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Mobile supported teacher training in Sub-Saharan Africa. Which contributions and how to analyze them?

Eilean von Lautz-Cauzanet

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Mobile supported teacher training in Sub-Saharan Africa:

Which contributions and how to analyze them?

Thèse de doctorat de l'Université Paris-Saclay
préparée à l'École Normale Supérieure de Cachan
(École Normale Supérieure Paris-Saclay)

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Introduction

While the research presented in this dissertation represents a three years process of intensive research, it can actually be considered as education and development journey that started over 9 years ago during an internship at the OECD in 2009: Terms like ‘ICTs’, ‘Web 2.0’ ‘cloud collaboration’ were gaining popularity among education researchers and policy makers, and sometimes used in a somewhat speculative way. During the four months of this internship, my task was to look for evidence on how ‘innovative technology use’ pertaining to the above cited terms might allow improving the quality of higher education. In the end, ‘*might...*’ was the only conclusion I could presented in what would be the first research paper of my career. Its title, “*ICT-based networked collaboration*” was at the time a summary of researchers’ key expectations – it would also be a sort of prophecy of my research interest for the next decade.

Indeed, the ‘*might*’, the lack of actual evidence on implementation and impacts, contrasting with the overall excitement and the presentation of innovative technology solution as ‘miracle solution’ for both developing and developed countries had intrigued me.

During my next research internship at UNESCO Quito in Ecuador, I had once again the task to gather evidence on technology and education, focusing this time mostly on teacher education. More results of the use of telecentres, radio and television based training were becoming available, and both researchers and policy makers were ready to press that innovation and technology would only make sense if they make sense to the teacher. Still: There was no country-wide, large-scale evidence of systematized, ICT based teacher training to be found. Nevertheless, there were an increasing number of traces and attempts, expectations that seemed to be less speculative and more realistic.

The years passed and my journey continued at UNESCO and the UNESCO International Institute for Rural Education (INRULED), a career start strongly influenced by what can be considered as transition between two development phases: The in 2000 initiated Education For All (EFA) movement approached its deadline with mitigated results, and the international community finally adopted in Incheon, Korea the next milestone: The Sustainable Development Goals (SDG) affirm the global engagement towards an inclusive and quality education for all, aiming for the construction of education systems embedded in a process towards sustainability. Progressively, I grasped the magnitude of challenges pertaining to innovation in education and teacher policies, and joined teams and projects that were working on the design of education initiatives aiming for the achievement of these sustainable goals.

I realized that the biggest challenge was finding solutions that take into account the realities and constraints of developing countries – and those of the development cooperation sector.

Constantly, the question of the degree of suitability of innovative solutions to yearlong problems, particularly when it comes to teacher policies, arose and ended-up occupying for good a central place in projects and research I worked on. This tendency was also influenced by what can easily be considered as ‘booming’ growth of the communication sectors in Sub-Saharan Africa – even in those countries whose education situation remained source for concern. More than ever, innovation and technologies, particularly mobile phones, were discussed as a solution. In a certain way, because of their increasing diffusion and adoption rate, mobile phones seemed to be presented as a ‘miracle solution’ which didn’t have to be invented anymore and would be already in the hands of many teachers, ready to learn with quality content ‘everywhere and whenever’ they want.

It was in this context full of promises that, eventually, I was once again intrigued by the discovery of another grey area contrasting with the mostly enthusiastic tone of researchers and policy makers:

Commissioned by INRULED to identify and analyze successful pilot projects using technology for training in rural, developing areas, I discovered the multiple facets of ‘pilot projects’. Looking at their experimentations and looking at the most recent results of the research community, I came to the conclusion that yes, there is some evidence that mobile phones could be realistically used and generate promising contributions for teachers. When I looked however at the reviewed pilot projects, it struck me:

Terms like ‘evaluation’, ‘scale-up’ and ‘sustainability’ were omnipresent in their description and presentation, but in the end, all projects shared one common characteristic: Even the most successful and promising mobile training projects reminded me of ‘one hit wonders’. There were no follow-up, no traces of attempted scale-up; when organizers could be identified and contacted, they were mostly already working on the next call for pilot projects. This lack of impacts and contributions after the end of the pilot was even more surprising as sustainability and research based policy making had overall been considered as key desirable. Indeed, when it comes to education processes and contributions, knowing if, how and why contributions

sustain appears to be indispensable for the development of education policies and projects. This is even more valid as these seek to contribute to a long-term and sustainable improvement of the education situation.

Still, looking at these pilots, there didn't seem to be an answer to the question: What has become of it?

➤ *The structure of this dissertation*

This dissertation seeks to answer this question by analyzing one of the recent mobile teacher training projects: IFADEM in Madagascar. Using a mixed-methodology approach, this dissertation looks the medium-term contributions, how they evolve and which factors influence these contributions.

Following on from this introduction, the narration of the thesis is organized through a further 8 chapters: The first two chapters provide the research context of this dissertation. It exposes the close link between the evolution of education policies, teacher recruitment strategies and the need for a both realistic and qualitative teacher training. After a recall of the exceptional growth of mobile infrastructure sector, the use of distance and notably mobile supported teacher training is discussed with regards to its promising reputation for education. An analysis of recent mobile teacher training projects; with a focus on the IFADEM project in Madagascar will be conducted. The research context allows understanding that there is a clear need for research on the contributions of mobile supported teacher training. Indeed, the review exposed in these first two chapters reveals not only a lack of evidence when it comes to the implementation of mobile teacher training. Most importantly, it is the absence of information on medium-term contributions that is striking, given that educational phenomena and practices that depend on an appropriation process may only be identifiable over time. This issue seems to be closely related to the overall short-term approach of pilot projects.

This overview of the research context naturally leads to the research question of this dissertation, exposed in chapter 3. It exposes those questions which guided the studies aiming to identify the multiple possible natures of sustainable contributions through a multidimensional and longitudinal lens. After a presentation of the theoretical framework which grounded this research, the rationale of the chosen mixed methods methodology, the research design process and used methods will be presented. Chapters 5 to 8 are the core of

the dissertation, each chapter corresponding to one of the four studies which are all inter-related. The first study (Chapter 5), analyzes from an exploratory perspective the reported and observed contributions of the IFADEM training among former participants. It reveals amongst others that the sustaining contributions are mostly mobile phone supported and well embedded in the professional and private sphere of former individuals. These sustainable usages are driven by intrinsic motivation, and sustain because of a strong collective appropriation experience that acted as 'kick off' phase for new practices. Given the domination of mobile usages, the second study (chapter 6) focuses on mobile communications, one of the reported key contributions of the IFADEM training. It confirms the sustainability of phone communications despite the end of external organizational or financial stimuli, and shows also how phone these sustainable communications reflect the ongoing appropriation of mobile for work and private matters.

Using both descriptive and inferential statistics, this chapter allows further to identify those key factors that allow for this appropriation process to happen in the first place. Besides this identification of what can be called 'risk and success factors' for sustainable mobile teacher training contributions, this study reveals also the importance of ongoing peer to peer communication among former participants.

Subsequently, the third study (Chapter 7) analyzes structures and processes of these mobile supported connections. As indicated by respondents interviewed for the first study, the presence of a stable, collaborative teacher network could be confirmed. Its analysis allows qualifying the ties among former participants, which are both of instrumental and expressive nature. Multiple motivations to be part of this network contribute to its sustainability and autonomy over two years after the end of the training, strengthened by the presence of leaders who ensure internal and external information flow. Overall, it provides an additional perspective on the importance and outcomes of a collective appropriation process, and confirms the findings of the previous studies: The sustaining contributions and mobile practices are driven by intrinsic motivation, i.e. the needs for autonomy, competence, and relatedness.

Finally, the fourth study (Chapter 8) shifts perspectives: While the previous studies have focused on teachers' practices, it approaches the question of medium-term contributions and

pertaining factors for sustainability through the lens of organizing stakeholders, i.e. those who fund, organize, design and evaluate mobile teacher training.

This study analyzes how these actors perceive the question of sustainable contributions. It indicates not only that actors perceive themselves as part of a system with considerable political pressure and demands that constraint significantly their activities, leading to a short term perspective on success factors. When analyzing their descriptions of medium term contributions, it could be revealed that not the project beneficiaries (i.e. teachers) but projects partners are considered as both objective and obstacle. The descriptions of these project partners seem to indicate an often difficult and sometimes patronizing relationship, which occupy a central place in projects preoccupations’.

More precisely, actors depict a development policy environment that uses project pilots as organizational and political instruments, and project partner relationships characterized by domination and ‘voluntary’ submission. The collision of a normative discourse of high moral value with a technical and organization oriented discourse is one of the striking results of this study. Overall, it provides an crucial view on how external factors may directly impact on the design of pilots, the achievement of positive contributions and the actual interest to identify the latter.

PART I
Research context

Chapter 1: The teacher training challenge in Africa: Can mobile technology be an appropriate solution for a massive problem?

➤ *The bigger picture on teacher recruitment and the need for a 'new' training approach*

For a better understanding of the need to research the question of teacher training modalities in Sub-Saharan Africa, a preliminary comprehension of their historical context and evolution appears indispensable. In a certain way, the highly topical question of appropriate teacher training is *per se* a progressive result of almost 30 years of teacher policies. These policies, their origins and most importantly, their consequences on the structure of the workforce, have since the 1990 contributed to an often passionate debate on necessary teacher characteristics and their implications for teacher training.

As mile stone within this debate is the *Jomtien World Declaration on Education for All*, (UNESCO 1990) which was adopted in 1990 in light of the dramatic education situation in many developing countries, particularly in the Sub-Saharan region, where 105 million children of primary school age were out of school (UIS Database). The declaration was reaffirmed 10 years later in Senegal during the *World Education Forum* in Dakar. The subsequently adopted Dakar Framework for Action, elaborated as result of the assessment of the progress towards the Jomtien goals, contained six *Education For All Frameworks*. Goal Nr. 2 aims to ensure “*that by 2015 all children [...] have access to and complete free and compulsory primary education of good quality*” (*Dakar Framework for Action*, p.15). This goal was subsequently included among the *Millennium Development Goals* (MDGs) established by the United Nations a few months later (UN, 2010).

During the following decade, being confronted with projection of steadily increasing number of primary school aged children, the increased allocation of funds made it possible for Sub-Saharan countries to make primary education their priority. Structural policies were conducted in view of facilitating the access to primary school, including the abolishment of school fees in many countries, like Benin, Burundi, Mozambique, Uganda and Tanzania. Several key

reforms had a particular focus on teachers, more precisely on their status, salary and level of recruitment. The massive recruitment by governments and local communities of non-civil servant teachers figured among these reforms. Recruitment has been steadily increasing ever since; the proportion of non-civil servant teachers (community and contractual teachers) has even become dominant in some countries, e.g. in Madagascar.

In terms of quantity, this policy allowed to increase the number of children accessing primary education: The number of children enrolled in primary schools constantly rose, e.g. from 82 million in 1999 to 136.4 million in 2011 in Sub-Saharan Africa. In terms of net enrollment this allowed to increase the proportion of 52.6% in 1990 to 78% in 2016. This quantitative success of reforms can't be denied, but is nuanced by the fact that in 2016 there were still over 22% of children between the ages of 6-11 out of school (UIS, 2016).

In parallel to this quantitative success, since 2010, a discussion on the quality and sustainability of these recruitment policies emerged. Several voices claimed that the recruitment of teachers who are not civil-servants and have not received in-service training would necessarily impact negatively on student performance. These voices referred to international evaluations which seemed to prove them right: the level of both teachers (e.g. English or French skills) is worrisome, students' performance decreased throughout the last year. However, certainly counter intuitive and not always well accepted research results indicate that it is certainly an issue to have teachers who lack competences, but that those competences which make a difference have not been provided hitherto in traditional training models. With other words, quality teaching and providing key teacher competences is important, but concerns all teachers: trained civil servants and non-civil, non-trained teachers.

Indeed, it appears that the issue of lacking teaching competencies is independently from so called 'observable' teacher characteristics, and that the largest variance in student performance is actually due to characteristics and interactions which are difficult to observe and to measure. As a result, recent teacher training recommendations shifted progressively, focusing now merely on practice oriented, collaborative and hybrid training schemes, presented as capable to provide teachers with those 'student performance impacting competences'.

In this context, and in light of the massive development of the telecommunication sector in the African region, mobile technologies made their entrance on the education and development scene. Nowadays, they are increasingly discussed as promising training tool and as appropriate approach to take up both the quantitative and qualitative challenge pertaining to teacher training in Sub-Saharan Africa.

Having this simplified, 'bigger picture' of the research context in mind, shall help subsequently to understand the following structure of this chapter:

In the first section of this chapter will be exposed the concrete context and consequences of massive recruitment policies in Sub-Saharan Africa on teacher statuses, followed by a recall of research results on observable and non-observable teacher characteristics on student performance and resulting recommendations on teacher training. Understanding the research findings behind the argument that traditional recruitment and training modalities could not lead to the expected results is indispensable to subsequently understand why mobile supported teacher training is discussed as suitable alternative in the first place. The both infrastructural and educational explications for this supposed alternative, as described by the research literature, are exposed in the second section of this chapter. Finally, this chapter will also show that despite the evidence of high expectations, there is a clear need to adopt a longitudinal perspective on mobile teacher training solutions.

1. Universal Primary Education (UPE), the impact of recruitment policies and the need for a new training approach

A recall of evolutions in teacher salaries, and how they are linked to recruitment and primary education, is indispensable to understand the rationale behind recruitment policies. Teacher salaries are the largest expense in every education system and directly linked to the question of universal primary education. In Sub-Saharan Africa, on average 70% of public expenses in the area of education are allocated to (active) teacher salaries.

Studies involving around 50 developing countries have shown that the level of salaries influences on the performance of an education system: The higher the share of teacher salaries, the less a state is able to recruit teachers, given that its budget is limited (UNESCO et al. 2009). When simulating the completion rate according to the level of salaries, the

mobilized volume of education resources and repetition rate, it appears that for an average African country, the completion rate won't exceed 75% if the salary level is above 3,5 or 4 time the national GDP (Gross Domestic Product). With other words, high salaries lead to a contraction of public education (Mingat 2004).

Understanding this link allows subsequently to understand the rationale behind recruitment policies of the 1990 and 2000 and their consequences on both teacher recruitment, the rise of new statuses and eventually enrolment (PASEC, 2015):

During the economic crisis and subsequently international financial institutions, basing their arguments on research indicating that a high teacher salary like the IMF (International Monetary Fund) pressured African countries to adopt budget reforms including the reduction of government expenditures. These concerned also the salaries of teachers: The World Bank supported reforms that aimed the achievement of *Education for All*, and the IMF had decided in the 1990 that the allowance of loans would be now depend also on reforms concerning the management of the public sector, defining as main goal macroeconomic stability and the resolution of problems related to the economic crisis. The launch of the *Poverty Reduction and Growth Facility* (PRGF), enabling the access of low-income countries to concessional loans for supporting poverty reduction programs and strategies as developed in *Poverty Reduction Strategy Papers* (PRSP), obliged concerned countries to reduce the overall civil service payroll.

Resulting international development strategies and the related recruitment policies of these decades based their recommendations on research results, e.g. from sociologist and economists like Eric Hanushek, establishing an analogy of education to the concept of production (Box 1). They argued that the output school performance would not be linked to the input financial resources. This research found that a decrease in teacher salaries and the recruitment of cheaper teachers without in-service training would not impact negatively on students' performance.

These findings led to reduced civil servant teacher recruitment and a temporary decrease of the teacher workforce volume. Shortly after, the massive recruitment of new teacher types led to a considerable increase of the teachers in Sub-Saharan Africa (UNESCO 2015; de Koning 2013; UNESCO et al. 2009).

Box 1: The concept and debate concerning the education production function – the academic backbone of recruitment policies in the 1990

In order to understand how this introduction of teachers initially conceived as ‘ersatz’ teachers have progressively turned into a massive phenomenon supported by governments, impacted on teacher status policies and, ultimately, enrollment rates, it is important to understand the notion of education production, inextricably related to education and, more precisely, recruitment policies. In 1966, the sociologist Coleman concluded in his study on determinant factors for student learning that there was only a marginal effect of various school inputs on student achievements and compared to the impact of families and friends (Bernard 2007; Coleman 1966).

Based on this study, economists developed the concept of “education productivity”, applying the economic concept of production function in micro-economy: “*Schools are considered as units of productions among which employees (teachers) transform resources (public education expenditures, e.g. positions, training and salary of teachers, school resources, buildings etc.) in human capital (student performance)*” (translated from Universalis, 2017).

Production theory is defined as relationship between the necessary inputs needed to obtain the maximum of a product, and economists seek to measure the link between the resources and the output. In the educational analogy, the concept of maximization of profits equals a maximization of knowledge acquisition. The question of efficiency is approached also in a micro-economic manner: Micro-economy theory considers that firms face technical constraints and that ‘*only a certain combination of inputs allow to produce a given amount of outputs, the firm must chose realistic production plans*’ (Bernard 2007, citing Varian, 1992, p. 320). A more efficient system obtains more output for a given set of resource inputs, or achieves comparable levels of output for fewer inputs, other things being equal. The output of education refers to that portion of student growth or development that can be reasonably attributed to specific educational experiences ((Sifuna et Sawamura 2010).

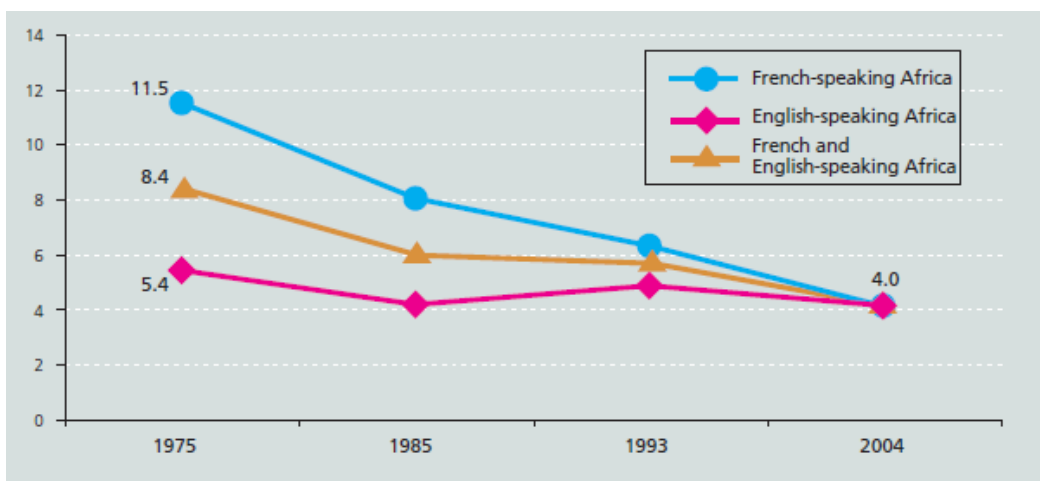
This analogy to production theory was reaffirmed in the 1990 by economists, mainly led by research conducted by Hanushek, who had worked since the 1960 on the question of education productivity and found that there was no statistical significant relationship between budget intensive inputs (i.e. teacher student ratios, teacher qualifications, salaries) on one

hand, and students performance on the other (measured via standardized tests, equaling the measure ('price' in the micro-economy). Hanushek found also that there was no consistent evidence linking student performance to observable teacher characteristics (Rasera 2012; Bernard 2007; Costrell, Hanushek, et Loeb 2008; E. A. Hanushek 1998; E. Hanushek 1996). However, research findings based on this concept of the education production function were questioned with regards to the coherence of considering education as a homogeneous product and discussed as controversial particularly because of their role in determining national and international development policies. Voices accuse international donor agencies to justify policies that implied cuts in public expenses, including teacher salaries by referring to these studies without questioning the validity of the methodological approach and lack of a theoretical framework (Auletto, 2016; Rasera 2012; Bernard 2007).

Overall, salaries were reduced drastically, particularly in former French colonies countries where salaries had been long time adapted to French salaries – exceeding the actual financial capacity of these countries, not capable to hire more teachers with the same cost of unit – and were hence very high in comparison to English speaking nations in Africa.

This is an important aspect and helps to understand the evolution of teacher salaries: it can indeed be ascertained that salaries were almost divided by two between 1975 and 2004 (Figure 1). In francophone countries salaries were almost divided by three (falling from 11,5 times the GDP in 1975 to 4 times the GDP in 2004) converging progressively with the salaries of English speaking countries (Mingat 2004).

Figure 1: Variations in average primary school teacher salary in Africa

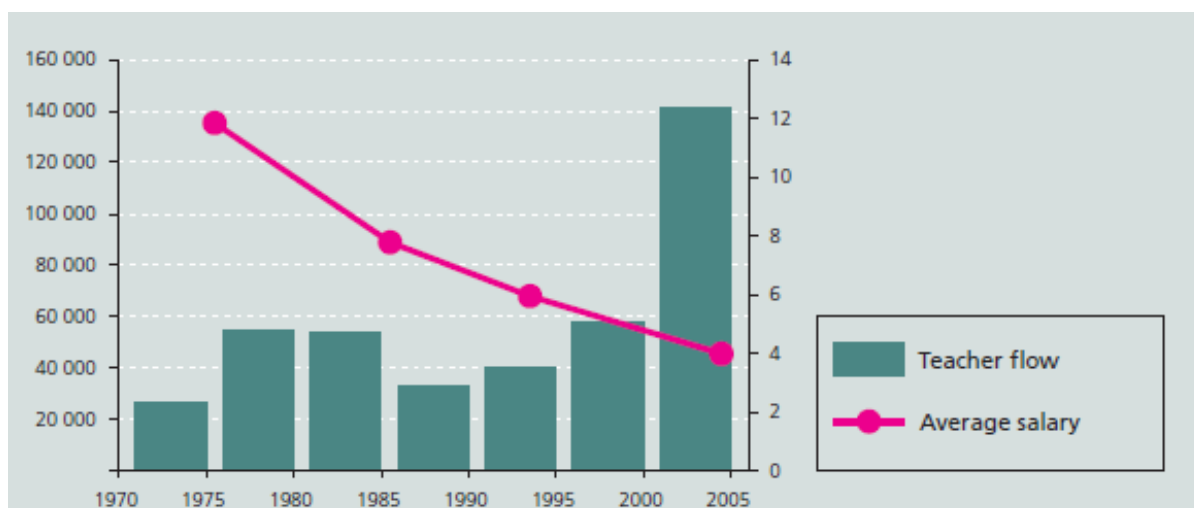


Source: UNESCO, 2009 / Mingat 2004; Salary in terms of x times the regional GDP per capita

First, this decrease in salaries came along with a freezing in recruitment: The objective was clearly to reduce public expenses. After a few years however, the reduction in salaries was related to the attempt to hire, with the same budget, and increased amount of recruited teachers. Indeed, when considering the flow of teachers, a UNESCO study focusing on 15 francophone countries – including Madagascar – shows the recruitment flows of teachers has been multiplied by 5 during the period 1970 – 2005, with a peak between 200 and 2005 (Mingat et Suchaut 2000) (Figure 1)

Even though not entirely separable or build chronologically, it is possible to talk about an evolution characterized by two phases: The first phase can be clearly explained by the difficult economic situation and the pressure of international finance institutions. The second phase of recruitment increase is linked to the first one, but is characterized by a new dynamic: Indeed, communities had spontaneously started to compensate the lack of civil servant teachers, recruiting individuals among the locally most qualified people, mostly without professional training. These choices were stimulated not only by the economic situation, but also by political instability, and civil wars, which made the teaching profession particularly difficult and unattractive in concerned – often rural – areas, e.g. in Central Africa (RESEN 2007).

