (04:19 – 04:21 episode). Right after inviting to share more the teacher reminded a student about a tool they have been developing. So a waiting time was only a second and a student did not even have the chance to give it a thought. The second waiting episode is longer (04:45 – 04:56) with a teacher waiting for 11 seconds while student is thinking of a new feature and giving it two seconds more after asking a guiding question “what size, what shape, what colour”. Waiting for so

long and asking prompting questions gave its results and a student was able to come up with one more feature. The last waiting episode (05:13 – 05:18) lasted for six seconds giving a student enough time to think. So we can assume that when the task allows it a teacher may have the tendency to give enough time for a student to think. At the same time, we should be cautious since this assumption is made on the basis of one example only. More evidence would be needed.

One measurement unit of the **(2) quality of student engagement** is also connected to waiting time. This time the researcher counted (a) the number of seconds given to a class to think on a question before someone was invited to share his opinion. Since some students are always more active than others, not giving enough time to think may result in a teacher working all the time with the same students and not engaging all the class in the work. Therefore, it is important that there is a certain encouragement for participation and a waiting time before a student is invited to speak.

Just as with the previous criteria, the longest waiting time was identified for T4-nk whose waiting time was six seconds and longer for 27%, 67% and 50% of all the waiting instances during three lesson pairs respectively. The longest waiting time identified was 34 and 27 seconds. Both T1-iv and T6-as also have quite long waiting times. For T1-iv 26% and 17% of all waiting instances were equal to or longer than six seconds, and for T1-iv, 14% and 40% of all waiting instances for two lessons respectively. In contrast to his colleagues, T6-as does not necessarily call students to respond but is rather waiting till someone voices his opinion. Students do not always raise their hands but sometimes merely voice out their idea when they have one. So the waiting time may depend on how quickly a student comes up with an idea rather than how much a teacher would be waiting until he decides who exactly is going to share an idea. So there may not be a clear culture of raised hands on the lessons of T6-as which is obviously present on the lessons of T1-iv and T2-nk.

What concerns non-experienced teachers, it was identified that T4-os does not give more than two seconds of waiting time and picks up a student practically immediately after a question was asked. In fact, the classroom discussions resemble more a teacher-classroom interaction rather than a teacher-student interaction since some

students voice their opinion out loud even if a teacher reminds the class from time to time that they have to raise hands. We can assume that the culture of raised hands has not been reinforced. On T3-sg lessons, on the other hand, students do raise their hands and do not voice anything out before being called. The waiting time for engaging students, however, was not very long and only in a few instances a teacher would wait for three seconds and more before calling out a student.

Another unit for measuring the quality of student engagement is **(b, c)** checking whether the first student who is invited to speak is the one who was the first to raise his hand and checking whether this is all the time the same student who is speaking. In the case of T1-iv and T2-nk, it was identified that the teacher engages different students in the dialogue and does not have the habit of calling the first student who raises his hand. What concerns T6-as, as mentioned above, it seems that the teacher did not establish a culture of the 'raised hand' so those students who are more active have more possibility to participate since they dare to voice their opinion more often. This is supported by one more unit for measuring the quality of engagement that of **(d)** the number of students who are invited to voice their answer after the first student gives his opinion. The analysis revealed that T6-as involved one or two students on average in voicing out their opinion after the first student shared his point of view. We can assume then that the teacher does not hold control on student engagement and relies more on student initiative. What concerns T1-iv and T2-nk the engagement rate was identified to be around 4 students per question on average. The lesson analyses gives evidence that T1-iv and T2-nk are concerned with student engagement and consciously work on involving all students in classroom work.

As for non-experienced teachers, there is not enough data to make any assumptions because their lessons did not have enough examples of open conversations. As mentioned above, the majority of questions asked by T4-os were knowledge-based questions so if a student knew the answer, he raised a hand and could voice his reply. If the reply was correct, there was no more need to seek for the reply of other students. If it was wrong, the second student would normally correct the mistake. It could have been noticed, however, that T4-os never encouraged students to raise

their hands and participate but merely worked with those who showed interest themselves.

The last criterion which is left refers to the quality of the **Dialogue and Questioning** and measures the **(1.2.) ability to deal adequately with students incorrect, incomplete or wrong answers**. Taking into account there were no real dialogues with students during T3-sg and T4-os lessons, I could identify the strategies only for experienced teachers. The major characteristic of the strategies of T1-iv, T2-nk and T6-as include:

1. Absence of an immediate rejection of the wrong answer. A teacher would privilege another way of showing student that his reasoning has faults.
2. Giving an example which would make a student see there is fault;
3. Asking some guiding questions which would make a student see there is fault;
4. Paraphrasing the question;
5. Pursuing students' reasoning by asking to elaborate on the answer and explain or prove it.
6. Asking 'is it so?' question with a tone which would indicate doubt on behalf of the teacher;
7. Asking students to check their notes (results of the previous lessons) which should lead to their understanding of the problem with their reasoning;
8. Giving an additional task which should lead to students understanding the problem with their reasoning.

As mentioned above, the strategy of immediate rejection of an answer was used very seldom. Other strategies used which served to encourage students to express their opinions without being afraid of failure. What was interesting to notice in T2-nk strategies is that the teacher is rather often using a neutral voice tone for accepting students' correct answers. This is important if a teacher wants to engage several students in a dialogue and make sure as many students as possible understand and follow the conversation.