Figure 2: Changes in average teacher salary (GDP per capita) and teacher recruitment flows in 15 French-speaking African countries



Source: UNESCO, 2009 / Mingat, 2009; Countries : Benin, Burkina Faso, Burundi, Cameroun, Chad, Côte d'Ivoire, Djibouti, Guinea, Madagascar, Mali, Mauritania, Niger, Senegal, Togo and Tunisia.

It appears comprehensive to expect that this massive recruitment of teachers outside of the traditional has had an impact on the characteristics of the teaching workforce and to assume that, ultimately, this would ultimately influence the quality of education. While the following section will indeed show that the massive recruitment came along with a massive structural change, it will then present fairly counter-intuitive on determinant teacher characteristics.

The objective of the following section is to show how research findings on determinant teacher characteristics and competences have ultimately put the question of a designing a teacher training capable to enhance such characteristics and competences in the limelight of both research and policies.

1.1 The choice of a quantitative solution for UPE: Consequence of the introduction of new teacher types

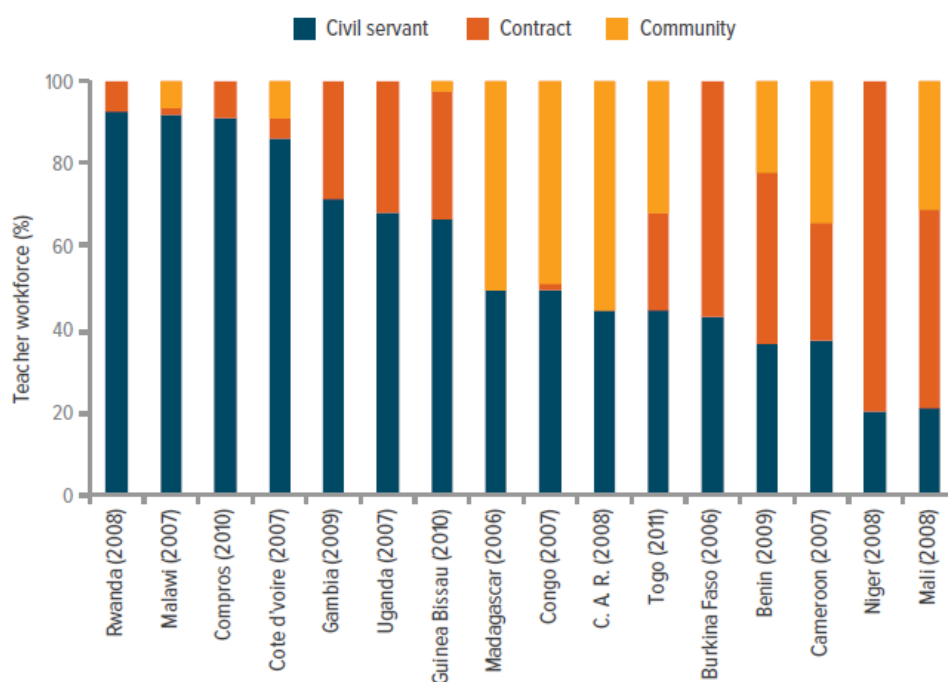
1.1.1 Composition and characteristics of the new teacher workforce

National and international educational initiatives that aimed to enhance further the development of primary education, combined with aggressive policies for the reduction of salaries came along with further restructuring of teacher statuses' (Lauwerier et Akkari 2015).

Pressured by both national and international financial partners, and often financially unable to train at and hire teachers from national teacher training institutes, governments started turning to alternative teachers statuses which had emerged spontaneously. These teachers were teachers who had not the status of civil servants. Often, they were hired spontaneously by the local villages – so called 'community teachers' – or in a more systematic manner by the government – so called 'contractual teachers'.

Today, other than civil servant teachers constitute a significant proportion, and even the majority of primary school teachers in many African countries (Figure 3).

Figure 3: Teacher workforce by contract type, selected countries in sub-Saharan Africa, late 2000s



Source: (UNESCO 2015c)

The massive recruitment of these teachers status has led to a change of the academic profile of the workforce: Indeed, the newly recruited teachers have often a **lower academic level** as well as a lower training profile. Differences can vary according to the national context, but overall the academic level of these different teacher statuses is mostly lower than the one of civil servants, with again some slightly differences between contract and community teachers:

For community teachers, there is often **no minimum requirement** and mostly below higher secondary education. In the case of contractual teachers – and community teachers hired by the government, the academic level is often similar to their peers with a civil servant status. Overall, it is usually higher than the academic level of a regular community teacher (UNESCO et al. 2009).

Today, according to the PASEC 2015 study focusing on francophone countries, pupils of many countries, e.g. Burkina Faso, Côte d'Ivoire and Chad are taught by a teacher who has only a lower or upper secondary education degree. In contrast, teachers with a university

degree a rather rare: Their proportion is mostly below 25% at the end of the primary school cycle and even below 20% in countries like Benin, Burundi, Cameroun, Congo, Niger and Togo.

Besides the overall impact of the recruitment process on the average salary of teachers – evocated earlier in this section - significant differences exist also in terms of salaries and level of training, even if these gaps vary from one country to another: Indeed, as shown by Mingat and Suchaut, a civil servant teacher costs twice as much as contractual teacher and four times more than a community teacher hired by parents (Table 1) (Mingat et Suchaut 2000).

Table 1: Salary level of primary school teachers according to their status (in per-capita GDP units)

Country	Civil Servants	Contractual teacher	Community teacher (hired by parents)
Benin (2002)	5,2	2,1	1,3
Burkina Faso (2002)	5,8	5,6	2,2
Cameroon	5,3	1,4	0,8
Congo	2,4	0,9	0,6
Cote d'Ivoire	4,8	-	-
Guinea	3,5	1,1	-
Mali	5,8	1,5	0,9
Niger	8,9	3,5	-
Senegal	5,7	2,6	-
Chad	8,2	-	2,3
Togo	6,4	3,3	1,3
Average	5,6	2,4	1,3

Source: Bernard, 2008

With regards to **pre-service training**, a large number of non-civil servants have gone through accelerated training or no training at all. Gaps appear to be directly related to different implementation of education reforms in francophone and English speaking countries: While 9 out of 10 students living in countries analyzed in the SACMEQ (mainly English and Portuguese speaking countries) assessment are taught by a teacher who had received at least

one year of training, this ratio drops to only 54% in PASEC (mainly francophone) countries (UNESCO et al. 2009). When it comes to in-class training and professional training, the increase of non – civil servants explains also the very high proportion of primary school teachers who have either none or only than 5 days of training during the last two years (PASEC, 2015).

1.1.2 Impact on enrollments and future needs

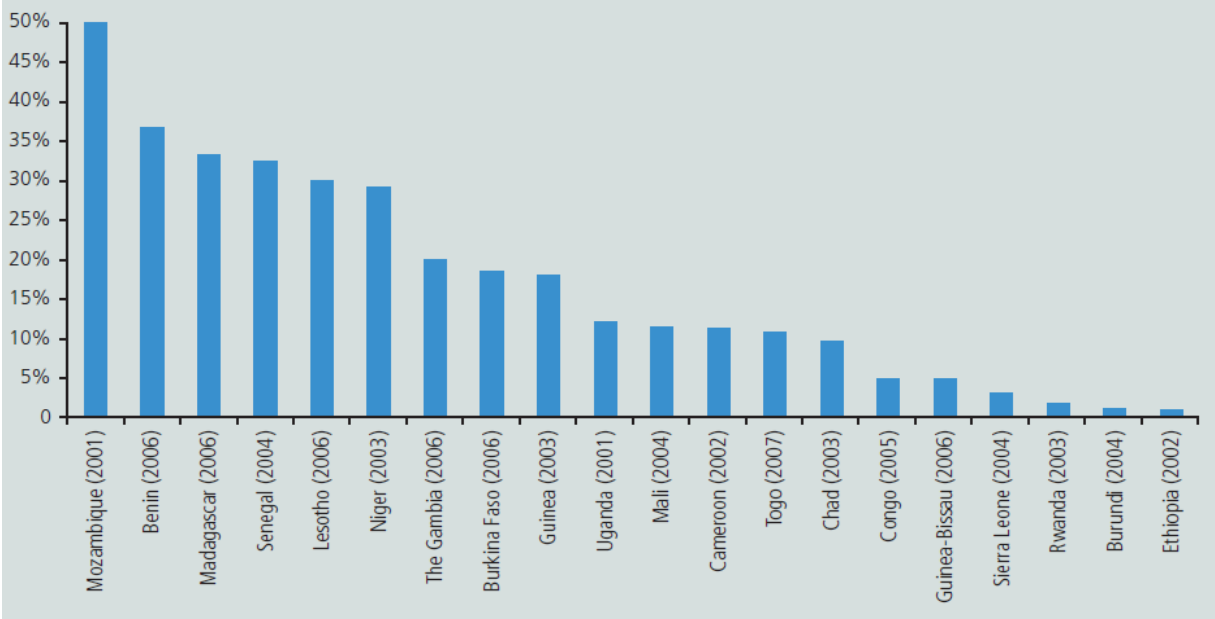
Overall, it can be ascertained that the massive recruitment of community and contract teachers with lower qualifications and training have had a noteworthy influence on UPE. Depending on the country, the intensity of recruitment and level of salaries, this impact is more or less striking. UNESCO has, based on data from 20 African countries, estimated¹ the impact of these recruitment policies on UPE and concluded that these have led to an overall increase in enrolments of 16%, equaling to over 6 million children.

Among those countries which had the most significant ‘enrolment benefit equivalent’ figure Mozambique, Benin, Madagascar, Senegal and Lesotho: between 29 and 50% of potential increase in enrolments is considered as a result of recruiting or subsidizing these new teachers. In Madagascar, it is estimated that by 2006, additional 1 236 239 children had been enrolled thanks to this recruitment policy. These benefits are lower for countries such as Ethiopia, Burundi, Rwanda, Sierra Leone, Guinea-Bissau and Congo, but can’t be denied (Figure 4).

Given the need for massive recruitment of teachers in the future in order to achieve UPE it is likely that these recruitment policies will continue and therefore it is likely that the proportion of non-civil servant teachers increases. This is particularly true for Sub-Saharan Africa, where 67% of the additional primary school teachers needed worldwide between 2012 and 2030 are situated.

¹ This ‘enrollment benefit’ was obtained for a base year for which precise information on teacher payroll is available, by comparing the actual number of pupils enrolled to those that could have been enrolled if the payroll had been exclusively devoted to the recruitment of teachers with the most favourable status and salary. The purpose of this calculation is of course only to give an order of magnitude of the impact of the reforms undertaken by the countries since, over a longer period, a deterioration in pupil-teacher ratios or a reduction in expenditure excluding teacher salary would have enabled an increase in enrolments even if the most favourable conditions of recruitment had been maintained.

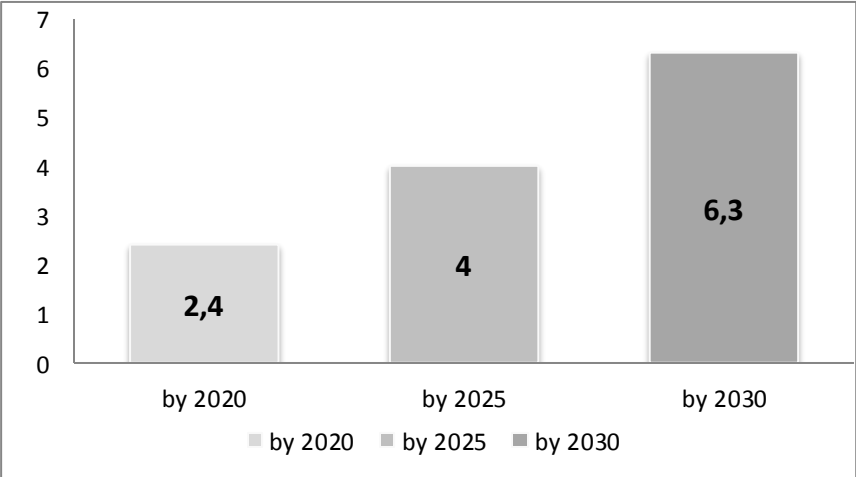
Figure 4: Estimation of increase in enrolments (in %) due to the recruitment of non-civil servant teachers paid by the government (21 African countries)



Source: UNESCO, 2009

More precisely, about additional 6.3 million primary teachers are needed by 2030 in Sub-Saharan Africa: 2.4 million to fill new teaching posts to accommodate all children and another 3.9 million to replace the teachers who retire, change occupations or leave the workforce due to illness or death (UNESCO GMR 2014). In order to achieve UPE by 2020, 2025 and 2030 – taking into consideration the fast growing school-age population – this equals an additional 2 million every 5 years. In Sub-Saharan Africa, more than 70% of countries face shortages of primary school teachers (UIS 2016).

Figure 5: Primary school teachers in Sub-Saharan Africa: Recruitment needs by 2030 (million)



Source: UNESCO Institute of Statistics, 2016

1.2 Concerns about quality

As evocated earlier, it can be considered as a well comprehensible reflex to establish a causal link between the massive recruitment of untrained teachers with lower qualifications and the overall decrease of student performance. While the situation in terms of education quality in Africa is indeed source of concern, research indicates that there is a more complex link between teacher characteristics and quality education.

1.2.1 An unsatisfying situation in terms of qualified teachers and teacher-pupils ratios...

Several voices – e.g. among academics, teacher unions and civil society – have regularly criticized the massive recruitment of non-civil servant and less qualified teachers at lower salaries and training level. They refer to the danger of seeing the quality of education diminished and question studies on the impact of teacher status on student achievements. The sometimes very passionate debate is well reflected by quotations as follows, showing how sensitive the subject has become:

“Children cannot be enrolled in good conditions. School performance is closely connected to the level of teacher qualification. All this is favorable to the government withdrawal sought by the World Bank who, in order to justify its policies, publishes studies indicating that untrained teachers succeed better. Don't go too far.”

(De Ravignan 2007)

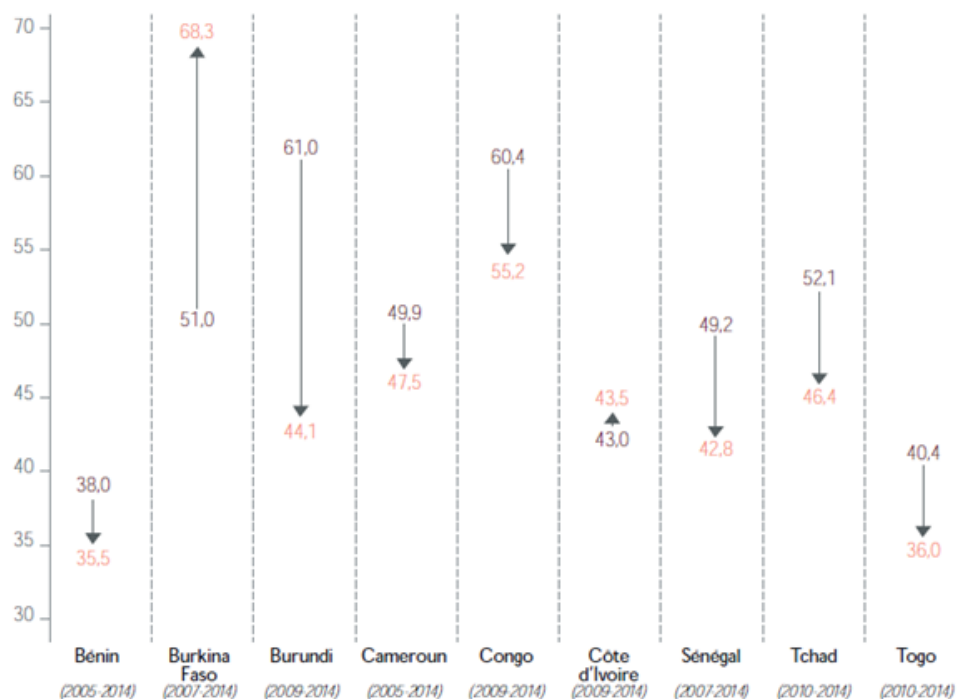
Efforts have been made, e.g. at the Bamako Conference in 2004, to provide the recruitment policies with a framework that would allow non-civil servant primary school teachers to improve their qualifications, career prospects and working conditions.

When criticizing the negative impact of the recruitment policies, voices point towards the stagnation and even increase of Pupil Teacher Ratios – and consider this as a symptom of a recruitment policy that would have failed to ensure quality education. Also, they criticize that this recruitment has led to large amount of teachers who have, according to international tests, no or inadequate competencies, which would in turn, explain the low levels of student performance. In the following will be looked into both problematics before presenting to which extent these issues are *de facto* related to the massive teacher recruitment process.

➤ *No improvement of Teacher – Pupil Ratios*

When addressing the question of quality, the pupil -teacher ratio (PTR) has been considered since the Dakar Forum as measure for assessing progress, a lower PTR considered as important for quality learning. Indeed, PASEC evaluation (2004, 2012, 2015) that large class sizes are negatively correlated with school performance. However, average PTRs have decreased less then hoped in African countries: While in primary education, teacher recruitment grew by 75%, enrolment grew at a pace. With an average of 42 pupils per teacher, Africa is the continent with the highest PTR at the primary level, which is higher than the widely used as maximum considered benchmark of 40:1. In 2012, 23 out of 26 countries (among 161 analyzed) with levels beyond this threshold were located in from Sub-Sharan Africa. In the case of francophone countries, PASEC (2014) has shown that the PTR could be lowered in 8 out of 9 cases. However, besides Benin and Togo, a countries studied besides are characterized by PTRs above the 40:1 benchmark.

Figure 6: Evolution of Pupil Teacher Ratios – Comparison PASEC 2014 with last available PASEC evaluation



Source: PASEC 2014

Furthermore, research suggests that high PTRs cannot be considered as stand-alone indicator for quality education: Hanushek reviewed 96 studies that attempted to link various

educational inputs to student performance in developing countries. 31 of these studies investigated specifically the effect of pupil-teacher ratios, but only 8 identified a significantly association of reduced class sizes with improved academic achievement – a fairly inconclusive finding (Hanushek 1995, 1999).

Later, Hanushek finds that of the best available, single-state, value-added studies of individual classroom achievement, only 4% result in positive and significant small class effects. There are even more studies indicating a negative and significant relation (13%), suggesting that small classes result in poorer student performance (Hanushek 1999)

Table 2: Percentage distribution of effect off class size on student performance

	Statistically significant		Statistically insignificant		Unknown %
	Positive %	Negative %	Positive %	Negative %	
Universe of studies					
All value added studies	12	8	21	26	35
Single state	4	13	30	39	13

Source: Hanushek 1999; Effects based on value added models of individual student performances

These findings have been confirmed since, e.g. by Michaelowa who agreed with Hanushek and finds that the effect of class sizes on the quality of learning is in general very modest and even not significant in the African context (Michaelowa 2003). Furthermore, PASEC 2015 has found that even if there was an effect on student performance, this effect happens to be fairly weak and observable only at the beginning of the primary school cycle. In Kenya for example, by reducing class sizes from 80 to 46, and in the absence of other reforms, the country achieved no significant increase in students' test scores (Duflo, Dupas, et Kremer 2007).

Indeed, literature suggests that a reduction in Pupil - Teacher Ratios is befitting the learning process only if accompanied by other measures, e.g. improved pedagogical methods and competencies ((Duflo, Dupas, et Kremer 2007; Bernard 2007; Bernard, Tiyab, et Vianou 2004; Angrist et Lavy 2001; Mingat et Suchaut 2000)

➤ *High amount of teachers without the necessary competencies and training*

When the massive recruitment of non-civil servant teachers is criticized, voices often refer to the indeed increasing amount of teachers who lack those competencies which are necessary to impact positively on student performance. The lack of these competencies are indeed a source of concern nowadays (Hardman 2015; Dembélé et Lefoka 2007).

Box 2 : Which competencies make the biggest difference?

Based on large scale analysis reviewing over 800 meta-analyses, John Hattie ranked teaching practices according to their effect sizes on performances (Hattie 2008). More precisely, Hattie identified

high-impact, evidence-based teaching strategies:

- Direct Instruction
- Note Taking & Other Study Skills
- Spaced Practice
- Feedback
- Teaching Metacognitive Skills
- Teaching Problem Solving Skills
- Reciprocal Teaching
- Mastery Learning
- Concept Mapping
- Worked Examples

...and teaching strategies that had little or no impact

- Giving students control over their learning
- Problem-based learning
- Teaching test-taking
- Catering to learning styles
- Inquiry-based teaching

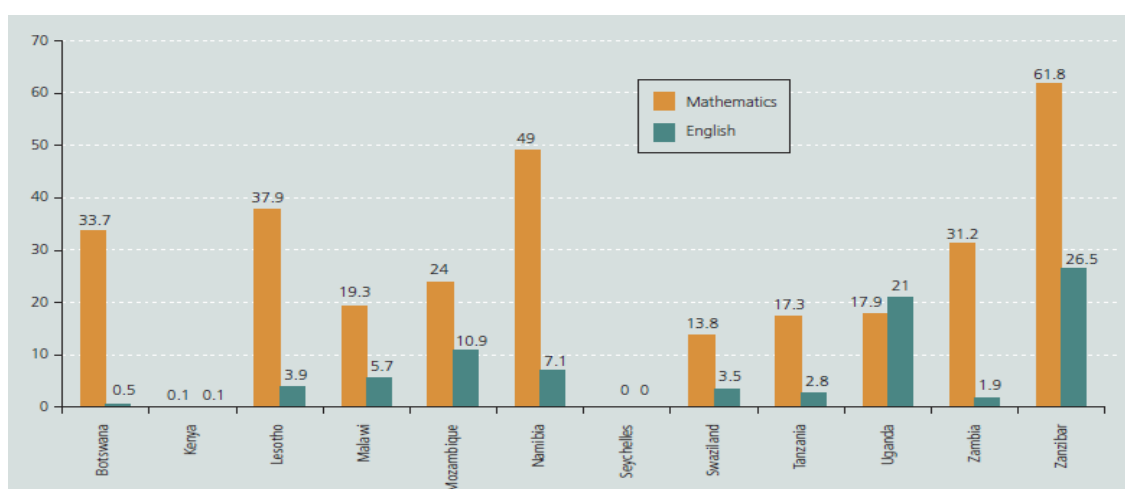
In addition, research agrees that classroom management, formative assessment and personal competencies are crucial and impact positively on student performance (Attakorn et al. 2014; Hattie 2008; Cornelius-White 2007; Evertson 2006; Marzano, Marzano, et Pickering 2003; Walberg 1990).

Research found that teachers in Sub-Saharan Africa are characterized by teacher-fronted methods, made up of teacher-led explanation, recitation, chorus responses and exclusive use of chalk/white board as only resource. This practices have been criticized as they do not support critical thinking, conceptual learning, or problem-solving and teamwork skills and ultimately do not allow pupils to increase efficiently their knowledge (Akyeampong et al. 2013; O’Sullivan 2006; O-saki et Agu 2002; Hornberger et Chick 2001).

In addition to these professional and pedagogical competencies, teachers in Sub-Saharan Africa do also lack the minimum level of reading and mathematics skills:

SACMEC (Southern and Eastern Africa Consortium for Monitoring Educational Quality) results show that 7 % of teachers in the studied countries do not achieve the two highest levels of reading and mathematics, which are however considered as satisfactory threshold for teaching (see Figure 6).

Figure 7: Proportion of teachers who did not achieve level 7 and 8 of the SACMEC assessment in mathematics and English



Source: UNESCO, 2009 based on SACMEC 2 data

PASEC considers the lack of teachers' competencies in mathematics and language also as a problem in the case of the francophone countries covered by the studies and is worried about the consequences: Respectively 70% and 50% of students have not acquired the necessary language and mathematic requirements at the end of the primary school cycle in PASEC countries.

The link between teachers' capacities and student performance appears clearly in the PASEC 2015 assessment: A large majority (82%) of pupils in year 6 declares that lessons focus on reading only, and on grammar and syntax (70%). They report only occasionally practices that implement reading in view of subject comprehension. PASEC analyses that these practices reflect an adaptation of the teacher to both the low level of primary school pupils in the area as well as their own difficulties. Only rarely, oral expression and comprehension are considered as priority – despite the fact that these practices are considered as crucial for the

acquisition of writing skills. Furthermore, the report underlines the importance of ensuring that teachers have linguistic capacities (e.g. French in a French speaking African country), as these are also crucial for the implementation of both language and mathematic lessons, which need to be provided in the mother tongue of the students (PASEC, 2015).

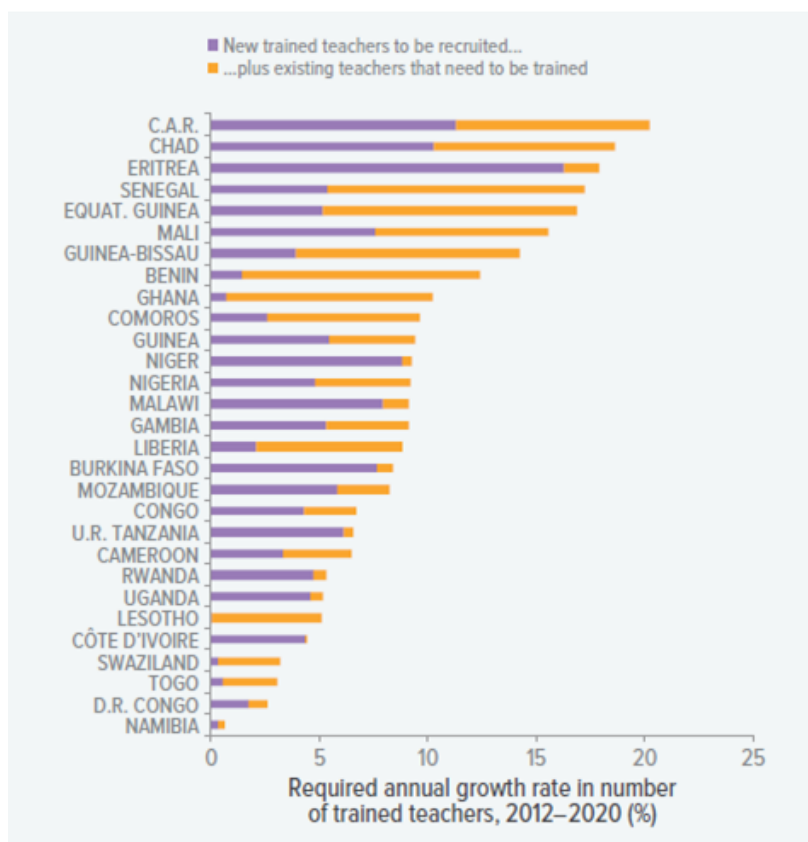
In light of these findings, and considering that the state is in charge of providing teachers with these necessary capacities through systematic training, it is easy to understand why UNESCO talks about a double challenge: African countries do not only have to recruit a high number of teachers, but governments face the additional constraint of finding a solution to provide new and teachers already in post with the competencies they currently lack.

Even more, for 10 out of 29 countries in Sub Saharan Africa including Benin, Equatorial Guinea, Ghana and Liberia, the challenge of training existing teachers is greater than that of recruiting new teachers (UNESCO GMR 2014, p.8). For example, if Chad wants to ensure that by 2020, all children complete primary school and are taught by a trained teacher, it would need not only to increase its workforce in term of proportion by 10% (recruiting only trained teachers) but also provide additional training to 25% of untrained teachers already in class (Figure 8)

The challenge to train teachers is also directly related to the challenge of limiting Pupil-Teacher Ratios: While some countries do not have to *recruit* a large number of teachers to achieve UPE and respect the threshold of 40 pupils per class. However, they face the challenge of training a large number of teachers in order to make sure that students do not only learn in classes smaller than 40, but held by trained teachers with adequate capacities.

The lack of qualified teachers – and very high PTRs – is a particular serious issue in rural and isolated areas. The issue of finding qualified teachers for rural school while facing a surplus of unemployed or underemployed qualified teachers has been widely analyzed in literature, and suggests that the problem of unqualified teachers in rural areas won't be solved by hiring simply more teachers.

Figure 8: Required annual growth in numbers of new and existing trained teachers to reach universal primary education by 2020



Source: EFA Global Monitoring Report team calculations (2014) based on UNESCO Institute of Statistics database

Rural areas have been identified as being less attractive as many teachers do not want to stay in rural areas due to social, professional and cultural isolation (Adedeji and Olaniyan 2011; Mulkeen, 2005). Low salaries, lack of access to professional opportunities and obligation to take on multiple duties make rural teaching even less attractive to qualified teachers (Castle, 1995). These issues, combined with the previously mentioned issues like civil wars, have favored the recruitment of local, community teachers with low capacities.

As a consequence, the PTR ratio is very high in rural areas: In Nigeria for example, the ratio was in 2010 around 1:100 in the rural and poor state Kano. Similar proportions were found in Ethiopia, where respectively only 1 and 4 out of 100 primary school trainers were trained in the rural regions Somali and Afar.

Interestingly, these certainly worrisome proportions of teachers who lack competencies and need to be trained concern all teacher statutes - including civil servants. A more in depth analysis of the link between status, teacher competencies and student performances needs is hence of interest. As criticized in the report the UNESCO report '*The Teacher Challenge*', educational stakeholders rapidly jump to the conclusion that the high amount of unqualified teachers is a problem that has its roots only in the massive recruitment of community and contract teachers, and that it is their recruitment that ultimately explain the low performance of students (UNESCO et al. 2009).

As will be detailed in the following, research results show that this impression does not match the reality. It appears that the nature of the 'teacher challenge' consists in finding a manner to provide adequate in-service teacher training to the workforce as a whole, independently of their status.

1.2.2 ...that cannot be explained by observable teacher characteristics

Willing to explain the significant discrepancies in primary school students performances, an increasing amount of studies have focused on the impact of observable teachers' characteristics on student performance. As presented in the following, research results identified the teacher to occupy a central role when it comes to student performance, but not for the expected reasons: Indeed, findings indicate that observable characteristics as status, diploma, training, experience and gender do barely impact on the variance in student performance (CONFEMEN, PASEC 2017; RESEN 2016).

As can be seen in the case of Mali (Figure 7) pupils with high initial levels are those who achieve the best final outcomes, all other things being equal. However, difficult to observe and measurable teachers characteristics, as well as teachers' interaction within the classroom and their environment are also found to be crucial – particularly when it comes to compensating low initial levels of students.

Box 3: The case of Mali - Analysis of Prior Schooling Factors on the Basis of the Initial Level of Students' Learning Outcomes

	Model 1		Model 2	
	(R ² =0.241)		(R ² =0.242)	
	Coefficient	Sig.	Coefficient	Sig.
Student Variables				
Initial level	0.4258	***	0.4223	***
Female gender	- 0.0844	**	- 0.0780	*
Over-age	0.1241	**	0.1214	*
Repeated Grade 1	- 0.1915	***	- 0.1989	***
Repeated Grade 2	- 0.2373	***	- 0.2438	***
Teacher/Classroom Variables				
Teacher Variables				
Has the DEF (Basic Studies Diploma)	réf		réf	
Has a post-DEF qualification	- 0.3281	ns	- 0.3100	ns
Has less than a DEF qualification	- 0.3570	ns	- 0.3440	ns
Contract status (Ref: civil servant)	0.3034	**		
Basic training of 1 year or more			réf.	
Basic training of 1 year or less			0.3032	ns
Basic training of 1 to 3 months			0.3145	***
Received complementary training	0.0807	ns	0.0733	ns
Classroom variables				
Is Double-Shift	- 0.1997	ns	- 0.1836	ns
Is multi-grade	- 0.0634	ns	- 0.0657	ns
Class size	- 0.0017	ns	- 0.0020	ns
Is located in urban area	0.1125	ns	0.1346	ns
Constant	0.2181	ns	0.2212	ns

Note: *** Statistically significant at the 1% level; ** statistically significant at the 5% level;

[...] the models at the end of the day, only explain a small part of the fluctuations observed in the consolidated end-of-year test scores. The share of the variability of the scores that is “explained by the models” is 24 percent for Grade 2. Other explanatory factors of the level of student learning are thus still to be identified. Pupils’ initial level is the determining variable that has the greatest weight (the highest coefficient). Pupils with high initial levels are those who achieve the best final outcomes, all other things being equal. Among other individual characteristics, it is of note that girls’ structural progress is worse than that of boys (negative coefficient close to 10 percent). On the other hand, pupils older than the official school age progress with greater ease. The employment status and basic training of teachers cannot be considered simultaneously in the same model, the correlation between the two being too great. Both models considered differ therefore in including one or the other of these variables. Pupils whose teacher has contractual status make better progress (30 percent more) than those who are taught by civil servants (Model 1). When the status variable is replaced with one describing the basic vocational training, empirical results are just as clear: a short vocational training course (of one to three months) is preferable to longer training in as much as most pupils whose teacher has followed one such course make better progress (30 percent more) than pupils whose

teacher followed longer training, or had none (Model 2). Reflections on the status and level of initial training of teachers should not, however, be detached from those touching on issues such as teacher motivation, job stability and career advancement. Complementary training courses on the other hand, are far from producing the expected results: the results of pupils with teachers having followed one or several ongoing training courses are no better than those of pupils whose teachers followed none.”

Source: UNESCO, 2014

➤ *Teacher qualifications: Higher isn't better*

For over 50 years now, research has come to the conclusion that higher teacher qualifications are not necessarily accompanied by better student performances (e.g. Hanushek 1971; Simmons et Alexander 1978). More precisely, these studies progressively came to the conclusion that teachers with a Master's degree (five years after upper secondary completion) do not appear to perform better than their colleagues who have a lower academic level (Krueger 1999; Rivkin, Hanushek, et Kain 2005). In the African context, these findings could be confirmed, showing that, all things being equal, the impact of academic education on school learning achievements is moderate and sometimes nonexistent (Michaelowa et Wechtler 2006; Mingat et Suchaut 2000). The case of Mali (Figure 7) illustrates well this issue, with a non-significant effect of possessing a teacher diploma on students' performance.

Research acknowledges however that there is a minimum threshold of education for teachers: In their 2004 study mobilizing data from PASEC, Bernard, Tiyab and Vianou show that BEPC level is a minimum diploma when it comes to assessing the influence on primary school students learning (Bernard, Tiyab, et Vianou 2004).

Interestingly, research findings even indicate that a higher diploma can impact negatively on student's performance. Michaelowa explains this by the negative impact of a high qualification on motivation: The author shows, mobilizing data from five francophone countries, that teachers with baccalaureate degree or higher do not declare that they would chose this profession if they had the choice again. This is explained by higher qualifications would come along with higher professional and social aspirations (Michaelowa et Wittmann 2007).

Furthermore, it has been argued that this lack of positive impact can also be explained by the inadequacy of the education received at university for the work as primary school teachers:

“A university curriculum usually corresponds to a specialization in a given subject, and there is not really an obvious link between a specialization in law, economy or the humanities, etc. and the communication of basic knowledge to children in primary school [...] a university graduate has no systematic comparative advantage compared to a secondary school leaver.”

(UNESCO et al. 2009, p. 105)

These findings cannot be interpreted as sign that every teacher is capable of teaching. However, it shows that the already discussed issue of having high proportion of teachers lacking the necessary competencies for teaching is an issue that concerns the workforce as a whole – leading to the question of appropriate training for both categories.

➤ *Long pre-service training doesn't guarantee better student performance*

An often heard argument against the recruitment of non-civil servant teachers is their lack of training presented as the reason why overall student performances are so poor. However, de facto, Research could not identify evidence that an increased period of pre-service training – as it is the case of most civil servant teachers – would positively impact on student performance. Indeed, be it in developed countries like France (Bressoux, Kramarz, et Prost 2005) or the case of African countries (Michaelowa et Wittmann 2007; Bernard, Tiyab, et Vianou 2004), studies have shown a moderate if not inexistent effect of pre-service training on student performance. Again, the Mali case (Figure 7) illustrates well this argument. It is important to underline some methodological limits of these studies: Given that the content and methodological of pre-service training has evolved during the last decades, it is questionable if a year of pre-service teacher trainings can be actually compared. These studies do not make it possible to differentiate which of the pre-service training types were actually the most efficient ones, concluding that ‘on average’, there is no effect of pre-service training on students performing.

PASEC has conducted two studies that take into consideration both the status (civil servants and community teachers) and their respective training during the period 1999 – 2000 and 2004 – 2005 in Guinea, where the government had decided, as part of its UPE strategy, to hire 2000 instead of the usual 700 teachers (PASEC 2003; CONFEMEN, PASEC 2014). PASEC

compared teachers who had taken part in 1 year of training with a strong professional focus – several months of theoretical training followed by months during which they were responsible for a class while received training – with teachers who had received the traditional 2 years of pre-service training. Both were hired as civil servants after the end of the training. The two conducted evaluations showed that those teachers who had received the professional training were slightly more efficient in the second year; in the 5th year of teaching there were no difference anymore between them and the civil servant teachers in terms of students' performance (PASEC, 2003 and PASEC, 2006b).

With other words, this evaluation showed that the government was not only able to send more and quicker teachers into classes – crucial for UPE achievement - but also that students in these classes would learn as well with these teachers as with those who had cost 2 years of training. Knowing that two years of training cost around 24,4 million euros (15,5 billion CFA), this is a considerable amount of financial resources potentially to be more efficiently invested (Teachers for EFA - Guinea 2013).

While this type of evaluation remains rare, these results are interpreted as need to provide an adequate, cost-efficient type of training to teachers, be it before (pre-service) their career start or in parallel (continuous / in-service) to their teaching activities. An overall lack of evaluations in this regard can however be regretted. The study of Michaelowa and Wechtler is one of the rare analyses in the field, and could only detect a weak effect of continuous training on student performances (Michaelowa et Wechtler 2006). Again, this type of results shows the importance of analyzing current training approaches – as for example mobile teacher training, discussed in the next section - both in terms of content and organizational approach.

➤ *Impact of the status: Civil servants versus contractual / community teachers*

Recent research findings based on PASEC evaluations in Cameroun, Madagascar, Togo and Guinea indicate that students performance does not depend on the status of the teacher, civil servant or not (Bernard 2007). This remains a sensitive statement in the educational sphere. Still commonly counter-intuitive, but however less surprising when taking into consideration the previous findings on lack of impact of the diploma and pre- and in-service training, knowing that these new teachers are mostly lower qualified and trained during a shorter period. As stated by UNESCO “*if this [contractual teacher] policy had had a strong negative*

impact on learning, as sometimes supposed, the previous studies would have demonstrated this” (UNESCO et al. 2009, p.113).

Indeed, even as often described as counter intuitive, multiple research results indicate that the status of teachers does not impact on student performance, and are even performing better in some cases. Some results do even indicate that community teachers, certain conditions, perform better: Besides the Mali example (Figure 7), this is the case for Chad: The 2005 PASEC study – which however had not been designed to analyze the impact of non-civil servant teachers on pupil learning achievements - revealed that community teachers perform better in their second year the primary cycle and are as performing as civil servants in year 5 (PASEC, 2005).

The subsequent PASEC study focusing on teachers in Mali and Niger, and whose methodological approach was more sophisticated, revealed in the case of Mali a moderately higher performance in year 5 of contractual teachers, compared to a slightly better performance of civil servant teachers for the same year in Niger. Shortly after, another study using the same data but a different methodological approach² did come to the conclusion that there is no significant difference in terms of impact on performance between civil servants and community teachers – compared in schools of the same locality and with similar populations and environments (Bourdon, Frölich, et Michaelowa 2006).

Research results provide several explanations for this lack of significant difference: Firstly, the duration of teachers spend in class could be significant, and it has been found that the time spent in the class on instruction is significantly associated with student performance. (Cattaneo, Oggenfuss, et Wolter 2016; Duflo, Dupas, et Kremer 2007; Glewwe et Kremer 2006).

The explanation is here that community teachers would be more assiduous, given that they are directly paid by the local community – their absence leads to a direct loss of salary. Indeed, the closer ties of community teachers to parents appears indeed to be a plausible explanation:

² Grouping of classes according to the status of the teacher: The purpose was to select control classes managed by a civil servant teacher representing the same characteristics as classes managed by a contractual teachers.

The role of the community has been identified as being a criteria for positive effects from hiring contract teachers in Kenya, provided the parents had been trained to monitor teacher absenteeism and time on task (Duflo, Dupas, et Kremer 2012). Similar results could be observed in Mali, where language and mathematics scores of grade 2 and 5 students were consistently higher when taught by contract teachers closely monitored by the local community (Bourdon, Frölich, et Michaelowa 2006).

Another explanation put forward is the role of infrastructure: Civil servants do receive their salary often in the administration office situated in the regional capita, which implies sometimes several days of traveling – and hence absence from the class. In this perspective, it is possible that the educational impacts resulting from lower qualifications and competencies of community teachers becomes invisible because of the higher absence of their civil – servant peers (UNESCO 2015c).

Furthermore, it has been discussed if a lack of motivation among civil – servants explains the lack of difference in terms of teaching quality: In Mali for example, PASEC had revealed that civil servants, which are the most trained, the most experienced and the best paid are also on average the most discouraged.

➤ *Accumulated teaching experience*

Rivkin, Hanushek and Kain, based on results of an US based project have shown that work experience is a favorable element at the career start of a teacher, during his first year (Rivkin, Hanushek, et Kain 2005). Hereby they contradict Krueger, who had analyzed the same data and found that work experience has only a weak positive impact (Krueger 1999). There is however a methodological challenge: in many countries, more experience teachers find themselves in ‘good schools’, as found by Bressoux (2005), making it indispensable to include the initial level of students in this type of study. Michaelowa and Wechtler find, like Krueger, that there is only limited impact of work experience: In year 2 this impact is even inexistent.

➤ *Gender*

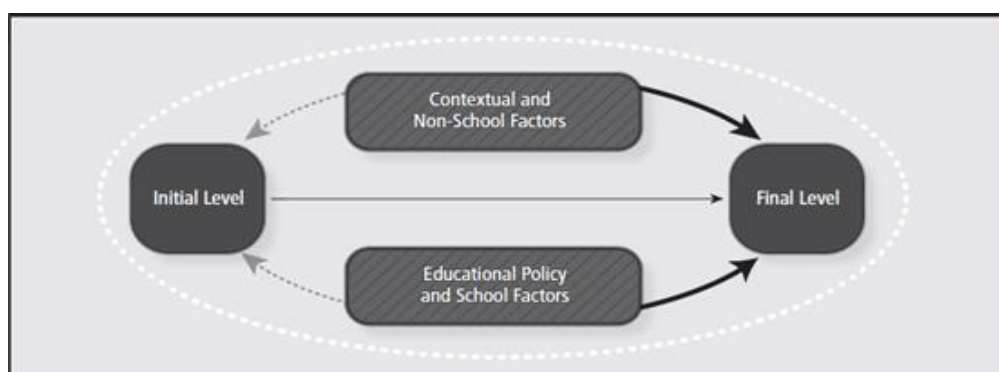
Finally, among observable teacher characteristics, gender can also be discarded as possible factor impacting on student performance. There were assumptions that girls learn better when their teacher is a woman whereas in many countries the majority of teachers are male, or that

female teachers would feel better with young children (and hence be better primary school teachers), or on the contrary worse as more absent due to family responsibilities. However, the results of the evaluations carried out clearly indicate that there is no systematic difference between men and women; as a general rule, pupils learn in very much the same way with a male or a female teacher (UNESCO et al. 2009; Bernard, Tiyab, et Vianou 2004);

➤ *The importance of the ‘class effect’: Determinant but difficult to observe*

In Figure 9 the factors of learning outcomes are split into two categories: contextual (or non-school) factors, and educational policy (or school) factors.