These are the main results which were revealed during the analysis of teachers' instruction and interaction. We can use these results to build and complete teachers' praxeological profiles.

3.3.5. Discussion of the Results: Description of Teaching Praxeologies

The studies helped me to identify the main components of teaching praxeologies of teachers who work on implementing the problem-centred education. The following components seem to be important and reflect a certain level of competence in the domain of organising the problem-centred education:

- Lesson aims:
 - Planning lessons from competences that students have to develop AND providing motivating context of the task, within which students would work on developing this competency. The aim may be formulated as:
 - How to compare (*punctuation marks*);
 - How to write a (*qualitative text*);
 - How to define (*a problem*);
 - How to describe (*foods in English*);
 - How to assess (*the quality of an answer*)
 - Discussing lesson and task aims with students;
- Format of instruction: Organising instruction in a 'loop' format, where the aim of teacher-student interaction is to improve the first result produced by students or help them get out of difficulty;
- Building certain classroom culture:
 - Discussing expectations in the beginning of the teaching-learning process and agreeing on certain rules: teacher's attitude to 'wrong' answers and "I don't know" replies;
- Introducing new way of working:
 - Introducing explicitly new types of tasks, e.g. sorting task;
 - Introducing explicitly new meta-tools (e.g. ENV) and agreeing on terminology;
 - Connecting new format of work (meta-tools and strategy building) to the content of the lesson subject (e.g. ENV and how it helps to learn about punctuation marks in Russian)

- Keeping track of a developed strategy in a tangible, accessible format:
 - Writing individual conclusions in worksheets, note books, portfolios, etc.
 - Developing a general tool on the board and making it accessible;
- Controlling the quality of teacher-student interaction
 - Ask students develop, specify, explain their ideas;
 - Ask students explain why-s and how-s;
 - Give students time to think;
 - Engage all class: wait, select less active as well as more active, ask as many as possible;
 - React properly to correct, erroneous and wrong answers.

Different combinations of these components were identified in expert teachers' praxeologies.

For instance, T1-iv seems to have a rich combination of essential components (Figure 39).

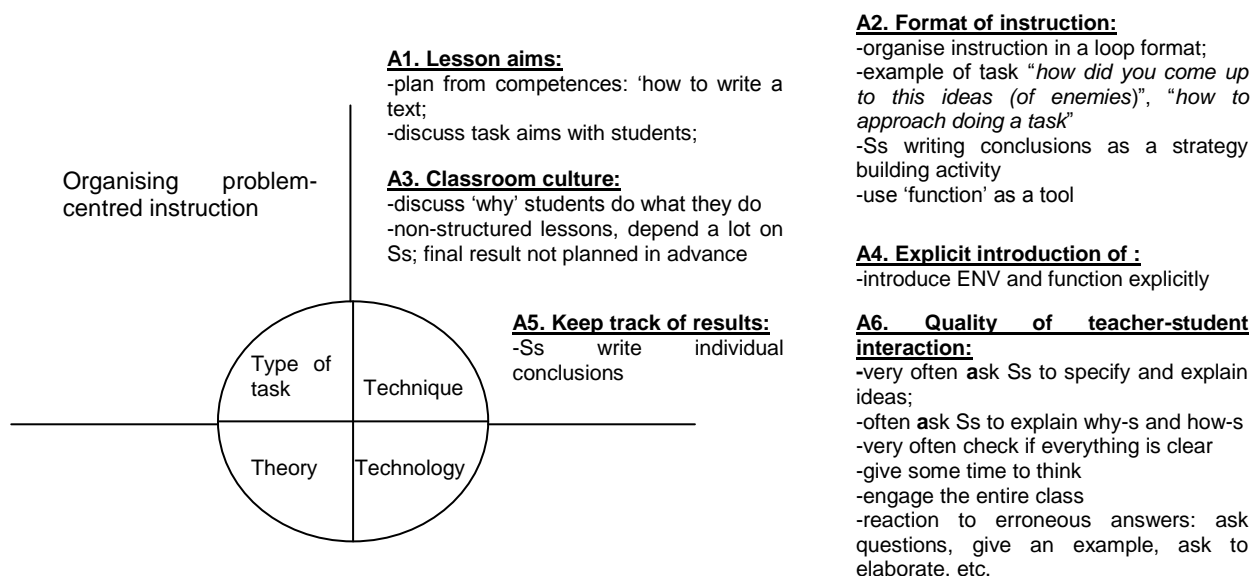


Figure 39 Praxeology of T1-iv. Type of task: organising problem-centred instruction.

She (A1) plans lessons from competences students have to develop (however, the context selected for doing it may not have been the most successful since students did not accept the challenge eagerly), (A2) organises instruction in a loop format,

(A5) makes students write individual conclusions which serve as a strategy. Moreover, (A6) her interaction with students has various features of a qualitative interaction. During the first year of working with the problem-centred approach the teacher acknowledged to (A3) discuss a lot the aims and reasons behind the approach with students and to (A4) introduce ENV meta-tool. Even though the teacher acknowledges that during the previous years students built certain strategies, (A5) there is no available draft that students could keep on working this year, therefore this component is not features in T1-iv's praxeology.