Figure 9: The causal analysis of learning outcomes



Source: UNICEF 2014; The solid line arrow represent the relationships that are often studied whereas the dotted line arrows represent those that are usually not.

Contextual or non-school factors are those that relate to the environment beyond school and include children’s personal characteristics: their family context and social status of their parents. These factors have been identified as highly associated with learning outcome, but in the short-term, policy makers have little power to act on these.

Moreover, *educational policy and school factors* do fall within the field of action of education policy makers. They include school infrastructure, the learning materials, the professional characteristics and teaching modes, the monitoring of teaching staff and so on. These factors are usually presented as key determinants of learning outcomes.

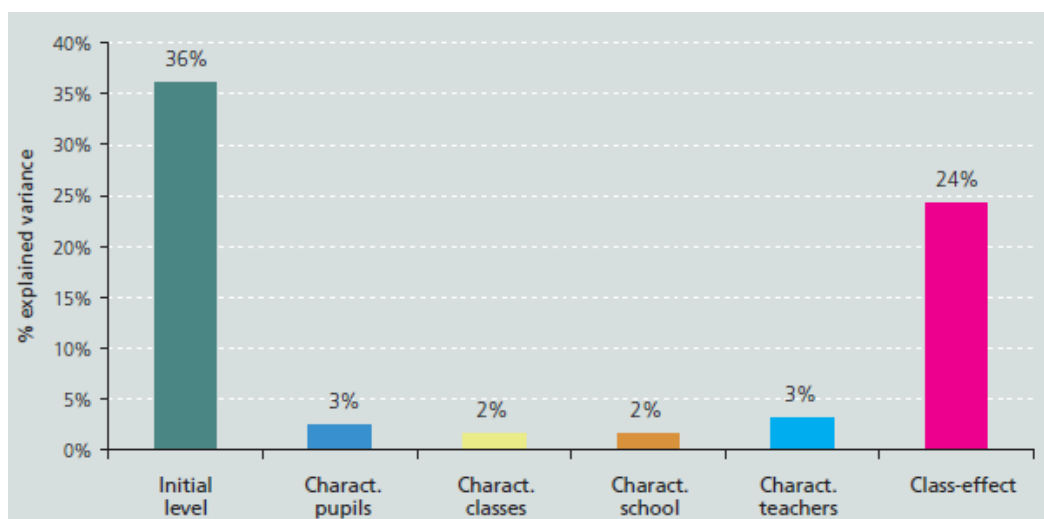
The figure illustrates relationships that may be current or historical. The arrows represent the process of how these factors affect learning outcomes. Students’ earlier schooling and other historical factors appear as significant in the learning process at a given point in time.

When looking now at Figure 10 and the six considered variables, it can be ascertained that the most important factor in explaining differences in results between students at the end of the year is the pupil's level (non-school factor) at the start of the year (accounting for 36% of differences). This factor is seen to be more important than his or her personal characteristics, as well as more significant (in terms of contributions) than the characteristics of classes (2%), schools (2%) and teachers (3%).

This type of result is often considered as counter intuitive, particularly when it comes to the modest contribution of teacher characteristics on students' performance (3%). Instead, the so called 'class effect' reveals that the fact of being in one class rather than another, with identical context and pupil characteristics, translates into considerable differences in school achievements.

This strong inequality of classes is assumed to be attributable to the teacher – which explains why the terms 'class effect' and 'teacher effect' are sometimes used to describe the same process. This effect is due to difficult to measure characteristics like charisma, motivation and teaching skills. More than ever, the teacher appears to play a crucial role for student performance, but not in the way (qualifications) it is still expected by many. Teachers appear e.g. as powerful vector to compensate poor initial student level or school infrastructures.

Figure 10: The influence of the different factors on students' scores over one school year in 10 sub-Saharan African countries



Source: UNESCO, 2009 / BREDA

This effect of unobservable characteristics, which makes it difficult to differentiate between 'good' and 'bad' teachers, has already been identified by many researchers. Rockoff for

example, found in a 10-year study of the same set of teachers, that differences in teacher quality account for 23 percent of the variation in student test scores (Rockoff 2004). From another perspective, Sanders had already found that lower-achieving students are the most likely to benefit from increases in teacher effectiveness and that these effects are cumulative over time (Sanders, Wright, et Horn 1997). One of the most well-known meta analyses of factors affecting student performances has been conducted by Hattie (Box 2) who found that all teacher characteristics which de facto impact on student performances were related to skills and 'non measurable' characteristics (Hattie 2008).

However, Bressoux underlines that the class effect, even if it is composed of unobservable teacher characteristics, includes but does not reflect a unilateral impact of a teacher. Rather, it must be understood as the product of an interaction between teachers and their pupils. Considering this effect as interaction is crucial, as it allows understanding that teachers' positive impact on student performance can be impacted by external influences (Bressoux, 2000). This is particularly true in the African context, where the environment and administration can affect pupils performances, e.g. because of the harvest season during which many children work, late notice to teachers regarding their job appointment leading to absence of teachers in schools, can be impacted by absence due to harvest season, teachers be absent because of late nomination (UNESCO et al. 2009). Also, rural zones are confronted with the problem to attract and retain teachers in these zones, difficult teaching conditions impacting negatively on their motivation.

UNESCO underlines the fact that there is still room for further investigation on what exactly composed the class effect, particularly as studies focusing on both developing and developed countries have used different methods to assess it, making comparisons somewhat difficult. The report considers that the class effect shows “*significant differences in effectiveness between classes in great number of African countries [...]*”. It suggests that the revelation of such an important effect invites to consider “*the learning process as a complex highly interactive process in which the teacher plays the central role*” (UNESCO et al. 2009, p.120). More generally, this recommendation indicates also a shift that seems to have operated throughout the last years, led by a more positive, rewarding perspectives on teachers and their source of motivation (Box 4).

Box 4: Shift in perspectives on teachers' motivation: From accountability to recognition

According to declarations made during informal discussions with representatives from international organization and researchers during this research, a reported a 'shift of paradigm' on teaches' motivation has accompanied the overall shift away from a quantity dominated vision towards a reflection of the importance of quality teaching and determinant teachers characteristics. In a simplified manner, this shift is described as follows: In the 1990 and 2000, the attitude towards teachers was driven by a willingness to hold them accountable for poor student performance. The World Bank photo cover of 2011 report 'Making Schools Work – New Evidence of Accountability Reforms', picturing a 'lazy' African teacher in an empty classroom seems to be symptomatic for this negative perspective (Bruns, Filmer, et Patrinos 2011). During the last few years however, policy makers and researchers seem to consider as key priority to recognize and motivate teachers' in order to ultimately achieve satisfying student performance. The increasing number of literature on teacher motivation is considered as symptom of this shift, particularly as it is 'defended' by institutions and reports overall considered as influent when it comes to presenting priorities. The last (2017 / 8) Global Monitoring Report is presented as one of the key symptoms of this shift, clearly underlining the importance that the education system has to be held accountable for teacher motivation, and not only the teacher alone. A look at the Incheon declaration of the Sustainable Development Goals seems also to confirm this shift of paradigm: *"We commit to **quality** education and to improving learning outcomes, which requires strengthening inputs, processes and evaluation of outcomes and mechanisms to measure progress. We will ensure that teachers and educators are empowered, adequately recruited, well-trained, professionally qualified, motivated and supported within well-resourced, efficient and effectively governed system "* (Incheon declaration, Paragraph 9)

In light of the high effect of the class effect on student performance, and taking into consideration the complexity of the class effect and their sub-factors, the question of finding an efficient way of providing teachers with support and training that takes into consideration these sub factors (motivation, pedagogic skills, administration environment, pupils environment) is hence considered as increasingly important. Also, when considering the importance of school time for student performance, it appears clearly that this is an also an aspect to be considered when thinking of organizational aspects of teacher training.

It is noteworthy that these results remain counterintuitive and criticized by several voices: A certainly true critique is the fact that there is an overall need of evaluations that also take into consideration the specific management of non-civil servants. It is this lack of temporal objectivity that is criticized by researchers, e.g. Rasera, who considers as invalid the argument that current teaching policies do not impact students' performance. In contrast, he argues that teachers are supposed to be hired for 30 or 40 years and that studied with short-term results are hence not necessarily valid (Rasera, 2012).

While the implementation of large and long-term evaluations is certainly not easy, conducting more systematically medium-term research appears indispensable and certainly informative. Independently from this lack of evaluations, the previous sections have allowed to comprehend why the finding of the ‘class effect’ has led to new recommendations for appropriate teacher training.

1.3 Resulting recommendations for teacher training

Besides the implications that these findings have on up-coming recruitment processes and their selection criteria, the conclusions on the central role of teachers in an interactive learning process have also allowed to draw conclusions on the need of an teacher training. It is commonly acknowledged that this teacher training shall provide teachers with those competences that ultimately impact on student performance (Hattie 2008; Schwille 2007).

This need appears even more obvious as African countries face today a dual constraint: Knowing how important the duration of class time for student performance is, and in light of the uneven amount of qualified teachers among the profession, researchers recommend to provide an ongoing training which is different in terms of content and organization. The in the following exposed recommendations will make it easy to understand why mobile technologies are eagerly presented as tool facilitating the implementation of these recommendations (section 2 of this chapter).

1.3.1 A teacher centered approach with a stronger focus on practices

In terms of content, UNESCO refers to successfully tested training schemes, e.g. in the Gambia, Lesotho or Eritrea, where the content has been inspired by the curriculum of the pre-service training, but has a much stronger focus on pedagogic practices. This approach is said to adapt better to the uneven levels of work experience and offers a better balance between theory and practice.

Various researchers have conducted research the ‘ideal characteristics’ of this type of teacher training. Burns’ extensive literature review has identified similar, theory and practice balanced recommendations when it comes to providing quality professional training (Burns, 2011).

For Burns, adapting the content as much as possible to the existing (and lacking) knowledge of teachers is crucial. The author has identified key criteria, which specifically address unobservable teacher characteristics. According to Burns, the content of efficient distance in-service teacher training must

- be competency-based focused on helping teachers develop those knowledges, skills, attitudes, and dispositions demonstrably shown to improve teaching
- be based on an understanding of teachers' needs and of their work environments
- focus on deepening teachers' content knowledge and pedagogical skills
- include opportunities for practice, research, and reflection
- include information related to student learning for teacher development

Overall, there is a strong focus on concrete practices and a shift away from in-service training during which teachers essentially focused on theoretical approaches behind their teaching.

A more practice focused training is also said to give more space to the teacher as an individual.

Indeed, these contemporary recommendations build on long existing research on in-service training and approaches that consider that the teacher as an individual must be involved in – service training as it alters their attitudes towards changes in teaching practices and school innovation (Neil 1986).

This implies also that the training content must take into consideration the previous work experience of teachers, the latter affecting the expectations, satisfaction and ultimately degree of participation in the training (Anderson, 1979).

Furthermore, a practice oriented training involving active deliberations and feedback is said to be also contributing to knowledge acquisition and acceptance of change (Rikala et Kankaanranta 2012). Not only these mechanisms would allow generating a climate in which individual differences are respected, but are a process of providing guidance and information that help learners to reflect actively on their current practices:

“Feedback [in distance teacher training] is essential to improved performance. Giving individuals a clear goal, and the means of evaluating their progress, increases the likelihood that they will attain their goal. This process is critical to individual self-efficacy, the belief that with the right tools and information, individuals can attain their goals and be successful.”

(Burns 2011, p.136)

1.3.2 Hybrid training schemes

As recalled by UNESCO, the additional needs for qualified teachers will accentuate pressure to find training systems that can handle – both from an organizational and financial perspective – the increased amount of recruited teachers, making traditional training schemes that implied two or three years lasting courses incompatible. Instead of offering full time initial training, alternatives are discussed, e.g. short period of introductory training combined with workshops during the holidays or weekends that build on the progressively acquired work experience, combined with in-service distance training. While this type of training would again allow to combine theory and practice, another important advantage of this type of training is also seen in the possibility to avoid losing months or years during which a teacher cannot yet take up their position or, in the case of in-service training are absent from class because of because of their training (UNESCO 2015). Hybrid and distance in-service teacher training appears to be acclaimed both in developed and developing countries (Depover et al. 2004) it has been qualified “*a direction to follow*” because of its particular suitability with the African context (UNESCO et al. 2009, p.96). Indeed, in light of the high proportion of untrained teachers in rural and isolated areas it is increasingly considered as alternative for rural teachers – even more as teacher training institutions cannot handle the high amount of new recruited teachers but are also mostly centralized in urban areas, often several days of travel away from rural schools and workstations. Distance training, combined with local face to face support, e.g. via a tutor, and designed with separate modules is discussed as a possibility to face this heterogeneity of skills and unequal needs of teachers (Depover et al. 2011). The organizational flexibility is also said to be a better fit for teachers’ work and life reality. UNESCO cites here Zambia and Gambia, where teachers are respectively trained 18 and 30 months via this modularized training (UNESCO, 2009).

Providing distance training to these teachers is also considered as a **career development incentive** – even more if associated with certification, salary increase and career advancement – and seen as recommendable mean to increase teachers’ effectiveness and motivation. On-the-job, both via distance training and in face to face workshops is considered as particular useful within the African context as it supposedly allows to adapt to the particular teaching reality of these teachers – e.g. providing multi-grade and rural specific teaching methods (Adedeji et Olaniyan 2011).

Similar to the recommendations on teacher centered training content, the increasing amount of findings on the importance of the teacher in an interactive learning process have led to the recommendations to design the hybrid training with a focus on teachers professional skills. For example, all best practices in distance teacher training, gathered by the Washington Centre of Development, put teachers, their environment and their interactions with colleagues at the heart of recommended schemes: Training should be “*embedded in educators’ workplaces*”, and be “*grounded in a sense of collegiality and collaboration among teachers and between teachers and principals to solve important problems related to teaching and learning*”. They recommend hence that distance training shall build professional learning communities, which would help to “*overcome inertia of status quo and helps teachers make complex changes*” (Burns, 2011, p.134).

It is important to note that the interaction and collaboration appears indeed key for current distance teacher training approaches: Distance models which are based on a collective training scheme, including several actors in the learning process, e.g. coaching and mentoring, study groups, lesson study, action research, mutual observation and assessments, in which the teacher has to partly learn autonomously and is stimulated by a collective training experience have been said to be particularly efficient (Cushing 2011).

1.3.3 Collaboration as a crucial factor for quality education and training

Among the most frequent recommendations for training schemes able to tackle those factors which ultimately lead to higher student performance figure training schemes that foster collaboration among teachers. As will be detailed in section two of this chapter, mobile teacher training is supposedly enhancing teacher collaboration. It appears hence indispensable to recall the benefits of collaborative teacher training in a first place.

The **concept of teacher collaboration** has been interpreted in a broad sense, for example as a form of school climate or culture encompassing norms of collegiality, trust, and social support or a management instrument to enhance school effectiveness (Moolenaar 2012). For this dissertation will be focused on the concept of teacher collaboration as being one of the multiple characteristics of professional learning communities. Given that teacher learning is situated in a dynamic social context, research considers that teachers have multiple opportunities to interact and, subsequently, learn from each other. These multiple opportunities are situated both in formal and informal settings: , teacher learning takes places both within *formal* professional learning communities and structures, e.g. training and courses as well as *informally* in teachers' daily practices, through informal communications and exchanges among peers (Mayrowetz 2008).

This interaction with peers with peers in sub-groups – i.e. groups of teachers within a school or in between schools – has been found to **influence (positively) on the quality of teaching** itself, as it reinforces constructive school norms of formal support, increases a feeling of shared responsibility for student achievement which, in turn, helps teachers to achieve instructional goals (Anderson 2010).

The teaching quality has also been found to be influenced by teacher collaboration as – provided a certain degree of quality of the contacts and their resources – the collaboration process creates a space in which teachers can access novel resources and information diversity, enriching their teaching content and methods (Moolenaar, Slegers, and Daly 2012).

This impact is directly linked to a process of social influence that takes place in collaborative learning communities. Teachers influence each other to the extent that they share common pedagogical beliefs, attitudes, and ideas about teaching practices (K. Frank, Chong, et Belman 2010; Marsden et Friedkin 1993; Bidwell et Yasumoto 1999).

For this kind of influence and change to happen, researchers conclude that teachers must be aware of where to find the needed expertise in their network. This process of social selection would impact on the extent to which teachers reach out to others. Moolenaar ascertains that those teachers are often unaware of each other's expertise and experience. Often, schools

would fail to capitalize on the expertise of teachers who are isolated from the knowledge exchange in their schools social selection (Moolenaar 2012).

Research suggests also that teacher collaboration, and more generally frequent teacher interaction, is directly linked to teachers' **attitude towards reform and, subsequently, the success of reform**. As resumed in Moolenaar's literature review on that subject, this link 'teacher collaboration – reform' is due to the fact that the

“...success of reform initiatives is not just dependent on the level of individual teachers' knowledge but also on the extent to which the social structure in schools allows for knowledge to be exchanged, shared, discussed, and adapted.”

(Moolenaar 2012, p.27)

In this regard, research agrees on the fact that the patterns of teacher relationships matter, because every reform is supposed to be accepted, and then become embedded in the routines, actions and behaviors (Camburn, Rowan, et Taylor 2016; Coburn 2005). Moolenaar refers here to recent case studies that have found to case studies analyzing which school network characteristics lead to the success or fail of school reforms, citing frequent teacher interactions as one of the key characteristics for success (Moolenaar 2012).

In addition, the patterns of teacher collaboration are also found to influence on the depth and spread of reform: Depending on the patterns and quality of horizontal and vertical relationships in between teachers allowing them to exchange their opinions and information about the reform; and between teachers and actors considered as reform experts (Moolenaar cites here principals, coaches, and educators with experience in implementing reform), the reform itself will be more or less successful (Moolenaar 2012; Atteberry et Bryk 2010; A. J. Daly 2010)

With other words, implementation and success of reform do not only depend on the technical and curricular aspects of reform, but also on the social environment (A. Daly et Finningan 2012). Considering that a reform implies a learning process, the research on teacher collaboration and reform is here consistent with the constructivist learning theory, which in turn argues that learning in an active process that requires a change in the learner (Zakrajsek 2016).

Besides the contribution on teaching practices and school reform, one of the ultimately most important impacts of teacher collaboration is the possible impact on student learning (van Amersfoort et al. 2011). While it is methodologically a challenge to establish a clear association between teacher collaboration and school performance, researchers have tried to bypass this problem: They indicate that higher teacher collaboration comes along with broader access to resources and knowledge. Teachers within teacher networks can accordingly achieve higher instructional goals and performance improvement compared to teachers who are not part of a similar network (Lomos, Hofman, et Bosker 2011; Vescio 2008; Yasumoto 2001). Observed impacts were for example situated in the area of formative and summative assessments in the area of reading, provided teachers had shared knowledge about reading comprehension before (Moolenaar 2012).

In addition to the benefits of increased access to resources individual access to resources, it appears that the patterns of teacher relationships are of particular importance. More precisely, research on the density and centralization of teacher networks in schools indicates that, because of the combination of school- and teacher-level variables - collective responsibility, collective efficacy, trust among principals and teachers, and teacher influence on decision making – teacher collaboration can lead to student performance improvements (Goddard, Goddard, et Tschannen-Moran 2007; Moolenaar et Slegers 2010; Yasumoto 2001).

Closely related to reform, teacher collaboration and teacher networks have also found to be linked to **innovation**. Given that this dissertation focuses on the use of mobile technology in teacher training, this is a particularly interesting aspect: The amount of research in that area is considerable when looking for cases in developed countries: For example, various case studies indicate that increased teacher collaboration increases teachers' willingness to assimilate innovations (Moolenaar et Slegers 2010), particularly in the area of ICT related school innovations (K. A. Frank, Zhao, et Borman 2004).

This increased acceptance of innovation is explained by the fact that teacher collaboration would allow for the creation of a safe space where teachers can engage in innovative practices and experiment with new instructional strategies without the fear of being punished or ridiculed (Moolenaar 2012). Moolenaar refers here to research on school with dense social network structures which have found to be characterized by higher levels of trust among

peers, open attitudes towards change and common perceptions of collective goals and the schools capability to achieve these (Moolenaar et al. 2009, 2010; Moolenaar, Daly et al. 2011). In turn, these findings join the previously exposed impacts of teacher collaboration on teaching practices (Penuel et al. 2007).

The here exposed benefits of teacher collaboration are useful to understand why, subsequently, teacher collaboration figures among recommendations for teacher training. Indeed, while research has for a long time considered teacher collaboration as beneficial in general, there is recently a high interest in collaborative teacher training dynamics, particularly in the case of distance and hybrid training schemes.

Researchers found for example that teacher's needs – obviously indispensable for teacher training - could best be understood through collegial relations or through sympathetic supervision (Neil 1986). More than simple exchanges among teachers, their active participation, e.g. practices simulation within groups of training peers, mutual planning of school goals and collective design of the process towards these goals have found to be effective (ibid).

Besides increasing the effectiveness of knowledge acquisition during teacher training, collaboration is considered since several decades as crucial for teacher training as it would ensure that the training itself is accepted, considered as worthwhile and valuable by teachers, particularly when this collaboration takes place in form of teacher participating as planners and decision makers in the training process (Ulrick 1981; Miller 1977). With other words, teacher collaboration is found to be particularly beneficial when it is not limited to peer to peer collaboration, but includes other entities of the training, e.g. teacher trainers, project organizers. For example, researchers observed – when teachers participate as planners and decision makers during their in-service training – a high regard for the ensuing teacher education activities (Sandholtz et Reilly 2004; Henderson 1975).

Finally it has to be noted that, while there is indeed a high number of case studies and research in this area in developed countries, these contrast with the lack of research findings on innovative teacher practices due to increased teacher collaboration in African countries: A clear need for a social network lens on teacher collaboration supported by innovative tools appears recommendable.

2. The mobile infrastructure boom in Sub-Saharan Africa: Boom and challenges

The purpose of this first section was to show how the massive need and recruitment of teachers and the subsequent structural change of the teaching work force has led to the question of student performance and, in turn, to the question which factors influence on the latter. Research indicating that long time as highly determinant considered observable teacher characteristics (e.g.; experience, diploma, status) are less important than difficult measurable factors such as, for example, charisma, motivation, pedagogical practices, interaction with the environment. These findings have given rise to another question: Which type of teacher training, both in terms of content and implementation, is appropriate and allows focusing on these difficult to measure factors? Research in this area recommends a teacher centered, practice oriented teacher training implemented in a hybrid manner (distance and face to face) in order to suit the African infrastructural reality of teachers, and a training scheme that enhances and is built on teacher collaboration.