T2-nk praxeology is very close to that one of T1-iv (Figure 40). She (A1) plans her lessons from a long-term perspective and aims at the development of students' ability to describe and compare objects of study. In the context of her lessons, the development of the comparison skills is done in the context of the study of punctuation marks which should lead to their correct usage in sentences. The description and comparison is done with the help of the ENV meta-tool. Both lesson and task aims are constantly discussed with students.

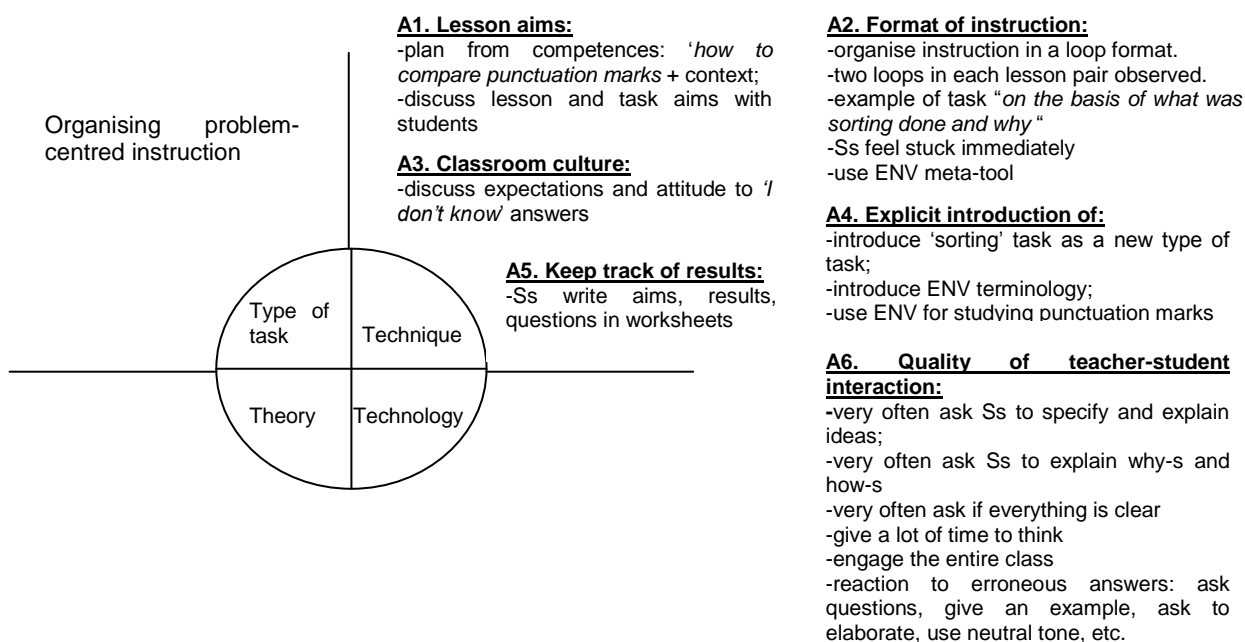


Figure 40 Praxeology of T2-nk. Type of task: organising problem-centred instruction.

Since this is the first year the teacher worked with this class and the observed lessons were among the first ones conducted in the framework of the problem-

centred education, the teacher (A3) worked on building a certain classroom culture, discussing with students why 'I don't know' answers are not acceptable and what would be a better alternative. She also (A4) introduced new types of tasks and ENV terminology, giving students opportunities to understand their meanings. The observed lessons were (A2) organised in a loop format and students (A5) took notes in worksheets gradually developing their strategies. The quality of teacher-student interaction (A6) was of a very high quality with the teacher constantly pursuing students' reasoning and engaging all students in the process.

A combination of essential components was identified in T6-as praxeology (Figure 41).

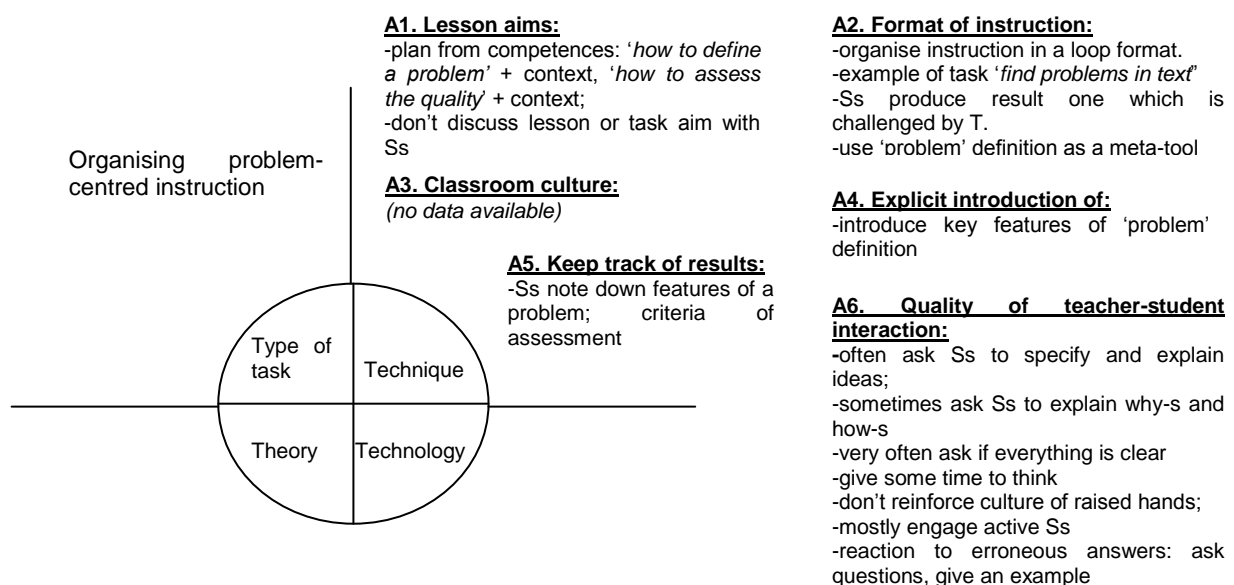


Figure 41 Praxeology of T6-as. Type of task: organising problem-centred instruction.

The teacher (A1) both formulates lesson aims as 'how to' statements for students to acquire and succeeds in offering a context in which students (A2) act and fail and thus require help to get out of the cognitive conflict. In the process of work (A4) the definition of a problem is introduced through students' activity and not passively explained. Students (A5) write down the conclusions, thus keeping track of the strategy. The difference with T1-iv and T2-nk teachers' praxeologies is that (A3) there is no information on how the classroom culture was built. It is also worth mentioning that T6-as (A1) does not discuss lesson or task aims with students. Moreover, (A6)

the students' engagement is not being controlled a lot by T6-as, despite which, the general quality of teacher-student interaction remains high.

Looking at the praxeologies of non-experienced teachers, T3-sg and T4-os (Figure 42, Figure 43), we can make the following observations.

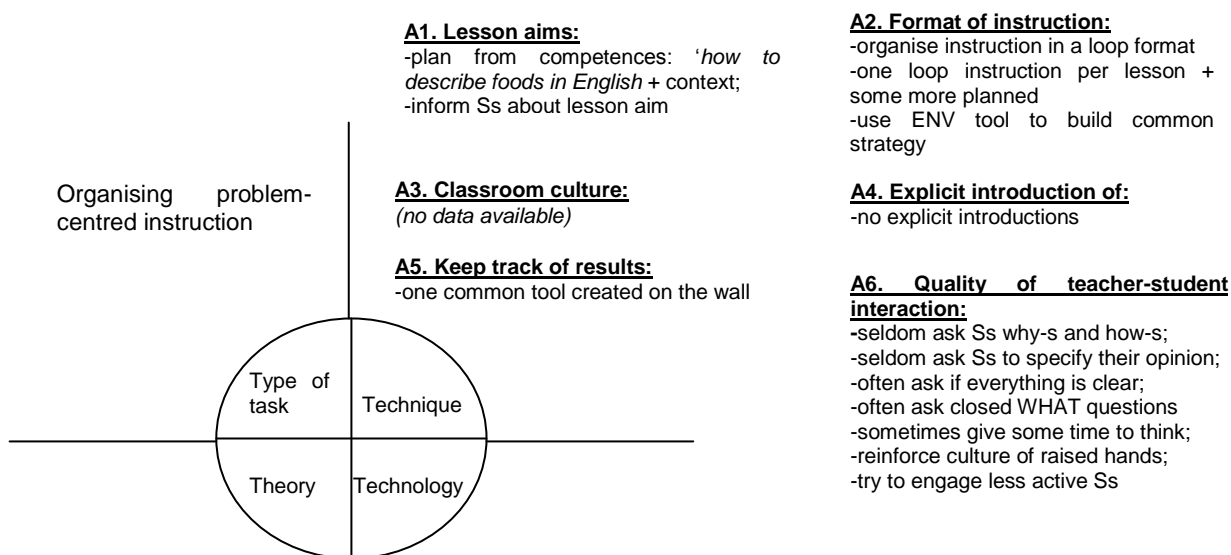


Figure 42 Praxeology of T3-sg. Type of task: organising problem-centred instruction.

Even though both teachers seem to be planning from competences students have to acquire, only T3-sg seems to succeed in creating a relevant context for students to experience cognitive conflict, accept the challenge, develop and use the tool. And only the instruction of T3-sg has one identified loop and several loops which are planned ahead.

Another slight difference between the two teachers is the quality of teacher-student interaction. When given the opportunity, T3-sg seems to give students a bit more time to think, tries to engage more students in the conversation and has an established culture of raised hands. In terms of the types of the questions asked, T3-sg seems to have less closed WHAT questions and more CLEAR questions than T4-os. In terms of keeping track of the results, even if we could observe T3-sg building a common tool on the wall, it is difficult to say whether T4-os would finally have a common (or individual) tool as well since the lessons observed were only the

beginning of the process. At the same time, taking into account there was no tool developed after the first lesson observed, we can assume that keeping track of the results in terms of the developed tools and strategies and their further application is not currently planned by T4-os.