However, this type of training it has to be noted that despite these research based recommendations on hybrid, individualized training schemes with collaborative dynamics, traces of these training types are – on the contrary of many developed countries – still limited and organized in an unsystematic manner in developing countries. If organized, they are so mostly in waves (e.g. in Madagascar) and in form of pilot projects, which is mostly due to the absence of a stable budget for distance in-service training - and training in general (UNESCO et al. 2009) OECD, 2005; OECD, 2008).

It is indeed a reality that the organization of this new approaches to teacher training in African countries often depends on non-governmental and hence external financial support: The question of sustainability of these initiatives – and hence the potential to be upscale on a country level in case of evidence of success – can't be ignored and must be further researched, focusing on completed projects and looking at their medium-term effects.

This question of sustainability is particularly interesting as the use of mobile phones for teacher training has, amongst others, been recommended because of its supposedly potential to be a sustainable teacher training tool in African countries.

To understand this argument and other supposed benefits that have transformed mobile teacher training in a subject with high expectations, the following sections are organized as follows: Firstly will be exposed how the infrastructural development of Sub-Saharan countries has created a field considered as prosper for the use of mobiles in education, before exposing the concrete research results focusing on concrete benefits – and challenges - of mobile supported learning and training. This overview will show why there is a clear need to conduct in depth research on mobile supported teacher training in Africa, with a medium-term approach and transparent and adequate research methods.

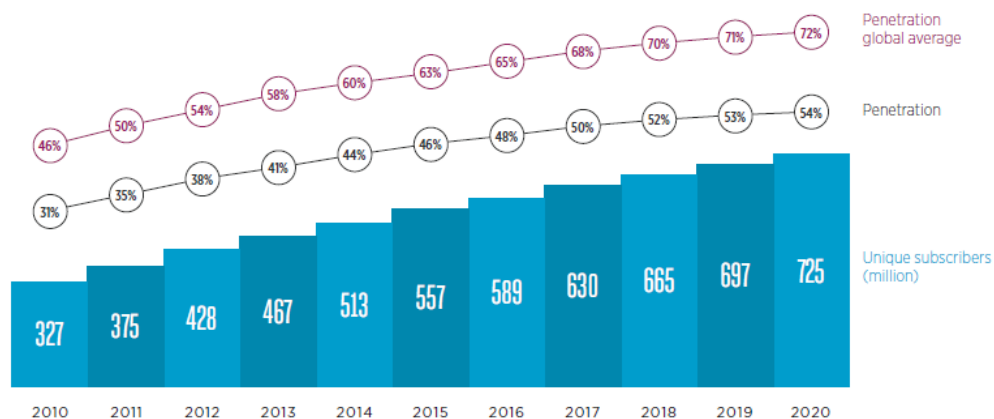
2.1 Real promises: A quickly developing mobile technology infrastructure

In the following will be provided an overview of the way the IT infrastructure in Africa has gone through a significant process of transformation during the last decade. The amount of mobile subscriptions has been increasing, while communications and phone prices progressively decrease. Despite large areas without any network coverage, mobile internet is more and more used and expected to increase in the future too. Several infrastructural concerns persist however.

2.1.1 Massive increase of mobile subscriptions

According to the latest GSMA (GSM association) report, 46% of Africa's population had subscribed to mobile services at the end of 2015, equivalent to more than half a billion people. The highest amount of subscribers could be found in Egypt, Nigeria and South – Africa, accounting for around a third of the region's total subscriber base. GSMA and ITU, the UNs International Telecommunications Union, expect that by 2020, an additional 168 million people will be connected by mobile services across Africa, reaching 725 million unique subscribers by 2020 (Figure 11). Again, Nigeria belongs to the biggest areas of growth, followed by Ethiopia and Tanzania, contributing to contribute more than a third of new subscribers.

Figure 11: Unique mobile subscribers in Africa (Penetration / Penetration global average)



Source: GSMA, 2016

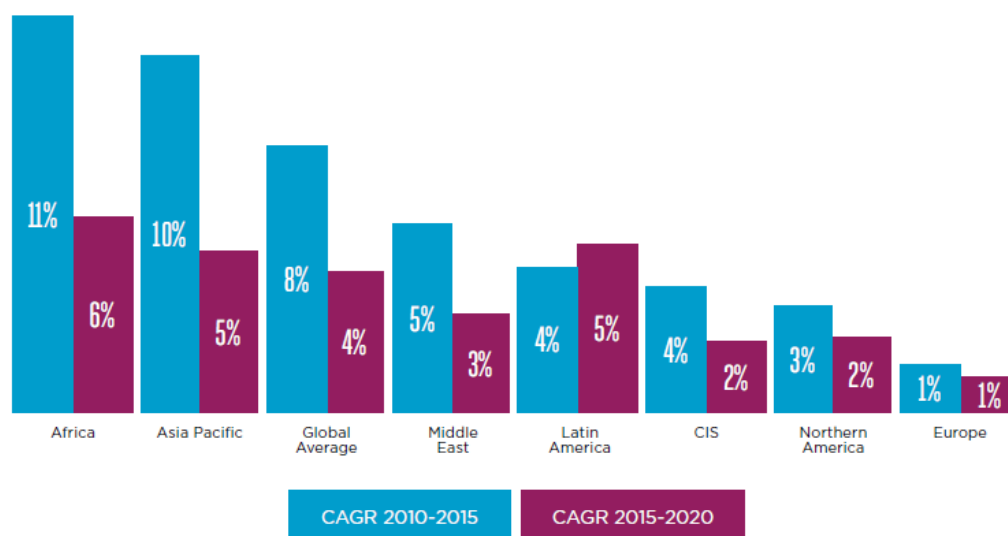
The overall interest in mobile technologies for development and education appears even more plausible when looking at the growth rate of subscribers (Figure 12): With an annual rate of 11% during the period 2011-2016, this is the fastest growth in the world. While it is expected to slow down, it won't stagnate: For 2020, experts expect a growth rate of 6% (GSMA 2016; ITU 2016a).

This increase is favored by efforts in the area of network rollouts and the migration to mobile broadband services stimulated by new device and data strategies. By 2015, 25% of all connections were composed of mobile broadband connections and are expected to increase to 75% by 2020.

Similarly, the number of 4G networks launches increased: 4G network launches are gaining traction: by mid-2016, there were 72 live LTE (long-term evolution – commonly called 4G) networks in 32 countries across Africa, and half of these had been launched in only 2015 and 2016. This development is expected in turn to lead to increase mobile data traffic growth in African countries.

In 2015, GSMA reports a traffic growth attaining up to 50% in several countries. One of the economic side effects is the share of data revenue among total revenue, reaching 15% on average and much higher in countries with a higher G.D.P, e.g. South Africa and Egypt.

Figure 12: Unique subscriber growth per region



Source: GSMA, 2016

When comparing the African region with the rest of the world, it appears that it is the second largest region behind Asia Pacific in terms of unique subscribers (12% of the global subscriber base). However, it is also the least penetrated: At the end of 2015, less than half of the population subscribed to mobile services, well below the global average of 63%, and lower than the average of the Middle East (58%), Asia Pacific (62%) and Latin America (65%) (ibid).

In their joint report, UNESCO and Orange, referring to research conducted by Chéneau-Loquay, underline the importance that have mobile phones with two SIM Cards in many African countries: Possessed by around 10% of mobile owners, it allows to adapt the communications according to the current offers of the providers and the quality of the network. In the case of individuals sharing phones – which is a common practice in developing countries (Street et al. 2015) – it allows also to use several repertoires. This usage has an effect on the rate of single subscription users (UNESCO, Orange, 2015; Chéneau-Loquay, 2012).

2.1.2 Increase of broadband network and increase mobile internet subscriptions

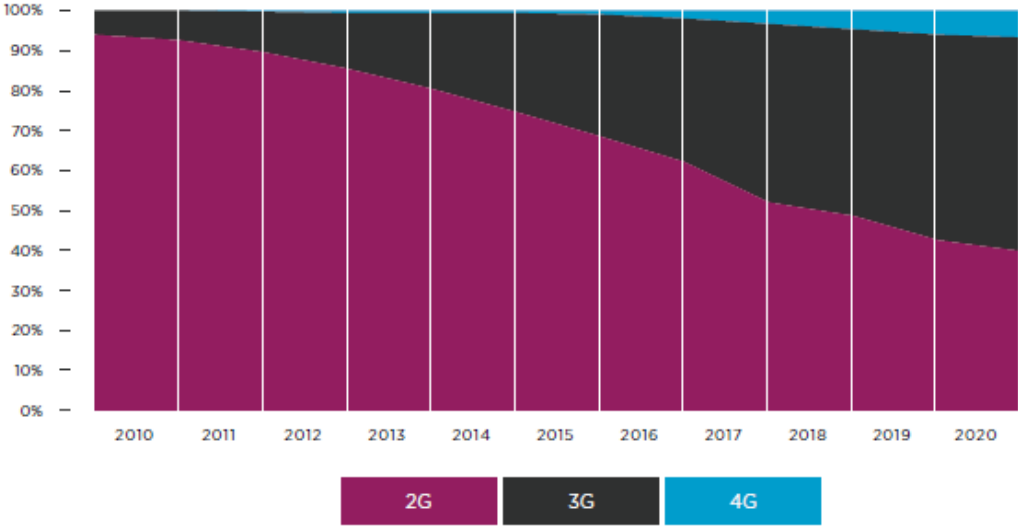
The already mentioned increase of mobile broadband connections due to network rollouts are foreseen to be even more significant in the future: By 2019, they are expected to almost triple,

overtaking 2G connections and attaining 60% of total connections by 2020. In comparison, this proportion was only 25% in 2015.

It is also expected that 3G technologies will account for the vast majority of mobile broadband connections in the near future, but 4G network launches are gaining traction (Figure 13). As of June 2016, there were 74 ‘4G networks’ in 32 countries across Africa: half of these have been launched in the last two years, e.g. in Burundi in 2016, three networks in Tunisia, two in Tanzania, as well as a network rollout in Burundi, Liberia, Nigeria, Sudan and Uganda.

In light of these past upcoming rollouts, it is expected that there will be a further boost in mobile data traffic growth. Among those challenges that hold back the 4G adopting growth remain the device and service cost.

Figure 13: Technology migration in Africa – Percentage of connections



Source: GSMA, 2016

Similarly, the number of mobile internet subscribers has also steadily increased for the last years, and even tripled during the period 2011 – 2015. At the end of 2015, 300 million individuals had subscribed to mobile internet options in Africa and an additional 250 million are expected to subscribe by 2020.

2.1.3 Lower prices, higher smart and feature phone adoption rate

In parallel to the growth of mobile broadband subscriptions, the smartphone adoption rate has also steadily grown, doubling almost in the last two years. According to GSMA, 226 African have possessed a smartphone in 2016, accounting for a quarter of total connections in the region. This growth is expected to continue and is particularly strong in more developed and technologically advanced African countries, e.g. Egypt, Kenya, Nigeria and South Africa. By 2020 the adoption rate is expected to be more than half of total connections. This increase is explained by the increasing availability of low-cost device availability.

Indeed, the average selling price of smartphones has significantly decreased in African countries: While a smartphone cost 230 USD in 2012, its price dropped to 160 USD in 2015. However, this is still far too expensive for a large number of individuals: In 2015, an individual in Sub Saharan Africa had an average income of 45 USD per month (Lakner et Milanovic 2014). The increased availability of low cost smartphones and so called feature phones³ has led to an increased amount of smartphone owners. At the time of this research, the cheapest smartphones available were just below the 30 USD limit but only available in South-Africa (Business Insider, 2017). In Nigeria MTN Nigeria offers two models for less than 50USD and Orange, present in 20 African countries, has launched two models for around 40 USD (Orange 2017). As part of a partnership with Google, one of these models goes along with a low cost 3G subscription and reflects well the high interest of network providers and IT industry in the African market. Still dominant in African countries, a basic telephone can be acquired for around 10 USD (UNESCO, Orange 2015).

³ Sort of intermediate phones with less functions than a smartphone but more functions than a basic mobile phone, e.g. video and photo function but no access to online supported applications

Figure 14: Smartphone adoption in Africa % of total population



Source: GSMA, 2016

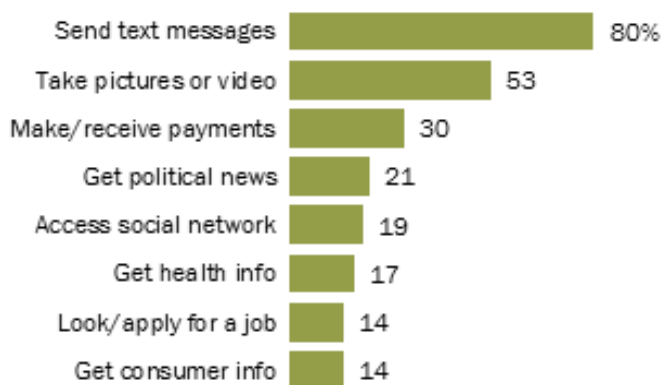
In parallel to this availability of new low cost phones, it is important to mention that there is a large amount of individuals buying officially refurbished or simply already used phones on the market from private sellers. While an analysis of this market in Africa could not be identified, it could be ascertained during the missions for this research in Madagascar that a refurbished and cheap smartphone cost around 20 USD.

Not only the tool itself, also have the communications become cheaper, favoring the subscription rate. This is due to competition between the telecoms operators driven in turn by a favorable regulatory climate. According to a joint UNESCO-Orange report between 2008 and 2000, prices for SMS and voice decreased by 23% Togo, 18% in Rwanda and 16% in Madagascar (UNESCO, Orange 2015). 2014, after years characterized by a tendency of price decrease, Vodacom decided to decrease in turn the average price per minute for voice communications in South Africa. Despite this reduction, Vodacom could increase service revenues (UNESCO, Orange, 2015; Techcentral, 2014).

2.1.4 Everyday usages of mobile phones reflect an advanced appropriation process

The proliferation of mobile phones has led to the emergence of new, mobile supported practices in the everyday life of African populations. An in 2015 by the Pew Research Center conducted survey in seven Sub-Saharan African countries indicates that after voice communication, sending SMS is the most popular usage (Figure 15). This activity is followed by using the phone as a photo and video camera. Mobile banking also is relatively common. In contrast, activities like obtaining political news, accessing a social networking site or getting health and consumer information via the phone, or use it to looking for a job are done less frequently (Street et al. 2015). It has to be noted that the survey did not focus on rural areas, more research in that area is needed as usages in this regions are expected to differ. Emergence of messenger applications are also noteworthy: In rather developed countries like South Africa, low-bandwidth messaging apps like WhatsApp was in 2015 the first or second app installed on new smart phones (Shapshak 2015). However, there is a lack of information on the use of WhatsApp in rural areas.

Figure 15: Most common phone usage in Sub-Saharan Africa (after voice)



Source: Global Attitudes Survey, PEW Research Center, 2015; 7052 face to face interviews in Ghana, Kenya, Nigeria, Senegal, South Africa, Tanzania and Uganda.

The domination of communication usages and mobile banking are interpreted as the motivated by the need to compensate the lack of basic infrastructures, e.g. landlines and access to banks.

➤ *Mobile phones and the culture of orality*

The domination of voice communication has also been interpreted being embraced because they fit both cultural specificities such as orality (Brady, Dyson, et Asela 2008; Hahn et Kibora 2008).

More precisely, the appreciation of the phone for of voice communication is explained by ethnologist as being related to the oral culture of populations, enhanced by a context where a high proportion of individuals is illiterate. Besides this pragmatic factor for oral communication and appreciation for the phone, Hahn and Kibora link the appreciation of the phone to the oral society where the importance of spoken word remains critical, and where prioritization of speech is an important principle deriving from this oral tradition. In consequence, the patterns of usage of the phone would reflect the social norms of the rural society: As people “*still have to respect the rule that ‘you may not say whatever you like to whoever you like’*” the relative status of individuals is often expressed through complex structure of greetings. Hahn describes explains this dynamic as follows:

“The notions of the oral society and the hierarchy of speech in oral communication are highly relevant to the usage of the mobile phone, regarding not only who may be calling whom, but also whether a person reacts to flashing or not and, last but not least, giving space for proper greetings and the directness in exchanges with communication partners.”

(Hahn et Kibora 2008, p. 101)

Oral societies, so Hahn and Kibora, provide the context and framework for a process which Hahn describes as ‘domestication’ of the phone in African societies, the result of a process of cultural appropriation. More precisely, the ethnologist describes three domains where this appropriation takes form. Firstly, there is social integration as, like already described, it fits well in the communication priorities of oral societies. The second (technological appropriation) and third domain (economic appropriation) are directly related to difficult technical, infrastructural and economic situations of users. Hahn observes that villagers exhibit an inventive attitude in extending the scope of the mobile network signals when they climb hills in order to make a call, or look for alternative ways to charge their phone or repair

batteries. There is also technological appropriation as individuals manage to ‘decode’ their phone, meaning they modify the phone restrictions in order to connect to networks from competing telecom providers. Finally, Hahn considers as the highly important sign of appropriation the practices related to the economic situation of users, oblige them to adopt a ‘zero budget strategy’ and make significant efforts to use the phone:

“In this context, appropriation means to create new modes of using the phone, including flashing, sharing a phone, organizing a communication centre, or even not using a phone until the last days before the account expire.”

(Hahn et Kibora 2008, p.104)

Finally, it is the interaction between the social and economic domains of the mobile phone that is symptomatic for the high appropriation of the phone in African populations. The mobile phone is considered as being increasingly domesticated as *“its technological features are exploited precisely to the level that is useful in the local context”* (ibid, p. 105).

2.2 Real challenges: Network coverage, cost, juridical constraints and lack of content

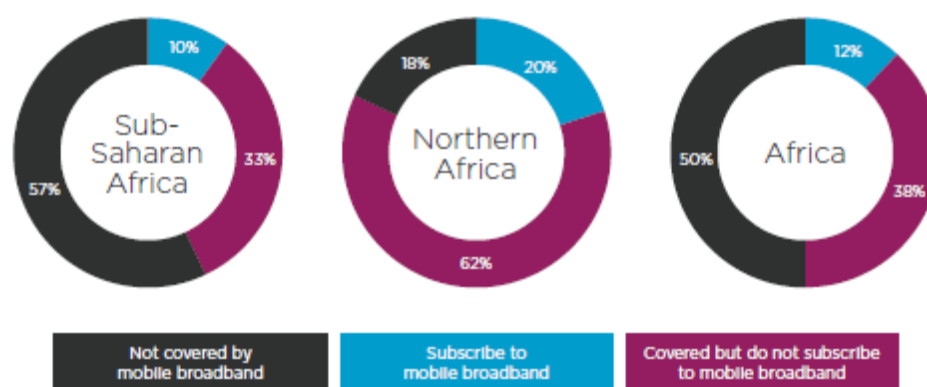
Despite the massive increase of mobile subscriptions thanks to better network coverage, lower prices and the resulting appropriation of mobile phones among African populations, real challenges remain. These are both of infrastructural, economical, technological and juridical nature. In addition, the low level of awareness and skills among the populations are considered as being often underestimated. These in the following factors, provide a more nuanced perspective when looking at the context of the mobile phone sector in Africa.

2.2.1 Insufficient network coverage

One of the key challenges remains the network coverage: Only 50% of the population has access to network coverage, equaling around 600 million people who do not have access to a mobile broadband service. Also, individuals with broadband network access do not convert necessarily into subscribers: As found by GSMA, three quarters of the population with mobile broadband coverage in the region – equivalent to 440 million people – haven’t yet subscribed to mobile broadband services (Figure 16). With regards to 3G and 4G networks, the situation

is also 30% lower than the global average: In Africa, 3G and 4G networks covered 50% and 16% of the population respectively, according to GSMA. The lack of network coverage is one of the reasons why it is expected that by 2020, only 40% of the African population will subscribe to mobile internet services. Particularly concerned are rural populations, as providers fear the high costs of infrastructure deployment in rural areas where communities are sparsely populated, lack access to grid electricity and live in challenging areas, e.g. forest and mountains. In addition, these populations are also often particularly poor and their purchase power low, making these areas even less attractive for providers.

Figure 16: Mobile broadband coverage per region in Africa



Source: GSMA, 2016

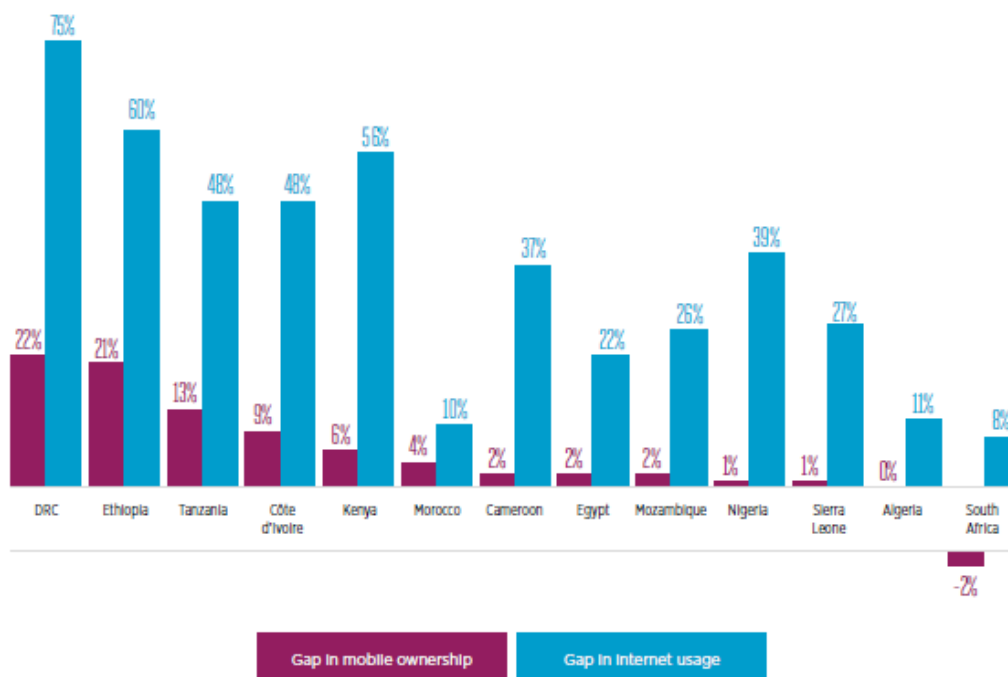
2.2.2 Affordability of mobile usages

Cost remains also an issue for the population itself. Countries in Africa have among the highest total cost of mobile ownership, cost including cost of the device and mobile services, e.g. voice, SMS and internet, as a proportion of income: Despite the increasing number availability of cheap phones, the subscription fees remain far too high for a large proportion of the population. According to the GSMA Intelligence Consumer Survey 2015⁴, in many African countries like the Democratic Republic of Congo, Mozambique, Senegal, Mali and Tanzania, the cost of mobile ownership is above 5% of personal income. Affordability is a

⁴Among the 54 countries, 13 figured 13 African countries: Algeria, Cameroon, Democratic Republic of Congo, Côte d'Ivoire, Egypt, Ethiopia, Kenya, Morocco, Mozambique, Nigeria, Sierra Leone, South Africa and Tanzania

particular key obstacle among low-income consumers: For example in Chad and Niger, the costs of mobile broadband service represent the double of the annual income of 20% of the population. Finally, the cost issue is particularly important for women, as they often have lower incomes than men (Adam et al., 2011). African women are 13% less likely to own a mobile phone than men. Interestingly however, the in mobile usage is much lower than the gap in internet usage (Figure 17).