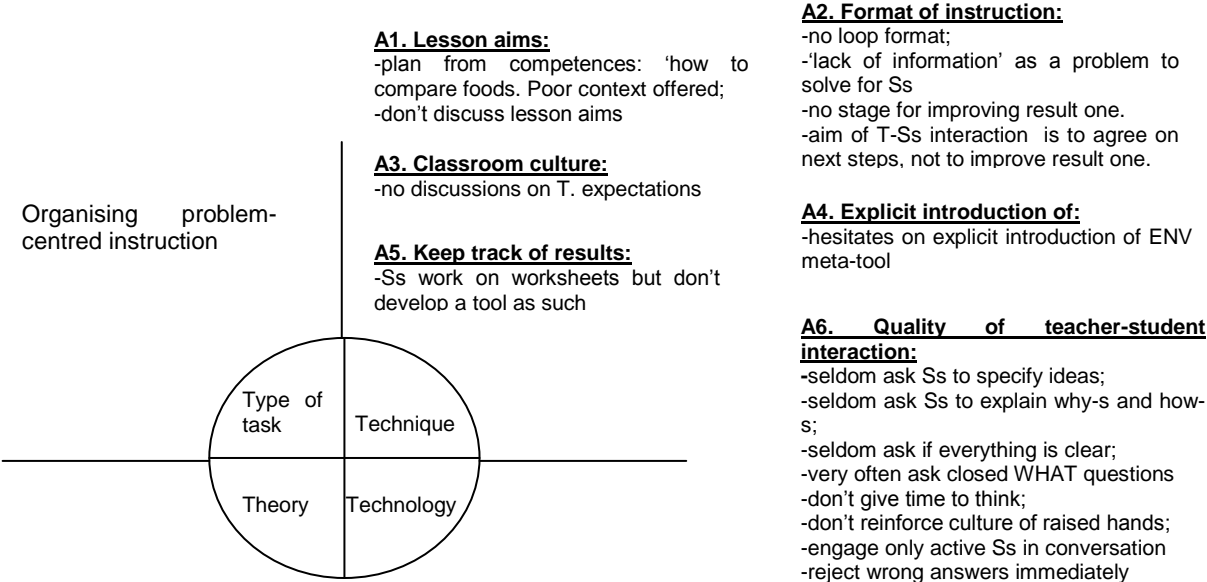


Figure 43 Praxeology of T4-os. Type of task: organising problem-centred instruction.

After analysing and comparing the praxeologies of teachers under study, I can make some tentative conclusions and hypothesis:

- Taking into account that all experienced teachers share a loop instruction (Figure 32) in their teaching praxeologies, we can assume that it has an important role to play in the instruction directed at the development of students' problem solving competence within the problem-centred education. The hypothesis which I would like to advance is that if a teacher regularly organises his instruction in a loop format, then the organised process has a strong chance to lead to the development of students' problem solving competence. This is due to the fact that a loop instruction has the potential to ensure the presence of three major components: students experience cognitive conflict, qualitative teacher-student interaction aimed at helping

students get out of cognitive conflict, space and time for strategy building. However, all the experienced teachers also have a high quality of teacher-student interaction, so we can assume that only loop instruction together with qualitative interaction can lead to a successful teaching result.

The further study is required in order to prove this hypothesis.

- Qualitative teacher-student interaction being an important factor in the loop instruction, the second hypothesis I would like to advance is in its respect. If a teacher who does not work on the problem-centred education has a high quality of teacher-student interaction, then he will be more successful in developing loop instruction and, thus, implementing the problem-centred approach on his lessons. As discussed above, the results show that non experienced teachers' (T3-sg and T4-os) instruction differs in two respects: T3-sg is much closer to a loop instruction in her practice and at the same time she has a better quality of teacher-student interaction. This allows me to assume that the ability to listen to students, pursue their reasoning and engage them appropriately in the discussion is a threshold competency a teachers should have if (s)he wants to become successful in organising a loop instruction and consequently implementing the problem-centred approach.

The given hypothesis has to be verified. Moreover, it would be important to identify which exactly features of the teacher-student interaction play more important role in helping teachers develop a loop instruction.

It is worth mentioning some limitations of the undertaken studies. As mentioned elsewhere, all the participants of the second study are school teachers. So we cannot assume that the loop instruction and the quality of the teacher-student interaction would seem to have as important role as I assume they do in the instruction of the school teachers under study. Moreover, it is also important to remember that the studies included a limited number of lessons so the assumptions were made on the basis of the available data only. More data would be required in order to reinforce the hypothesis advanced as a result of lesson analysis. At the same time, the analytical process was very meticulous making it very time consuming and analysing more lessons would be very difficult in terms of time frames. Now when the first results

have been made available, analysis of newly collected data may be easier because the object of the study is much clearer and one can purposefully look for the loop instruction or its absence. However, on the other hand, having a clear idea in mind may obscure a potential discovery, which the undertaken studies could not identify. Therefore, for the further studies, it would be useful to think of how to improve the efficiency of the analysis in terms of time without losing in quality.

Last but not least, it would be useful to supplement the collected data with additional information in order to get a triangulation of the results and/or new insights into the question under study. For instance, impartial lesson observation, discussion with teachers about the loop instruction and quality of interaction, analysis of teachers' reflections or descriptions of their lessons where they try to identify loop instruction, etc..

After undertaking both theoretical and practical analysis of teaching competencies and praxeologies for organising the problem-centred teaching-learning process, I can proceed to making the final conclusions.

Conclusion

In my research I was interested in the question of teachers and how they transform certain competences into their real practice. **The topicality of my research** was supported by the general **contradiction between** the need imposed by the knowledge society to develop problem-solving and higher-order cognitive skills of learners **and** the lack of teaching competence for the relevant teaching-learning process. I focused specifically on the teaching competence required for the problem-centred education (PCE). The choice of focusing specifically on PCE was based on several pillars:

- In comparison to other existing approaches and methods, the PCE is based on the problem-solving theories – OTSM-TRIZ – and explicitly aims at the development of learners' worldview centred on a problem;
- PCE offers specific meta-tools for developing learners problem-solving competence;
- A well described list of the so called inventive thinking skills that shows a clear list of cognitive skills which PCE targets to develop is available. It clearly distinguishes the PCE from other approaches that target other higher order cognitive skills and can be used for building tests to measure the efficiency of the teaching-learning process.
- Some tentative conclusions on the efficiency of PCE are supported by the research;
- The researcher has been personally interested in OTSM-TRIZ theory in general and the PCE in particular.

Since the research presupposed the study of teachers' real practice I used the anthropological theory of the didactics (ATD) and namely its core notion praxeology, and defined the object of my research as teaching praxeologies for the problem-centred teaching learning process. It allowed me to make a distinction between the notion of abstract competences and real praxeologies of teachers. Competences were seen as externally imposed lists of a set of knowledge, skills and values which are required from a person to perform a certain function, a certain job. Praxeology, on the other hand, is practice which belongs to a certain human being influenced by his social and cultural milieu. The study of praxeologies allows to identify what happens

in real life and how a certain abstract object, such as teaching competences, manifests itself in the real practice.

One of **the innovative aspects** of the research is that I proceeded from identifying teaching competences (the external demands), exploring in particular the competences required for the problem-centred teaching-learning process, and continued by the study of real practice, teaching praxeologies, exploring how teaching competences manifest themselves in real life.

By studying and comparing praxeologies, I expected to find the answer to the research questions:

1. How do teachers transform the theory connected to the problem-centred education into their classroom practice?
2. What are the difficulties and constraints that teachers face when trying to acquire components of the teaching competence required for organising the problem-centred teaching-learning process?

In order to answer the first research question I studied teachers' real classroom practice. The result of the study showed that there seems to be several important components of teachers' problem-centred instruction. These include loop instruction, aim discussion with students, keeping track of the developed strategy and the quality of teacher-student interaction.

A tentative hypothesis was made that the presence of the loop instruction in a teacher's praxeology would mean that there is a high potential that the teacher can develop inventive thinking skills of students.

Another tentative hypothesis was connected to establishing the link between the quality of teacher-student interaction and the loop instruction. The component of teacher-student interaction is common for the loop instruction (namely its stage 2, teacher-student interaction that should lead students to the learning activity on improving their first result) and is a separate component in the instruction as such. It is assumed that high quality of teacher-student interaction is a threshold which allows a teacher to develop loop instruction easier. The study showed that less experienced teacher whose instruction resembles that one of the loop has a better quality of teacher-student interaction than her less experienced colleague whose instruction

does not correspond to the identified loop. So it seems that the teacher has to be able to listen to students and engage the class in order to become successful in building a loop instruction. So one possible answer to the first research question - how teachers transform the theory connected to the problem-centred education into their practice – is that they do it by building on the competency of teacher-student interaction.

Both hypotheses require more research in order to be confirmed. Since the given study has an explorative nature and belongs to purely qualitative studies, I allow myself to finish it with the construction of the hypotheses rather than their proof. Figure 44 shows links between teaching competences for the problem-centred education constructed on the basis of the two hypotheses.

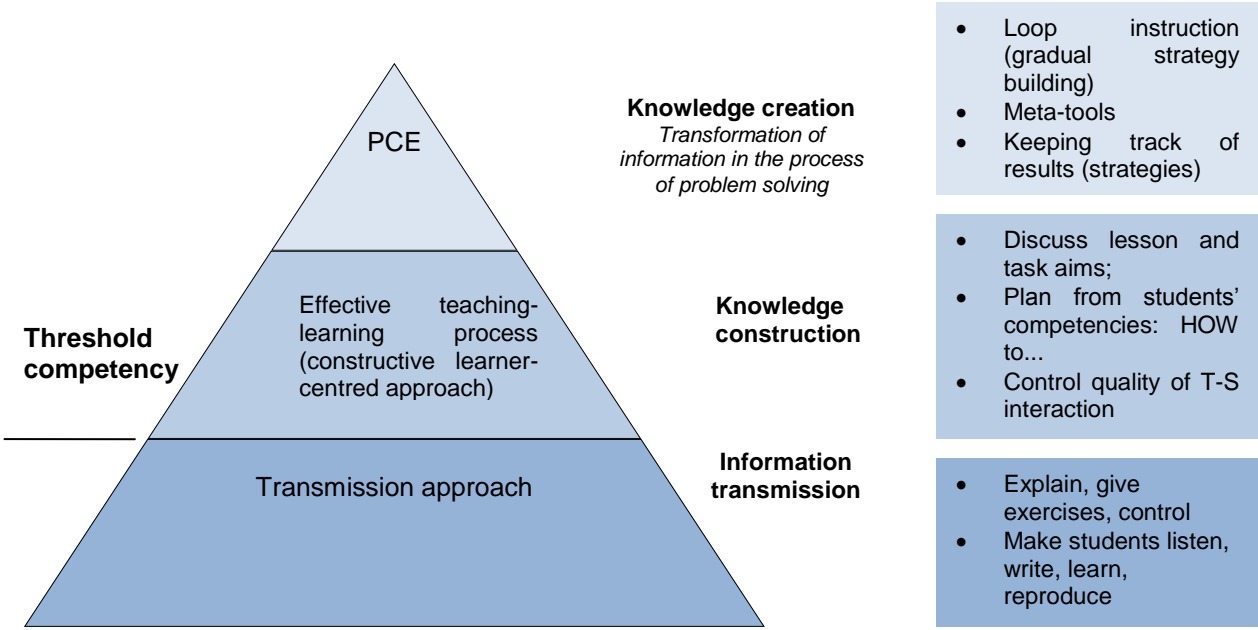


Figure 44 Links between teaching competences for the problem-centred education (constructed hypothesis)