Figure 17: Gender gap in mobile ownership and internet usage



Source: GSMA, 2016

2.2.3 Technological and juridical constraints

For Adam, even though the infrastructural development favors the presence of mobile phones in teacher training, the expansion does not come along with technical homogeneity, but with different phones types and operation systems, leading to the challenge of creating educational content that adapts to each of these constraints: For software developers it is cost intensive to develop customized, tailored educational resources available on all phones and promoted by providers (Adam et al. 2011).

According to Adam, ultimately, these factors directly affect both the scalability and sustainability of mobile teacher training projects:

“It requires constant investment in parallel development (different languages and mathematical packages) for a variety of systems and hardware that have different capabilities even when operating under similar system. It also requires software verifications and quality assurance that are not easy to do in educational environments.”

(Adam et al. 2011, p.35)

Another reported technical constraint potentially affecting the outcomes of mobile learning and training is the small screen size of mobile phones, insufficient memory capacities (Franklin et al., 2007; Newhouse et al., 2006). A recent example can be found in a 2016 interview published in online news site *The Times Higher Education*, in which Wolfenden, former president of the African education platform TESSA (Teacher Education in Sub Saharan Africa), agrees and explains:

“Our content is not designed to be viewed easily on a small mobile screen. There is quite a bit of text because when we built it we were very concerned about download speeds. There aren’t very many graphics, so it’s not good to look at it on a tiny screen.”

(The Times Higher Education 2016)

In addition to these technical issues, there are still **judicial issues and constraints** that can de facto constitute a considerable obstacle to sustainability of projects and their chance to be one day scaled-up. The overall lack of standards is regretted (Yerushalmy et Weizmann 2017); and the domination of licenses considered as preventing sustainability of ubiquitous mobile learning and training models:

“Licenses prohibit copying and printing, but also modifying, removing, deleting and augmenting (improving) or ‘in any way exploiting any of the eBook’s content.’ This stipulation, along with the ‘sole device’ stipulation, effectively negates any attempts at mLearning using such software, even if institutions are prepared to pay, pay again and keep paying, for the same licenses until they expire. And, if institutions don’t keep paying, they may no longer be able to access data or records linked to that product.”

For Buchter, there is a contrast between the educational discourse around mobile learning and training and economic incentives related to intellectual property: *“While there may be strong commercial incentives to protect certain kinds of intellectual property, the economic and educational arguments in favor of the concept in education are spurious to say the least.”* For the author, open source models are the only solution. He suggests to release intellectual property as OERs for use and adaptation under emerging licensing frameworks in order to encourage learners to become creators in the educational environment and share their results (Buchter 2011, p. 24).

2.2.4 Lack of technical literacy, awareness and content

Literacy rates in Africa (particularly in Sub-Saharan Africa) are among the lowest in the world, hindering use of mobile services. These barriers are particularly acute for the majority of the population who live in rural areas – a sort of vicious circle, directly related to the already exposed issues of high deployment costs for providers (The Times Higher Education 2016). According to the GSMA survey, it is the biggest barrier for two thirds of respondents in Ethiopia (62%) and Sierra Leone (60%) and for around 50% of the population in Tanzania and Morocco. In more developed countries like Algeria and South Africa, technical literacy is an issue for only 25% of respondents.

In addition to the lack of literacy, there are voices arguing that there is also still an overall lack of technological literacy, including ‘mobile phone literacy’, representing an obstacle to mobile teacher training: Too often considered as given, because of the increased, almost ubiquitous access to technologies, it is forgiven that not all teachers have access to or know how to use a mobile phone. The ubiquity of mobile phones has reportedly lead to the assumption that individuals are necessarily more ‘tech savvy’ and have necessarily all access to mobile phones (Cushing, 2011; Gado et al., 2006; McCaughtry & Dillon, 2008).

This lack of literacy among teachers comes along with a lack of literacy on the side of educators and those potentially in charge of teacher training: Researchers criticize the overall lack of expertise in integrating mobile technologies in teacher education. The lack of supported best practices in how to train teachers with mobile phones, or how to prepare them

for the integration of mobile devices is considered as a definite barrier to the potential success of mobile teacher training (Foulger et al., 2013; Valtonen et al., 2011).

When there is educational content for mobile teacher training, the lack of awareness of its existence is cited as an additional problem: Indeed, the awareness and locally relevant content was reportedly the biggest barrier to mobile usage for respondents of the GSMA Consumer Survey: 72% of respondents in Egypt and around half of the respondents in Algeria, Morocco, Nigeria and South Africa. It reported to be a less hindering issue in countries such as Ethiopia (18%), Tanzania (20%) and Sierra Leone (21%).

3. Expected benefits from the introduction of mobile technology learning and training processes

In the following will be presented the claimed benefits of mobile technologies for learning and teacher training as reported by recent research literature and project organizers, showing that there is indeed a field of potential, but most of all need for more research on medium and long-term perspectives on effects of mobile teacher training.

3.1 A growing interest in mobile education among development actors and researchers

As discussed earlier in this chapter, Information and communication technologies (ICTs), and more recently mobile phones, are increasingly seen as a potential viable solution, capable to uptake both the organizational and content related challenge of teacher training. The training and learning through mobile phones is usually defined as m-learning and considered as a sub-category of e-learning, involving a learning process via mobile network devices as cell phones, smart phones, personal digital assistants (PDAs), tablets and portable media players. The supposed ubiquitous access to information, colleagues and resources, made possible by technologies which combine the power of computers with portability, flexibility and supposed ease of use is what has made m-learning a popular subject in education and development research. Overall, and despite the previously exposed infrastructural, cost and content related challenges, the continuous development of the mobile sector has put mobile phones in a position where they are considered as vector of transformation in the education world and

quotes referring to its promises and potentials are omnipresent, as shows this quote from the World Bank:

“Access to telecommunication services rose on an unprecedented scale over the past two decades. This growth was driven primarily by wireless technologies and liberalization of telecommunications markets, which have enabled faster and less costly network rollout. The International Telecommunication Union (ITU) estimates that there were about 6 billion mobile subscriptions globally in the early 2010s. No technology has ever spread faster around the world.”

(World Bank, 2016)

Expectations towards mobile phone usage are indeed high, as show further declarations considering that *“the most promising technologies for teacher distance education in developing countries are cell phones”* (Burns 2011, p. 118) and expecting that *“the mobile communications sector has to qualify as one of Africa’s success stories”* (ITU 2004).

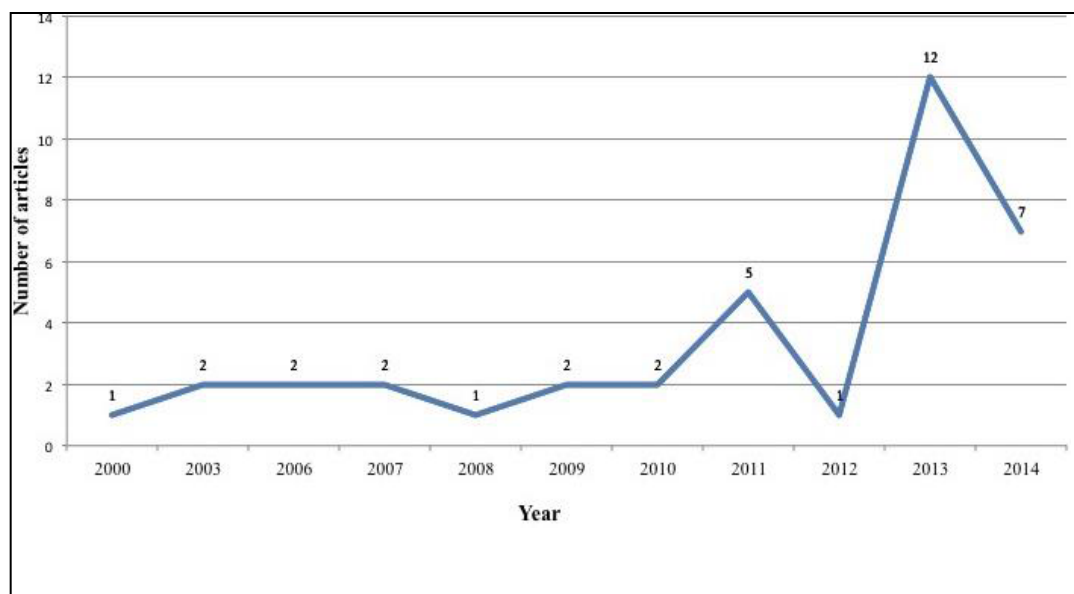
The multiple functions on mobile phones, e.g. voice and SMS communication, possibility to listen and record resources from audio-files, the radio or even the internet, making videos, accessing content and information, exchange with colleagues – the list of discussed potential usages and benefits is long, and so are the voices of educational stakeholders calling for an increased use of mobile phones (Lefkowitz 2010; Hartnell-Young et Heym 2009; Ally 2009; Valk, Rashid, et Elder 2010).

While mobile technologies have already in developed countries, “exploded as tools for student and, progressively, teacher training” (Burns 2011, p.107), the massive increase of mobile phones in the developing countries, including Sub Saharan countries, has increased their popularity among journalists and international organizations. Overall, there appears to reign enthusiasm towards the subject: In 2012 for example, the US television channel CNN declared that mobile technology had “immense” potential to transform Africa’s *“dysfunctional educational system...as mobile phones – cheaper to own and easier to run than PCs – gain ground as tools for delivering teaching content”* (as cited on The Times Higher Education 2016). An increasing amount of universities launched symposiums to discuss the matter, among which Stanford University with its m4Ed4Dev (Mobile for Education for Development) symposium, organized since 2011 every October in Washington

(<http://www.meducationalliance.org/>). International organizations like UNESCO and its annual Mobile Learning week or the World Bank have also put mobile technologies at the heart of education and development issues.

Mobile technologies in education and teacher training have also benefited from increased attention from researchers. While a comprehensive analysis of publication trends would exceed the framework of this dissertation, recent research on publication trends do de facto illustrate neatly this evolution: In his research on publication trends from 2000 to mid-2014 on mobile teacher training, Baran has identified a constant increase of articles: In the last two years, more than 50% of the articles of the period have been published (Baran 2014). Almost 38% of the studies on mobile learning were conducted in the U.S.A teacher education contexts followed by Australia and Finland, with an increasing internationalization – including a focus on African countries. This trend is consistent with other review findings on mobile learning (Hwang and Tsai, 2011; Wu et al., 2012). Baran’s research shows that the research concerned mostly pre- and in-service teacher training context; followed by teacher educator’s training and on coaching modalities (Figure 18). The majority of these studies had a cross-content approach, followed by studies on science, math and literacy. None of the identified studies focused on practical aspects like pedagogical practices.

Figure 18: Publication trends on mobile technologies in teacher training from 2000 to mid-2014



Source: Baran, 2014

3.2 Mobile phones, the latest trend in education?

Mobile phones are considered as part of a rather recent trend within the evolution of mobile technology making their introduction in the educational sphere (Table 3). They are considered sometimes as the generation following the arrival of low cost computers, and as more realistic option to tablets (Burns 2011; Adam et al. 2011).

Table 3: Key technology trends and their role in the learning process

Generation of Technology	Trends	Type of learning	Access
PC based innovation (early)	Low-cost computing devices (including recycled computers)	One-to-one, class room, laboratory and collaborative learning	Single or shared (offline and online)
Non-PC based innovation (medium)	PDA's, mobile phones, smart phones, 3G phones	Ubiquitous learning	Single and personal (always connected to mobile provider/s except PDA's)
New-age devices (latest)	Merging PC and mobile phones: iPhone, iPads, tablet PCs, eReaders and eBooks	Intuitive, interactive, touch-screen, peer-to-peer, collaborative work	Single but can be shared in certain contexts – still early and evolving (designed to be social and internet-friendly but can function offline)

Source: Adam, 2011

Adams differentiates divides the mobile technology trend into three generations: The first generations are PC based, low cost computing devices, introduced with the expectation to provide mostly one to one and class-room learning, and designed for single or shared access. This generation was followed by non-pc based, more nomad devices including mobile phones, with the key expectation of enabling ubiquitous learning. While this is the key expectation for Adam, a detailed overview of the discussion around expectations and potential of mobile phones will be provided in the subsequent sections. Finally, tablets are considered by Adam as the latest trend, accessible both online and offline and expected to allow for collaborative learning. Called 'new age' device, this designation however queries implicitly if these devices are yet suitable for the developing education context.

While an in-depth analysis of the different trends of mobile education technology would exceed the scope of this research, it appears however interesting to summarize the key criticism towards these two generations (PC and tablets). Indeed, understanding their weak

points allow subsequently understanding why the expectations pertaining to mobile phones are high.

➤ *Low cost laptops and computing devices (LCCD): Techno-centric and dependent?*

The last 15 years have seen a number of ambitious low-cost computing projects and technologies. Among often cited examples are for example the Intel Classmate or the One Laptop per Child (OLPC) initiative, also launched in a teacher training version called One Laptop Per Teacher (OLPT). These devices and models have, after first phase of enthusiasm, increasingly been criticized for their techno-centric approach (Warschauer et Ames 2010). As summarized by Adam (2011), the model is today also criticized with regards to its suitability for developing countries because

- of their dependency on large-scale production limiting the extent to which they can be customized to local needs
- the dominance of Latin characters and lack of technical standards / solutions making the use of some local languages in software and hardware difficult
- high-income consumers tend to be the target market for manufacturers despite the fact that lower-income users in rural areas are often cited as the target market for low-cost computing devices. In consequence, this reportedly led to a focus on issues such as improving performance capabilities and a shift away from developing country relevant environments (e.g. alternative power options)
- large scale deployment depend on government procurement support and subsidy.

➤ *Tablets and eReaders – not (yet) appropriated in terms of infrastructure and appropriation?*

As mobile phones tablets (i.e. tablets PCs and iPads) and eReaders have initially not been designed for an educational use nor for a developing country context. In developed countries they are nowadays very popular and widespread because of their intuitive functions, their touch screens and the possibility to access different types of media as well as the internet. Cost is one of the key criticism towards their suitability for education and training in Sub-

Saharan Africa, even the cheapest e-Reader are often not affordable, particular by rural populations (Adam et al. 2011; Website of the *Educational Technology Debate* 2011). In addition, they have been criticized for their lack suitability for the very dusty and tropical environments and dependency on the internet: Many functions on tablets can't be used in areas with no or slow internet connection, or by individuals who can't afford the cost pertaining to data use. Most importantly, individuals can't neither use tablets for communication nor use voice communication applications depending on the use of data, e.g. skype. As discussed, this is an issue for populations characterized by an economic constraints and oral cultures. Moreover, tablets have been criticized for their dependency on specific standards and formats, making the development of content sometimes difficult; locally relevant content is also lacking. The lower diffusion of tablets comes also along with a lower possibility of customer or repair services (Quentrec et al. 2015).

Overall, one of the key criticisms towards PCs and tablets are that they supposedly generate more usability issues because of the lower or inexistent degree of appropriation. This type of problem has been observed by Kukulsa-Holme, according to which *“devices, such as mobile phones and mp3 players, are more likely to be personally owned by, and hence more thoroughly familiar to, their users”* (Kukulka-Hulme 2009). Similarly, Antoniou and Lepouras (2005) found that owners' familiarity with their mobile phone is positively correlated to lower usability problems. Also, as found by Fantognon, who analyzed the appropriation process of a teacher training project in Benin, constraints and tensions during pedagogical practices are key obstacles to appropriation (Fantognon 2015).

3.3 An ubiquitous and hence cost efficient and familiar tool

In light of the acknowledged importance of providing a teacher training that is adapted to the African context, a training which allows teachers to continue their teaching while being trained, it is not a surprise to ascertain that “ubiquitous” is one of the most cited desirable characteristic of mobile learning, including in the area of teacher training.

Ubiquitous teacher training has been for a long time considered as desirable. This is particularly true in the case of developing countries, where the need for ubiquitous technologies has clearly been defined in the Declaration of Principles of the World Summit on

the Information Society. The latter asserts that *“ICT now offers the capacity to reduce many traditional obstacles, especially those of time and distance, and for the first time in history makes it possible to use the potential of these technologies for the benefit of millions of people in all corners of the world”* (ITU, 2003).

Other researchers go a step further and consider that mobile phones are considered as the ‘most’ ubiquitous form of knowledge technology in developing countries, referring to Ford and Leinonen from the Meraka Institute (Cox 2008) who consider that this ubiquity is enhanced by the overall facility of use and independence from ongoing electricity supply:

“From a developing country perspective, features such as limited or no dependence on permanent electricity supply, easy maintenance, easy-to use audio and text interfaces, affordability and accessibility are the most important considerations for using mobile phones as potential learning tool.”

(Adam et al. 2011)

Within the African context, the ubiquity of mobile phones is seen as powerful mean to reduce teachers’ isolation. Teacher isolation is a significant problem, particularly for rural areas, which find it very hard to attract and retain teachers in light because of their low attractiveness due to low level of infrastructure and services. In addition, teachers in rural areas benefit less often from training programs and professional development initiatives. Indeed, the already rare training programs are more often provided in urbanized areas, and rural teachers live and work often days away from training facilities.

The ubiquity of mobile phones is said to allow teachers to train in a flexible manner, independent from any physical facility, and at times that are convenient for them: knowing that is not rare that African teachers have a second professional activity, in addition to family duties this is hence an important point to consider. In the Asian developing context, the positive attractiveness of mobile teacher training for rural teachers could be shown in several studies: It was found that mobile learning was particularly beneficial for those who can’t follow courses in a traditional educational setting due to the constraints of work, household activities, or other competing demands on their time. For example, teachers participating in a

mobile supported teacher training program in Bangladesh underscored the benefits of being able to stay with their families during the training (Valk, Rashid, et Elder 2010).

Overall, the mobile phone is considered as potentially reducing both psychological and professional isolation of teachers. Since the introduction of technology in education, reduced isolation has been a desirable for rural education initiatives. Technology is expected to overcome teachers' isolation, breaking down their classroom walls and connecting them to colleagues, mentors, curriculum experts and the global teacher community on a continuous basis. (Carlson 2002). In the African region, mobile phones are perceived as the first realistic option of achieving this reduced isolation Trucano 2014).

Moreover, another type of isolation has said to be reduced thanks to the ubiquity of mobile phones: The perceived or actual isolation of autonomous, distance learners. On the contrary to 'older generation' distance training which used paper based materials sent by mail, the ubiquitous presence of mobile technologies, if used for a training project, can facilitate cohort socialization between and among students or can serve as a support mechanism to encourage students along in their distance education (Venter 2010; Thorpe 2002).

Traxler for example has researched the possibility to use SMS campaigns to motivate teachers during a mobile supported in-service teacher training in Kenia. Mafenya concludes on the basis another Kenyan study that *"using cell phones for educational purposes is enormous in a country of limited access to electricity and telephone networks, poor roads and postal services, and fewer people who have expertise of using computers"* (Mafenya 2014, p. 2).

When looking at mobile supported teacher training modalities, this is a very important aspect: Indeed, while there is much literature on possible benefits of mobile phones because of their potential to provide distance training to teachers without obliging them to be physically present in a training institution or a class, there is less available research on how mobile phones can be used to tackle challenges related autonomous training. If available, these concern mostly European and Asian context. Research remains rare – or project results unevaluated? – on this potential feature of ubiquitous mobile phones in an African context, even though autonomous learner isolation appears to be a key issue to consider when recommending large scale distance training (Ramos et al. 2007).

While ubiquitous teacher training itself is seen as a benefit ubiquity is often considered as a characteristic allowing for further benefits to be exploited:

Cushing and Traxler for example find that ubiquity allows for personalized learning since a multimedia device can be customized to all user requirements (Cushing 2011; Traxler 2010). It is the ubiquity of the mobile phone that allows increased access to distance resources and materials, independently from the location of the phone user. (Cushing 2011) For Valk, referring to work conducted by Sharples, this ubiquity leads de facto to a fusion of workplace and private sphere:

“Mobiles can support the great amount of learning that occurs during the many activities of everyday life, learning that occurs spontaneously in impromptu settings outside of the classroom and outside of the usual environment of home and office. They enable learning that occurs across time and place as learners apply what they learn in one environment to developments in another.”

(Valk, Rashid, et Elder 2010, p. 4; Sharples, Taylor, et Vavoula 2010).

Cox and Chan also refers to the creation of seamless learning space, and claim that the ubiquitous access to mobiles will create a technology-enhanced learning, characterized as seamless learning spaces (Cox 2008). Focusing less on the fusion of spaces, Sharples perceives the impact of ubiquity on work and private sphere as impacting on the process of the learning experience: the ubiquity of the mobile phone allows for a continuity of the learning experience across different learning contexts, representing a potential for a new phase in technology enhanced learning (Sharples et al. 2009).

Furthermore, the ubiquitous aspect of mobile phones is also assimilated by researchers with increased familiarity and, subsequently, higher acceptability of the tool for training purposes (Adam et al. 2011; Mumtaz 2000).