In order to shed the light to the second research question, - what are the difficulties and constraints that teachers face when trying to acquire components of the problem-centred teaching competence – I analysed teachers’ replies to written questions.

It was identified that one of the difficulty faced by teachers is the lack of awareness that a limitation or an obstacle in a task is the key for creating cognitive conflict in students' minds. Some teachers merely listed different types of tasks claiming these would create a cognitive conflict instead of identifying a limitation in those types of tasks which is the real cause for cognitive conflict to appear.

Another difficulty seems to be of a more general nature. Teachers seem to forget about the need to plan lessons from the aim rather than the task and the need to make lesson and task aims explicit to students. Any task students do should serve as a step towards solving a certain problem that students are aware of. The given obvious requirement still seems to remain obscure for some teachers which may be the reason why they face difficulties with the problem-centred approach. The study showed that a non-experienced teacher (T3-sg) who explicitly acknowledges the importance of the aim and its clarity for students had richer praxeological equipment which was more relevant for the problem-centred instruction.

Last but not least, it seems that one more stumbling point for teachers is to visualise the instruction in details for at least one lesson where the teacher would move from step one (challenge) to step two (building solution) and step three (reflection). When asked to clarify how their lessons would unfold, some teachers provide only descriptions of a general nature, which may mean they do not clearly visualise how they would move from one lesson stage to another, what exactly they will do and how students would respond. This is probably not surprising because being able to describe one's instruction in more details would mean that a teacher can assemble all bits and pieces of instruction together and see it in a continuous unity. This seems to be a competency of a higher level.

These are the general conclusions which could have been drawn from the undertaken research.

Coming back to the **innovative aspects** of the research, it is also worth highlighting that in the framework of my thesis, I was studying the approach which has its origins not only in educational sciences but also in the OTSM-TRIZ theory. If some research on the impact of that approach has been conducted (mostly with researchers being expert teachers who ran the experiment with several classes), the given thesis is the

first attempt known to the researcher to study experience of regular teachers on trying to integrate this kind of approach in their own practice. For reaching the understanding of the research object, the researcher combined the study of the theoretical literature on the problem-centred education, research on the so called teaching for thinking approaches as well as research on general effectiveness of the teaching-learning process. First of all, it allowed building a combination of the general aspects of an effective teaching-learning process and then of specific aspects of the problem-centred teaching-learning process. This way the researcher attempted to bring an approach which originated in OTSM-TRIZ theory closer to the professional world of teachers and educators.

Secondly, it gave first ideas on how real teachers integrate the new approach and which potential obstacles prevent them from being more successful. As discussed above, some difficulties seem to be connected to the lack of general pedagogical skills rather than understanding of specific aspects of the problem-centred education.

If we had to make some tentative suggestions for teacher professional development on the basis of the research results, we would highlight the following aspects:

- More attention should be paid to how teachers plan their lessons. Planning from the aim (both content wise and cognitive-thinking wise) should be practiced. Moreover, discussing lesson and task aims with students (or at least informing students about them) should become an indispensable part of the teaching-learning process for any teacher.
- More attention should be paid to helping teachers develop interaction skills with their students (pursuing students reasoning, asking to clarify, explain ideas, engaging all students in the process, giving time to think, etc.). In order for the teaching-learning process to be based on the constructive approach to learning, teachers should learn to listen to their students.
- Attention should be paid to how teachers develop tasks, which have the potential to create cognitive conflict in students' minds. Identifying a limitation or an obstacle which should provoke that conflict should be practiced by teachers.

- *« Comment se fait-il que en Master II on a encore des professeurs qui viennent de nous lire un texte ? Et je dis, 'mais vous êtes pas formé ?'. Il dit 'non, on a jamais été formé à la pédagogie'. Et ça, je n'arrive pas à le comprendre. Il y a une espèce de mythe qui est parce qu'on est bon dans un matière on est un bon enseignant. C'est pas vrai. C'est pas vrai. On peut être excellent dans son domaine et être un très mauvais pédagogue. Comme on peut être moyen dans son domaine et être un excellent pédagogue. Et troisièmement je pense que ça s'enseigne et ça s'apprend. [...] Je pense que pour beaucoup de gens la pédagogie c'est une évidence. Moi je connais mon sujet, je m'assois derrière un bureau, j'ai mon micro donc je sais enseigner. C'est pas vrai».* (François Mazon, ex general director of Cap Gemini France, https://www.youtube.com/watch?v=g_DmEBZwfIM)

Even if any research on teaching has its limitations, it would be unwise to deny that certain teaching competences are indispensable for organising a qualitative learning for students. Very often nowadays we speak about learning and we ignore the second essential component of the process, that of teaching. This may be due to the fact that 'teaching' nowadays has a negative connotation and is very often associated with the old transmission approach, when the teacher was considered to be a wise knowledge bowl whose task was to explain, transmit knowledge to students. However, forgetting 'teaching' in the pedagogical process may lead to an opposite extreme where responsibility for learning is put entirely on students' shoulders. Teaching-learning process has to be a unity of 'teaching' and 'learning', where the teacher, based on his pedagogical and psychological knowledge, organises the process in a way that makes students learn. For this purpose, the teacher needs to possess high quality teaching competences. And I can't agree more with François Mazon, teaching competences have to be developed if we want the teachers to be successful in organising a successful teaching-learning process for their students.

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Appendix 4 Bank of the available research on teachers in the domain of teaching-for-thinking

Appendix 5 Meta-reflection week: raw data (2011)

Appendix 6 Meta-reflection week: content analysis (2011)

Appendix 7 Bank of video data collected for the research (Sep - Oct 2013)

Appendix 8 Non-structured interview with T1-iv before the lesson (September 17, 2013)

Appendix 9 Non-structured interview with T1-iv after the lesson (September 17, 2013)

Appendix 10 Non-structured interview with T2-nk after the lesson (September 25, 2013)

Appendix 11 Non-structured interview with T2-nk after the lesson (October 23, 2013)

Appendix 12 Parsed lesson of T2-nk (September 25, 2013)

Appendix 13 Parsed lesson of T2-nk (October 16, 2013)

Appendix 14 Parsed lesson of T2-nk (October 23, 2013)

Appendix 15 Parsed lessons of T1-iv (September 17, 2013, September 24, 2016)

Appendix 16 Parsed lessons of T6-as (2009)

Appendix 17 Lesson summaries T1-iv (September 17, 2013, September 24, 2016)

Appendix 18 Lesson summaries T2-nk (September 25, 2013, October 16, 2013, October 23, 2013)

Appendix 19 Lesson summaries T6-as (2009)

Appendix 20 Lesson summaries T4-os (September 09, 2013, November 27, 2013)

Appendix 21 Lesson summaries T3-sg (May 22, 2014)

Appendix 22 T3-sg description of her lesson and her reflections on it (May 22, 2014)

Appendix 23 Non-structured interview with T4-os before and after the lesson (September 09, 2013)

Appendix 24 Analysis of teacher-student interaction for T1-iv, T2-nk and T6-as (in four parts)

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Renata JONINA

FROM TEACHING COMPETENCES TO TEACHING PRAXEOLOGIES: THE CASE OF THE PROBLEM-CENTRED EDUCATION

*De la compétence à enseigner aux praxéologies
d'enseignement : le cas de l'éducation centrée sur
la résolution de problèmes*

Summary in French

Cette thèse questionne les pratiques des enseignants et leur capacité à exploiter les appareils théoriques présentés durant leur formation à l'enseignement dans leur pratique quotidienne.

L'objectif est d'analyser des « praxéologies » d'enseignement, au travers de l'étude de la transposition qui s'effectue dans le cas de la formation aux théories de « l'éducation centrée sur la résolution de problèmes (PCE) » vers les pratiques concrètes d'enseignement. Le but est également d'apporter un éclairage sur la question de l'élaboration des compétences à enseigner qui s'appuient sur le modèle PCE.

Les parties théoriques s'emploient à définir la notion de « compétences à enseigner » ainsi que la notion de « l'éducation centrée sur la résolution de problèmes » (PCE). Le but ultime c'est de définir les compétences qui sont indispensables pour l'organisation de l'apprentissage dans le cadre de PCE.

La partie empirique étudie les praxéologies des enseignants qui travaillent avec PCE à travers des observations de cours, des entretiens portant sur leurs pratiques et l'analyse des réponses à un questionnaire lié à l'approche PCE.

L'analyse des données permet de découvrir dans les praxéologies des professeurs des éléments pertinents pour l'enseignement dans le cadre du modèle PCE qui représentent certains indicateurs de compétence. En plus, sur la base de cette analyse, une hypothèse a été avancée sur l'interdépendance de certains éléments.

Mots clés : *compétences à enseigner, praxéologies d'enseignement, enseignement, l'éducation centrée sur la résolution de problèmes, capacités cognitives inventives*

Summary in English

The research addresses the problem of teaching competences and the transposition of certain theoretical understandings into teachers' own practice.

The aim is to study teaching praxeologies of teachers who learn to work with the Problem-Centred Education (PCE) in order to shed light into the question of how teachers construct their teaching competence in this domain.

The theoretical part explores the concept of teaching competences in general and defines those relevant for the Problem-Centred Education in particular. The concept of the Problem-Centred Education is also defined and positioned among the existing 'problem' approaches. The aim is to outline teaching competences relevant for the PCE.

The empirical part aims at studying teachers' understanding and practical application of the Problem-Centred Education through the analysis of teachers' reflections, interviews and classroom practice.

The analysis allowed revealing certain essential components in teachers' praxeologies that are assumed to serve as an indicator of a certain level of teaching competence in the domain of the PCE. A tentative relation between some components has also been suggested.

Key words: Teaching competences, teaching praxeologies, teaching instruction, problem-centred education, inventive thinking skills