On the contrary to computer, mobile phones are not compartmentalized and currently used, even in developing countries, for a variety of purposes, for example recreation, leisure, education, economic purposes (Burns 2011). Hence, it is expected that teachers are more

likely to have already the capacity to use a tool, are less intimidated – with other words the appropriation process is supposed to be more advanced because of the enhanced ubiquity.

This appropriation is well described by Traxler, who considers that the mobile phone has, partly because of this ubiquity, mobility and flexibility the power to be a tool which expresses

“...part or much of their owners’ values, affiliations, identity and individuality through their choice and their use. They are both pervasive and ubiquitous, both conspicuous and unobtrusive, both noteworthy and taken-for-granted...”

(Traxler 2010, p. 1)

In turn, this ubiquity, higher familiarity and enhanced appropriation process is also seen as a factor for sustainability, a delicate aspect in light of the high amount of ICT and education pilot projects in developing projects: According to Stead, this positive impact on sustainability is explained by the fact that mobile technologies, as being possibility used for both private and professional purposes, empower users. This ultimately impacts positively on ongoing engagement and motivation which can continue beyond what the author calls the ‘*gadget honeymoon*’: On the contrary of ICT tools developed with an educational purpose only, mobile phones are considered as an integer part of daily habits – including for African teachers (Cox 2008; Stead 2006).

Finally, the advantages of ubiquitous mobile mobiles phones is also noted as beneficial from an cost-efficient point of view, potentially crucial for both training participants and organizers in developing countries: Mobile teacher training , because of the increasing ubiquity of phones in developing countries, can overcome the environmental and infrastructure challenges that hinder other learning modalities in rural and remote areas. Many of these areas are bypassed in terms of investments in costly, fixed telephone infrastructure but see their mobile phone network improve constantly, making mobile learning and training a more realistic choice (Valk, Rashid, et Elder 2010). Also, mobile phones are indeed less cost – prohibitive than other technologies, e.g. computer and broadband connections, still necessary in the case of many e-learning solutions (Visser et West 2005).

In this regard, mobile learning and training is seen as more accessible solution for populations in developing countries, contrasting with the large development of e-learning solutions in

developed countries (Valk, Rashid, et Elder 2010). Benefitting from the fact that ubiquity would come along with familiarity and acceptance, researchers argue that ‘bring your own device’ projects would allow to reduce project costs (Ally et Tsinakos 2014). Subsequently, this is discussed as potentially increasing the scalability potential of an initiative, given that costs are one of the key obstacles to scale-up and, more generally, sustainability. From another perspective, bring your own device models that lower financial constraints are also seen as possibly reducing the risk of corruption pertaining to the implementation of projects introducing large and costly numbers of devices.⁵

However, in the African context, there is no trace of projects having chosen this type of training modality. As seen earlier in this section, this shows that the claimed ubiquity is not yet as ubiquitous as it would need to be in order to systematically implement projects that make teachers bring their own phones. An illustrative example for this argument can be found thanks to interviews conducted for this dissertation with former participants of a mobile teacher training in Madagascar: individuals had reported that even though they already had used the phone of a family member or neighbor, the phone they had received for the training was the first one they possessed (von Lautz-Cauzanet, Bruillard, et Le Quentrec 2016). With other words, the notion of ubiquity has to be considered cautiously when making assumptions on training design and outcomes. When discussing the benefits of mobile phones for teacher training, other often with ubiquity associated benefits for teacher training are also reported: Access to resources, personalized learning and training and enhanced collaborative dynamics. Corresponding exactly to the current recommendations of teacher training in general, it is important to have a closer look at the research literature in this area.

⁵ Discussion with Dr. Erwan Le Quentrec, September 2017

3.4 Quick access to resources via platforms, applications, video and audio files

Research has shown increasing interest in the possibility to provide access to resources via mobile phones. Particularly focus lies on the fact that this access can be ‘quick and timely’ and ‘easy’ (Burns 2011).

➤ Education platforms

Even though they are not solely conceived for an access via mobile phones, educational platforms are noteworthy: Indeed, while the amount of teachers able to access a computer is low, the increased amount of teachers possessing mobiles confers them theoretically the possibility to use license free educational resources provided on these open platforms and to train themselves in an autonomous way. A popular platform is the TESSA (Teacher Education in Sub Saharan Africa) platform, launched by the Open University in 2004 with the specific goal of tackling the challenge of unqualified teachers in Africa. While reportedly many teachers use their mobile phones to download text documents and audio – sources on the website to prepare their classes, no evaluation on this type of usage is (yet?) available.⁶

International organizations and research are not the only actors interested in the potential of mobile education resources: The mobile learning market in Africa is currently growing by 39% every year and e-learning is expected to be a 530 USD market by the end of 2017 (Ambient Inside 2013) and the launch of several African mobile platforms, among which some focus, albeit not exclusively, on teachers: The Kenyan platform ‘Eneza’ for example is supposed to permit teachers to ‘refresh and enhance their skills in classroom management, guidance and counselling, instructional delivery as well as managerial skills in resource and staff management’ (www.eneza.com). The platform, especially designed for mobile access, had been tested for both teachers and students as part of a pilot project in the Dadaab Refugee camp in 2016 (All Children Reading, 2016). However, evaluations or available feedback on their training could not be retrieved. Further African educational platforms exist, but focus rather on students (e.g. ‘OkpaBac’, an Android mobile Platform in Togo) or offer services that

⁶ Wolfenden, former president of TESSA in an interview 2012: “They are now accessing learning materials through their phones, which was unheard of six years ago,” Wolfenden explains. “Now, when we go to rural schools and ask where they got a lesson idea from, it will often have come from a Tessa resource that they read on their mobile.”

allow teachers to track the progress of their students (e.g. Sterio.me, a Nigerian platform offering students the possibility to complete courses and receive feedback from teachers who have themselves developed and uploaded courses).

In Nigeria, Nokia has launched the free mobile platform ‘Nokia Life+’ which contains, amongst others, the service called ‘English Teacher’. This service provides a subject and practice oriented training to teachers for free. While it is available to all individuals, it has been tested as part of a pilot project organized by UNESCO in 2013. Details and impacts of this pilot will be analyzed in Chapter 2 of this dissertation.

While these platforms may represent potential in terms of available content there are not yet trace of many teacher training projects including these platforms in their project design. Similar to the criticism towards low cost computing devices, the need for public support in order to create large scale solutions is seen by some NGOs as main issue when it comes to achieving scalable impact, stating that “*to have any macro-level impact, private companies will have to collaborate with the government*” (The Guardian, 2017).

With an increasing amount of individuals possessing smartphones, educational applications – commonly just called ‘apps’ - downloadable on the phone, are considered as a highly promising resource for teacher professional development (Burns 2011). While there are independent applications proposed in the area of history, mathematics, literacy and so on, there are also initiatives that tend to develop educational applications with the deliberate purpose of being possibly used as part of an online learning program, e.g. by Google in partnership with several software companies. The engagement of large corporations in this area reflects the increasing interest towards the potential mobile educational resources in the form of apps: Continuously increasing, educational apps were the third most commonly represented category in the apple store in July 2017 and even the first category on the android counterpart platform. In the latter case, over 80% of these applications were downloadable for free – increasing their educational potential for the African (Statistica 2017; Appbrain 2017; Burns 2011)

However, while there is sound evidence of the use and impact of applications in development areas like agriculture (Hellström et Tröften 2010) no evaluation or research on mobile teacher

training using educational applications in the African context could be retrieved. The still low proportion of individuals possession a smartphone and internet mobile service is probably one of the most plausible argument and shows the a certain gap between enthusiasm towards future possibilities and current research results.

Indeed, reported traces of using mobile phones to access, amongst others, educational resources, refer to resources that can be perceived as ‘traditional’ in developing countries, but are still fairly innovative in an African context, e.g. the use of video and audio resources.

➤ *Accessing videos via mobile phones / preloaded videos on mobiles*

Video resources have been among those resources that are fairly systematically cited when referring to the potential of ICT in general for learning and training, both in developing countries and in an African context. While videos with a focus on content aim to provide a better knowledge of subjects to teachers, the potential benefit of videos containing teaching practices is that they would allow the demonstration of teaching modes, to record and share teaching practices among peers and stimulate a reflection on own habits and practices (Marshall 2008; Valk, Rashid, et Elder 2010; UNESCO, Orange 2015; InfoDev 2005; Blin et Munro 2008).

Videos are also reported to be an increasing popular way to provide quality resources for teacher training via mobile phones, and presented as a viable alternative to DVD players and video tapes (Baran 2014). In Africa, Bridge IT has tested videos, aiming to provide teachers with videos that they are then intended to play in class, enriching their lesson (Adam et al. 2011). A teacher training pilot project using video as resource for teachers has been organized in Pakistan in 2014 within a USAID supported project, where teachers were provided with videos on teaching practices and content. According to USAID

“...after studying the lessons [via their mobile phones] teachers’ subject knowledge increased 30 percent in English and 40 percent in mathematics. More than 90 percent of teachers have reported that the project has positively impacted their teaching. Principals have observed improved classroom instruction, increased student engagement, and spill-over benefits for other teachers and the community.”

(USAID, 2015)

Another Pakistan based project, implemented by Nokia, UNESCO and the Aghai foundation, allowed also teachers to access and download videos from an education library developed by Nokia/While a short evaluation report was published in July 2017, evocating satisfying results despite challenges related to the need of high bandwidth connections, no detailed information on the design of those videos, nor evaluations on how teachers reacted to and used these videos, nor any evaluation of any of these pilot projects could be retrieved. This can be both interpreted as another sign of the issue of lacking (or not shared?) medium and long-term evaluations, as a lack of academic research accompanying pilot projects.

Traces of recent project evaluations of completed projects or initiatives using videos that are intended to be seen by teachers for their training purposes on the mobile phone could indeed not been found in the African region. However, a recent launch of a mobile teacher training is noteworthy: In April 2017 has started the teacher training project FADEP, which trains teachers partly on a distance basis with smartphones containing both content and practice centered videos., the launch took place during the field research phase for this dissertation, and teachers seems to be very enthusiast. It appears important to analyze this type of project in order to assess how teachers benefit de facto from videos on the medium-term. Overall, this lack of available research on videos in mobile teacher training show recent both the use of mobile supported teacher training and the use of video resources on mobile phones for teachers are in the African context.

➤ *Audio files and audio pod casts*

Similar to video resources, audio files, and more precisely pod casts have often been presented as one of the promising type of resources for ICT based distance teacher training (Noor-Ul-Amin 2013). Audio Pod casts can be downloaded, often for free, on a computer or mobile phone, and cover a wide range of themes hypothetically useful for teachers, e.g. News, content-specific lectures, exercises. In developing countries, many universities have partnered with private industry to produce pod cast series, as for example the Stanford University, Cambridge University, Duke University, the MIT, the University of Melbourne. In Africa, Universities in developed countries e.g. The University of Stellenbosch and the University in Pretoria in South Africa have also started to provided pod casts. Furthermore, as mentioned

earlier, platforms like TESSA provide open source audio files, adapted to their curriculum to teachers and theoretically available on mobile phones.

The IFADEM project in Madagascar – which provided opportunity a field research based case study, results being discussed in the next chapter - has provided for their teacher training project teachers with mobiles phones on which audio-files were already downloaded. These were mainly songs and exercises for their pronunciation and encountered a large success among teachers. Positive aspects were the fact that teachers did not need an internet connection to download the files, and that these continued to be used even after the end of the pilot ended.

Otherwise, the research on actual implementation of mobile teacher training using audio-files remains quite an unknown terrain. In light of the overall enthusiasm towards audio files for teacher training, their actual use and impact needs to be analyzed further.

This appears even more important when considering the criticism towards the overall lack of content and when available, the insufficient suitability of the content for teacher training: It can be ascertained that there is a lack of educational content in many African languages. Only a few pilot projects have at this stage started to design educational applications in local, indigenous languages, e.g. a pilot project conducted by the National Open University of Nigeria called Nouedu.net like its website.

3.5 A training device for active, personalized and knowledge centered training

When discussion benefits of the introduction of mobile phones in teacher training, the recrudescence of researchers claiming that these would allow a personalized and knowledge centered training experience is striking. There are several underlying arguments : Firstly, researchers refer to the fact that the already mentioned ubiquitous, nomad and socially embedded character of mobile phones allows for personalized and contextual learning and training, making it more meaningful (Montrieux et al. 2015). Also, the fact that mobile phones would allow teachers to customize their transfer of and access to information according to their own needs, skills and knowledge would lead to a beneficial learner-centered learning (Sharples et al. 2007). Customized learning, adapted to all user requirements, is also

mentioned by Traxler as possible benefit of mobile phone usage in learning and training processes (Traxler 2010). More precisely, m-learning is expected to allow a learning which would be based on process of customized knowledge construction and not mere instruction (Valk, Rashid, et Elder 2010). This process of construction is customized as it goes beyond the possibility of producing a 'bank of knowledge possession' but represents earning that is 'just-in-time,' 'just enough,' or 'just-for-me'(Valk, Rashid, et Elder 2010 citing, p.5). In this new learning process, learners use the mobile phone as facilitator to finding, identifying, manipulating information. In the area of m-learning in teacher training, this type of learning is seen as a potential to provide teachers and future teachers with personalized learning experiences (Brown et Chalmers 2003).

With regards to the role of learners, m-learning would empower them to be active participants in their learning process. Kukulska-Hulme finds that teachers would, thanks to mobile learning solution, rethink the relationships with their peers and students, and reflect in turn on learning processes that increase their active participation (Valk, Rashid, et Elder 2010).

Particularly in teacher training, the transformation of trainees into actors is seen as a highly valuable benefit of m-learning: In a study on mobile support pre-service teacher training, Husby and Elsener used the mobile phones to allow teachers during early childhood literacy courses access videos via QR codes, allowing teachers learn at their own pace, letting them decide when they needed to watch again a video or move on (Husbye et Elsener 2013).

Another often cited example of teacher trainees becoming actors of their learning is the performance of flipped classrooms: These are used as form of blended learning in which students learn course content on the web via video, audio, or text and use class time to engage in activities and get individual guidance. In teacher training, mobile devices were reported to help establish these flipped classrooms. For example, Husbye and Elsener (2013) asked preservice teachers to access materials (e.g., video podcasts) before class and engage in hands-on activity during class.

This transformation of both the learning process and roles of learners has reportedly led to the availability of more efficient methods facilitating knowledge-centered learning. The mobile phone, would allow to "*learn with understanding – meaning that [learners] deepen their*

understanding of a specific subject matter rather than merely memorizing large amounts of information – and then use this knowledge as a basis for new learning through integration and interconnection” (Valk, Rashid, et Elder 2010, p. 5). In consequence, this methods would allow deeper explorations of content areas (Baran 2014).

According to researchers, the mobile characteristic of mobile phones is what allows also this personalized learning: According to Price, who designed in a participatory approach with teachers a smartphone app to support preservice science teachers’ awareness of the integration of geospatial ideas into science found that mobility, combined with other emerging features such as augmented reality and context awareness, helped facilitate contextualized and situated learning experiences (Price 2015).

In the case of teacher training, the methods would allow to provide more efficient methods to help teachers understand and develop new literacies (Husbye et Elsener 2013). Furthermore, several studies have found that m-learning processes allow improving teacher skills in content specific areas, e.g. mathematical skills through their exploration in the real world, and sciences through methods that include the use of mobile phones for scientific investigations (Baran, 2014). For example, in a study conducted by Gado, pre-service teachers equipped with mobile phones, were engaged in scientific inquiry to develop their understanding of sciences and mathematical concepts (Gado, Ferguson, et van Hoof, 2006). In another project, mobile devices were used by pre-service teachers to listen to educational materials, and teachers reported later that accessing professional development resources via mobiles helped them to develop both pedagogical skills and in the case of this language centered study, English-language proficiency (Shohel et Power 2010).

However, the majority of these findings are based on teacher training studies conducted in Asian countries. As found by Valk, the majority of developing-country m-learning interventions are being undertaken in Asia, and other researcher expect that despite the significant growth of mobile ownership in Africa, it’s Asia which could become the global leader in educational use of mobile phones (Valk, Rashid, et Elder 2010). While this means that the findings cannot naturally been considered as valuable for the African context – despite many commonalities, particularly when to comes to challenges faced by rural teachers – , it shows most of all that research on mobile teacher training and outcomes in an African context is urgently needed.

3.6 Collaborative learning – the queen of all expected benefits?

As exposed in the first section, the analysis on factors impacting on student performance has led to the recommendation that teacher training should be based on and stimulate collaboration. It is hence interesting to note that when looking at the expected benefits of mobile teacher training, references to collaboration both as process and as a result, are highly present.

When looking for example at the statements of mobile education experts made in interviews to the non-specialized / non-scientific press, it appears that the collaborative aspect of mobile phone is considered as one of the characteristics that differentiate the mobile phone from other ICT tools and used as an argument when explaining why it is one of the most beneficial tools: For example, Francisca Aladejana, professor of science education and provost at the College of Education in Ikere-Ekiti, Nigeria considers that *“SMS messages come at a very cheap cost and have made the use of mobile phones very attractive for these [teacher training] purposes. It has helped considerably to increase communication between teachers, students and parents.”* (The Times Higher Education 2016). A look at research literature confirms that there is an overall enthusiasm towards mobile phones and their supposed power to support collaboration: Researchers argue that if given that it is considered as proven that collaboration enhances effective learning, than the use of mobile phones, given that it is an interactive tools facilitating communication, is a recommendable training device impacting positively on educational outcomes. In the contrary to other technologies, mobiles would collaborative learning and continued conversation *“despite physical location and thus advance the process of coming to know, which occurs through conversations across contexts and among various people* (Balacheff et al. 2009). More precisely, the process of coming to know would be enriched through collaboration as the mobile phones allows participation in knowledge production, reflection on and sharing of practices (Aubusson, Schuck, et Burden 2009). According to several studies, the sharing of practices has found to be particularly useful in teacher training: Mobile devices’ connection capabilities were found to provide opportunities to share preservice teachers’ products (e.g., teaching videos) on the web and used a mobile mind map tool to co-regulate preservice teachers’ collaborative knowledge construction. The use of mobile phones in pre-service teacher training allowed teachers to share their understanding of content and engage in conversations, online (accessing platforms via the

mobile phone) and through the use of class-specific hashtags on Twitter: Trainees discussed class activities, commented on classroom experiences and shared resources for best practice (Husbye et al. 2013).

Similarly, Valtonen used mobile devices in teacher education courses to enable students to capture and share lecture notes via social software (Valtonen et al. 2011). In another study conducted by (Järvelä et al. 2007), trainees used a mobile lecture interaction tool to enhance participation during training sessions. Schuck also found that collaboration would lead to higher engagement and motivation, based on a study in which preservice teachers used the mobile phones to vote via SMS or voting applications (Schuck et al. 2013).

Furthermore, several authors find that mobile phones can allow teachers to engage in collaborative dynamics through which they resolve problems, understand the experiences of others, and create common interpretations and shared understanding (Valk, Rashid, et al. 2010, Sharples et al., 2007, p. 225-26). This collaborative process through mobile phones would also enhance self-reflection, more precisely reflection-in-action, a critical component of professional learning according to Aubusson (Aubusson et al., 2009).

Finally, the already exposed possibility of creating a personalized learning process within teacher training would, according to various researchers, be enhanced by the possibility to collaborate via mobile phones: Trainee teachers who would collaborate would not only have closer relationships, but also a much larger number of connections, with whom they would form a community that would allow to meet the changing needs of teachers over time, and construct collectively the knowledge they need (Baran 2014)

Finally, several researchers mentioned the benefit of using mobile phones for a facilitated collaborative mentoring approach between trainee and educators, often also called tutors or mentors (Baran 2014; Noor-Ul-Amin 2013; Adam et al. 2011; Cushing 2011).

Overall, the possibility to connect and collaborate is what makes mobile phones so different from 'older' technologies: As stated by Steve Vosloo, mobile education expert at UNESCO, underlines this difference to other technologies, "*radio and television are huge, and play a massive role, but they are broadcast media, whereas mobile technology is an interactive medium*" (The Times Higher Education 2016).

However, when conducting the literature review for this dissertation, again a significant lack of evidence on the use of mobile phones mentor and tutoring activities in teacher education in Africa could be observed: A clear need for research in this area, with a focus on African countries, has to be underlined. This is also true when it comes to the nature of mobile supported teacher collaboration, a term which has been criticized for its vagueness. For example, Grossman, Wineburg and Woolworth write:

“The word community is at risk of losing its meaning. From the prevalence of terms such as ‘communities of learners’, ‘discourse communities’ and ‘learning communities’ to ‘school community’, ‘teacher community’ or ‘communities of practice’ it is clear that community has become an obligatory appendage to every educational innovation.”

(Grossman, Wineburg, et Woolworth 2000, p. 43)

It appears hence interesting to analyze not only if a teacher community networks figures among contributions of a mobile supported training, but most of all to analyze the characteristics and dynamics of this network, provided it could be identified.

4. A representative example: The case of Madagascar

While the first part of this chapter has allowed understanding the underlying dynamics and evolutions of teacher recruitment policies and expectations towards mobile technologies, the following section shall focus on Madagascar. Madagascar faces similar education and teacher recruitment challenges like many Sub-Saharan countries. Fairly representative in this regard, it is also where IFADEM, a mobile teacher training project, was organized from 2012 to 2013. As IFADEM was chosen for an in-depth case study underlying this dissertation (chapter 5 to 7), it is indispensable to provide an insight of the country's' development, education and technology context. The presentation will shed light on a country with a unstable past, a struggling but promising economy accompanied by arrival of innovative technologies like solar energy and a steady increase of mobile telephony penetration. In a certain way it appears that this uneven development provides both challenges the IFADEM would later seek to address – the need for quality teacher training in a developing country – while indicating in

the meantime a possible 'way out' in form of increased penetration and appropriation of mobile technology even in rural areas.

4.1 Low, slow but steady – Madagascar's development context

The island of Madagascar is the fifth biggest island in the world and inhabited by around 23 million people who live mainly in rural areas (70%). Its economy is driven by agriculture and ecotourism. Agriculture contributed to over 29% of the national GDP in 2011 and employs over 80% of the country's population (World Bank Database, 2015). The country ranks 155 out of 187 in terms of the Human Development Index 2013/14. With a GDP of around 400 USD it is one of the poorest countries in the world. More concretely, around 90 % of the population lives with less than 2 USD per day. The already precarious economic situation worsened after the political crisis of 2009, when President Ravolamana was chased away and a transitory government established. The months following the overthrow were characterized by a period of significant uncertainty and international mistrust in the national economy. In consequence, the economic growth shut from 6,1 % to -0,91 %. Furthermore, a large amount of technical and financial partners suspended their national support programs, leading in consequence to the suspension or end of numerous development projects – the IFADEM pilot for example, as will be detailed later on, was directly affected by this crisis (UNDP 2013).

In recent years however, a relative political stability led to the end of sanctions and the development of strategic reforms, supported by international partners and donors (IMF, World Bank, European Union, U.N. agencies, bilateral donors). These reforms came in pair with the return of international aid. Today, today the country receives again significant support from the international community, as shows the recent commitment made during the Conference of Donors and Investors organized by the Malagasy government in Paris in December 2016 with the support of the African Development Bank, the World Bank Group, and the United Nations Development Programme (UNDP): Madagascar received a commitment of \$6.4 billion in support of its development projects (2017-2020). In addition, an envelope of \$3.3 billion in investment was announced by the private sector (World Bank 2016). In 2016, the World Bank qualifies the medium-term outlook as encouraging: Gross domestic product (GDP) was around 4% in 2016, exceeding the average rate of 2.6% recorded over the past five years.

4.1.1 Solar-energy to compensate a failing electricity infrastructure

Among the various development infrastructure indicators available, two are of particular importance for this research: Electricity and, most of all connectivity. The in the following described evolutions and current situation are indispensable for a comprehension of the projects rationale:

Madagascar electricity infrastructure is poor: Based on 2015 data, Madagascar's national electrification rate reached only 15 percent of the national need (53 percent in urban areas and 6.5 percent in rural areas). Despite high resource potential and opportunities, Madagascar's power sector faces significant challenges, including the need for improved distribution and transmission capacity. In the World Bank's Doing Business indicator Madagascar has ranked last regarding the difficulty, delay, and cost of getting electricity: Electricity cuts are frequent, and it takes nearly 450 days to get a new connection (USAID 2013). In 2014, only 11% of the rural populations had access to electricity, which equals an increase of only 2% in 7 years and remains far below the rural Sub-Saharan average access to electricity. In this context, much hope has been placed on solar based electrification: In 2014, the Government developed a 'New Energy Policy' which promotes the use of renewable energy sources and provides exemptions from import taxes on products and components, including solar. According to the German development agency GIZ (*Gesellschaft für Internationale Zusammenarbeit*), this has led to a significant increase of importation of low-cost solar panels and solar supported electricity solutions, particularly from East-Asian and Chinese countries (GIZ 2016).

Both private investors and the international community expect the sector to grow, and solar energy has been tested for development projects: UNESCO for example has, within the United Nations framework for an 'International Decade of Sustainable Energy for All' 2014-2024 implements since a pilot program for solar electrification program of rural schools (UNESCO 2015b).

While the overall lack of import or market data that would allow to provide concrete statistics on the amount of solar panels is regrettable, the four field research missions to Madagascar (cf. chapter 4) have allowed to confirm the by the GIZ evocated business potential of the solar energy market; the overall presence of solar panels and mobile solar chargers was striking. Sold in supermarkets and traditional markets, even in rural villages, they clearly seem to be

part of the daily routines of the rural population. Similarly, a high presence of solar – powered kiosks where individuals can recharge electric devices like phones or radios, rent rechargeable lamps, but also offer services like printing or refrigerated drinks could be noticed. These kiosks are either run individually or are funded social enterprises funded by donors, e.g. the *Be Heri* initiative which trains female entrepreneurs and allows them launch their own kiosk.

4.1.2 The connectivity background: Mobiles in every second hand

Similar to the overall development situation of Madagascar, the telecommunication and connectivity sector is below the Sub-Saharan Africa average, but still growing.

Prior to the sector reform of 1994, domestic telecommunication services were poor and government controlled (African Development Bank 2013). Since the late 1990, Madagascar's technological and connectivity infrastructure has constantly developed, even though this development took place in smaller proportions: With regards to total amount of internet users in Madagascar remains much lower than the average amount of internet users in Sub – Saharan Africa. The overall increase of users has also been less strong, which is explained by the period of economic decline, leading to weaker subscriber growth in the telecoms sector, reduced consumer spending. As a consequence, this tendency has also led to an intensified price competition – and hence lower prices – between the three GSM mobile network operators in Madagascar – *Orange*, *Bharti Airtel* (formerly *Zain*) and *Telma*.

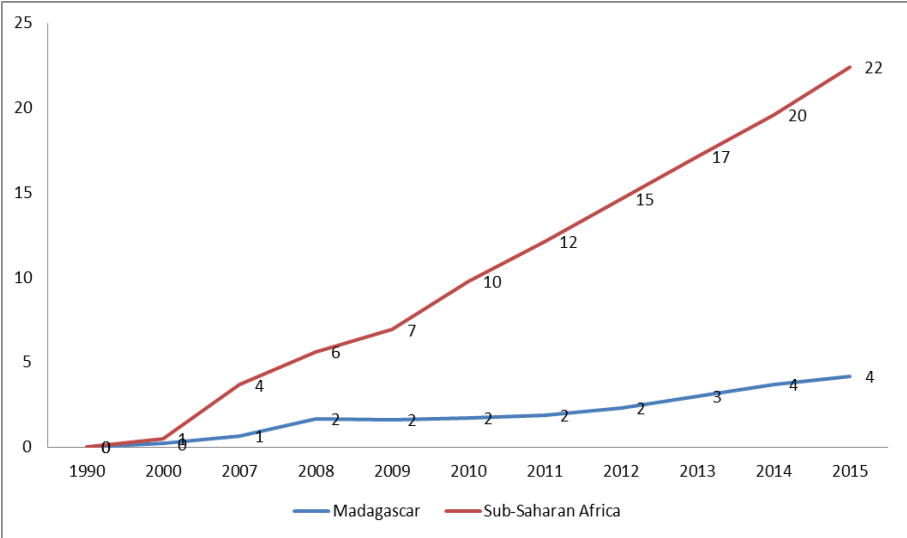
The arrival of the first international submarine fibre optic cables on the island in 2009 and 2010 (World Bank, 2012) has ended the country's dependency on satellites for international connections, bringing down the cost of bandwidth and making internet access more affordable. In parallel operators could increasingly launch 3G broadband services and reverse the after the economic crisis declining average revenue per user (ARPU)(Budde 2017; World Bank 2012)

However, when it comes to fixed broadband in Madagascar, there is still a very low penetration rate far below African averages. The amount of broadband subscriptions per 100 people remains very low and never got to the level of 2 out of 100 (ibid).

As internet access is not restricted to a broadband connection, the amount of internet users in Madagascar is slightly higher than the broadband users: the amount of internet users has

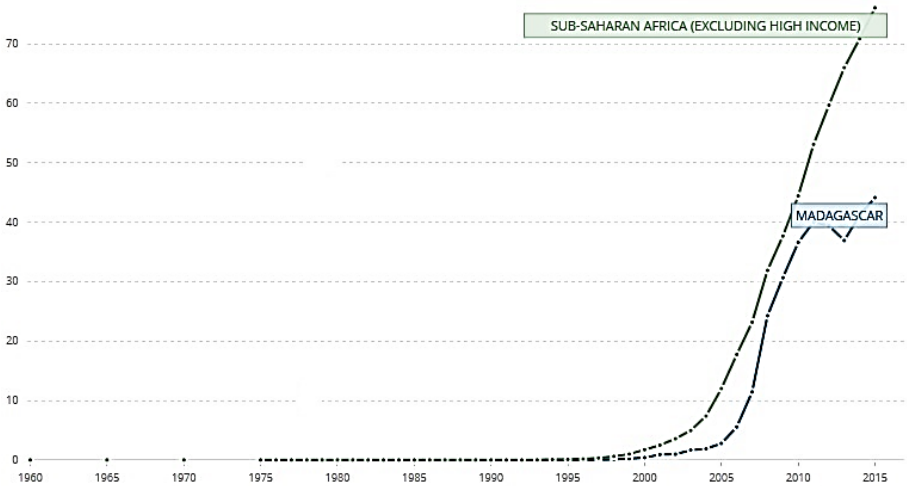
sextupled between 2006 and 2014, remaining however significantly below the average of Sub-Saharan developing countries (Figure 19).

Figure 19: Evolution of internet users per 100 people in Madagascar and Sub-Saharan Africa (high income countries excluded)



Source: World Development Indicators / World Bank

Figure 20: Evolution of mobile subscriptions per 100 people in Madagascar and Sub-Saharan Africa (high income countries excluded)



Source: World Development Indicators / World Bank

This increase is directly linked to the increasing amount of mobile subscriptions and the possibility to access internet via mobile phones: Even though there are less mobile phone subscribers in Madagascar than in other developing countries in Sub Saharan Africa, there has been a radical increase of mobile phone subscribers during almost ten years, which only slowed down slightly during the last 3 years: In 2015, 44 out of 100 inhabitants had subscribed to a mobile service (pre-paid or post-paid) (Figure 20). However, ITU statistics from 2016 show that only 10 out of 100 people access the internet via a mobile phone (ITU 2016b).

4.2 ...facing a dramatic educational context

Directly linked to and influenced by the development situation in Madagascar, the education system and its outputs is and remains source of great concern: Impacted by years of ‘malgachisation’ language policy, and struggling to provide quality Universal Primary Education (UPE), Madagascar does face its own kind of ‘teacher challenge’.

4.2.1 Madagascar’s education system and the consequences of the ‘malgachisation’

From an organizational point of view, Madagascar is divided in 22 regions and 111 districts. The education system operates via 22 regional directorates of education (DREN, French: *Direction Régionale de l’Education Nationale*) and 114 school districts (CISCO, French: *Circonscription Scolaire*) which are again sub-divided in 1600 Administrative Pedagogical Zones (ZAP). As many former French colonies, Madagascar’s education system is structured according to the French tradition and composed of 4 cycles (pre-primary, primary, secondary and superior). A 2008 law aimed to conduct structural changes and establish a 7 years lasting fundamental cycle followed by 5 year of secondary school, but in light of the political crisis of since 2009, the reform could be implemented in only 20 school districts. Hence, in the majority of primary schools, the regular cycle lasts five years and is, in theory, obligatory. Even though the access to primary school appears to be generalized, the number of students dropping out of primary school remains very high. *De facto*, around 25 % of children in the age of attending primary school are out of school.

Links between the unsatisfying performance of primary schools students and the country’s language policy history has been established by researchers: As explained by historians,

French was introduced as language of instruction and as a subject by the French colonists, holding the power from 1896 to 1960. After independence from France, French continued to be the language of instruction until 1972. For the next 19 years – period called ‘malgachisation’ – Malagasy was introduced as the medium of instruction at all levels in primary and secondary education. While teachers and students could now express themselves in their mother tongue, the lack of workbooks and adapted teacher training in Malagasy lead to an overall decrease of the quality of education. Dahl (2012) and Leclerc (2015) explain that the written mastery of Malagasy remained weak among all those who had studied during the *malgachisation* period – including those who would become later teachers. Dahl refers also to studies of 1986 and 1987, considering the following percentages as direct consequence of the malgachisation and an education system which had mostly focused on increasing the primary school rate enrolment (Dahl 2011; Leclerc 2016). Indeed, by 1987 the Malagasy education system was characterized by:

- a repetition rate of 50% after the first year of primary school
- a primary school drop-out rate of 11%
- a success rate at CEPE (French: *Certificat d’Etudes Primaires Elementaires*; exam at the end of the primary school cycle) of only 29,9 %
- a success rate at BEPC (French: *Brevet d’Etudes du Premier Cycle*; exam at the end of the junior secondary cycle) of only 30,2%

Dahl and Leclerc underline the importance of the fact that the main language of the Malagasy administration system had remained French. More generally, the language spoken by the Elite had always remained French. Indeed, the political elite in the cities have constantly sent their children to French-speaking schools to ensure future jobs. French language has been the first factor of social mobility, and in the cities poor families also aspiring for a better future for their young ones work hard to enrol their children at *écoles d’expression française* where they have to pay school fees.

The period of malgachisation ended with the fall of the social government, which was replaced by the third republic and a new constitution. Alarmed by the negative consequences

on the education system, various steps were taken; the new government undertook steps to cover again a significant role to the French language in the Malagasy Education system.

From a legal perspective, Malagasy and French are said to be national languages (Article 4 of constitution 2007). The national legislation is also pressing that « *the school ... should provide students the means [...] to master Malagasy, given its status as national language and mother tongue, [...] to master at least two foreign languages* » (Article 15, Law N° 2004 - 004). In contrast to these aspirations, French had been defined as the official teaching language at the secondary and university level. According to Dahl, this is a consequence of a malgachisation process which did not succeed. According to his analysis, 19 years of avoiding French has led to a lack of francophone primary school teachers, who are thus today unable to provide quality lessons in French and prepare their students for secondary level or even the final exam of the primary cycle: “*After the return to French from 1990 in colleges and from 1992 in the whole education system, the most common practice among the teachers was to explain the lessons in Malagasy and give summaries in French*” (Dahl 2011, p.43).

Officially, Malagasy is the language of instruction during the first two years of studies at primary school. From the first year on, French is taught as a foreign language. From year three on, geography, mathematics and practical skills are also taught in French. The 2008 reform - albeit implemented in only 20 school districts - modifies this structure and establishes a five year long lasting teaching cycle in Malagasy with French as an obligatory foreign language. Mathematics and sciences lessons are held in French only from the sixth year on.

However, despite the reforms implemented, the performance of students and the overall quality of the education system is source of concern nowadays: Even though the primary enrolment rate is increasing (around 3% since 2009) international assessments (e.g. PASEC) as well as national evaluations conducted by the Ministry of Education have revealed a decrease of students’ performances in Madagascar. Students score particularly low in mathematics and Malagasy. This decrease in student performance is explained by a massive increase of enrolments since the 2000s which has not been combined with sufficient investment to maintain the already low academic level (CONFEMEN, PASEC 2017).

Table 4: Scores (%) of correct answers at the PASEC tests / 5th year of primary school

	PASEC 1997	PASEC 2005	MEN 2012
Malagasy	N/A	50	43.5
French	42.6	31.4	26.8
Mathematics	59.1	51.3	40

Source: PASEC / CONFEMEN 2014

Furthermore, the low retention rate of primary school students is another issue: The political and economic crisis of 2009 came along with the end of the hitherto positive evolution of the primary completion rate which decreased from 74% (2009) to 68% (2013). Experts explain this tendency as the consequence of mistrust towards the national education system, particularly among the most disadvantaged populations. Even though access to primary education can be considered as almost universal (EPM 2010 - household survey 2010), the retention rate remains very low. In 2010, only 45 out of 100 primary school children were able to attain the fifth year of the cycle, and only 33% enrol then in secondary education (d'Aiglepiere 2012). Madagascar has not achieved the by 2015 fixed Universal Primary Education.

4.2.2 The Malagasy teacher challenge

➤ *Civil servants, community teachers and 'FRAM' – the structure of the workforce*

In Madagascar, the National Institute for Teacher Training INFP (French: *Institut National de Formation Pédagogiques*) is designated to implement on behalf of the Ministry of Education both the initial and continuous teacher training. The INFP coordinates 25 regional centers (CRINFP) located in the respective regions of the country, supposed to organize the respective training sessions on a regional level. However, the CRINFPs do not have the necessary resources to cope with the challenge to increase the number of recruitments while ensuring a quality primary school education.

Indeed, similar to many African countries, Madagascar faces serious challenges with regards to the recruitment, training and instruction quality of its teachers.

Since the Dakar Forum, Madagascar has launched various reforms in order reach the goals as defined by the United Nations' Education for All Initiative (EFA).

- the plan of the reform and development of the education system in 2003 (*Plan de Réforme et de Développement du Système Éducatif de 2003*)
- the Education for All Plan (2005)
- the Madagascar Action Plan (2008) - suspended with the start of the political crisis in 2009

As explained by Lethuillier and colleagues one of the mayor measures of these reforms was the massive recruitment of so called "FRAM", community teachers in view of providing universal primary education (UPE), a tendency whose origins and consequences were explained in chapter 1 and which could be observed in many developing countries. In Madagascar, these teachers, financed by the state and international donors joined the first contractual teachers who already had been recruited by parents associated in the late 1990s (Lethuillier, Jaillet, et Jarousse 2013).

These new teachers have been recruited by parent association and constitute now the majority of the workforce: Over 78% of all primary school teachers in 2014 were FRAM, and 52% of them were hired by the government (Cour et Rakoto-Tiana 2013; CONFEMEN, PASEC 2017).

Today, the Malagasy teacher workforce is composed of three teacher statuses:

- *Civil servants* Teachers who have received 6 to 2 years of training and have a permanent position. Sometimes, contractual teachers are made civil servants (e.g. 600 teachers in 2012). In 2014, only 21, 4% of the workforce was civil servant teachers.
- *Contractual teachers*: Contractual teachers who have been recruited by the government in view of being a teacher for maximum 6 years. After this period they can apply to become civil servants.
- *FRAM financially supported (hired) by the state and FRAM supported by the local communities (parent's association)*: in the first case, these teacher have been recruited

by the parent's associated and receive an additional allowance by the government. In the second case, the FRAM is also recruited by the community, but their salary and subvention is fairly unreliable: financial compensation, foodstuffs. According to studies conducted for the PASEC and PASOBA assessments, this amount of these compensations can vary considerably (CONFEMEN, PASEC 2017; PASOBA 2013). They do not benefit from any social protection or clear statutory framework (Education et Solidarité, 2014). Both have mostly the BEPC (lower secondary education). In recent years, the government has decided to provide intensive training to some FRAM teachers, but has not systemized this training.

While these massive recruitments have allowed to increase the primary school enrolment despite a birth increase of (3% per year) and reduced the ratio of students per teacher (51,6 students per teacher in 2002 to 42,7 students per teacher in 2011, 40 in 2013) new challenges have become evident throughout the last years. Like in many African countries, the issue of teacher absenteeism, the lack of non or inadequately trained teachers, and a failing teacher training system has been source of concern.

➤ *Absent and untrained teachers*

The country faces high rates of teacher absenteeism. In 2012, nearly 25% of principals were reportedly struggling with absent teachers, with an average number of day off school amounting around 13,5 days per year and much higher in rural areas (d'Aiglepierre, 2012). According to surveys conducted in 2007, and the external evaluation conducted in 2013, one of the main reasons for teacher absenteeism in Madagascar is the salary pick-up (Francken 2007). This is due to long journeys to the local administration where they perceive their salary. Another reason for teacher absenteeism in Madagascar is their double - employment: Teachers have to work in addition to their teaching profession, often because they do not receive their salary on a regular basis. In 2013 for example, FRAM teachers had to wait 7 months before receiving a salary. This led to nationwide strikes and a high amount of primary schools that were closed down during several months). Also, teachers do often have to walk a long way to schools, making the journey difficult and tiring, particularly during the raining season. Absenteeism is particularly high during this period (ibid, p.3-4).

Furthermore, school directors have difficulties to replace ill teachers quickly due to the absence of communication methods and the overall lack of teachers. In many cases, school directors have teach themselves when teachers are sick, which in consequence impacts on their director tasks (Ratompomalalala et Rakotonanahary 2013).

Even if present, teachers do not necessarily have the necessary capacities and training to deliver quality instruction: In Madagascar, the INFP (National Institute of Pedagogic Training) are in charge of the initial training of future civil servant teachers. Officially, this teacher training is conducted within the 25 regional centres of the INFP. The training is divided in five components: Teaching, communication, education analysis and regulation, management and school administration. The total training is supposed to last 889 hours and is divided in three steps: exploration, tutored internships and autonomous internships. According to the INFP, there are 25 regional teacher training centres and 400 teacher trainers in Madagascar, able to train 300 teaches per year. This training capacity contrasts with the 70 000 contractual and untrained teachers in the country (INFP, 2015)⁷.

However, this type of systematic training is organized for civil servants teachers only, today a minority. Indeed, depending on the status of the teacher, the qualification level varies (qualification meaning here having obtained a type of teaching degree, e.g. a CAP, *Certificat d'Aptitude pédagogiques* or CAE, *Certificat d'Aptitude à l'Enseignement*). Some contractual teachers have undergone training sessions organized by the INFP, but here again the training varies in terms of content and duration. In the case of FRAM teachers, the situation is worse; they do not undergo any systematic training at all. In 2013, according to PASOBA data, around 75,6% of teachers had no qualification at all, 3,2% held a CAP, 17,6% a CEA and 3,5% had taken part in other training schemes (PASOBA 2013). PASEC data in turn shows that large proportion of teachers has not the level required to teach French in French, nor to teach mathematics in primary school.

In addition to these challenges, there is also confusion on the choice of pedagogical approaches among those who have taken part in a training: Indeed, throughout the years the Ministry of Education has recommended a multitude of different approaches, and depending

⁷ Numbers given during an interview with the responsible of distance teacher training at the INFP, in April 2015

on the period a teacher has been trained, and depending on his status, she or he would later apply a different method: Today there are teachers applying the '*objective pedagogy approach*', while others implement the '*competency approach*' and others again a '*situated approach*'. These different pedagogic approaches have led to a certain degree of confusion and frustration among teachers, as well as multiple pedagogic materials which are not usable by all teachers ((Ratompomalalala et Rakotonanahary 2013; Lethuillier, Jaillet, et Jarousse 2013)

Finally, the lack of ongoing support and supervision is also an issue in Madagascar: According to PASEC referring to a provisory study from UNICEF, one pedagogic councillor is in charge of up to 100 teachers and more in rural areas. The 'local supervisors', called Chef ZAP, in charge of a dedicated amount of schools and their supervision have a fairly undefined, both administrative and pedagogic role and no specific training for the their function. Interview with Chef ZAP on the field, conducted for this dissertation, could confirm the latter.

The low performance of teachers and the need of adequate in-service teacher training and supervision have led to the recommendation to provide teachers with a practice oriented training approach, linked to a progressive improvement of their career (Lethuillier, Jaillet, et Jarousse 2013). This appears even more important as the amount of civil teachers who had received an initial training and will retire in the upcoming years: In the *Intermediate Plan of Education, the government indicates the plan* to replace at least 50% of retired civil servant teachers, but de facto does not have the capacity to do so (Lethuillier, Jaillet, et Jarousse 2013).

During an interview conducted with a ministerial representative at the INFP in 2015, it was affirmed that, in order to guarantee the presence of a sufficient number of teachers in the school in the following years, the Ministry of Education "*expects much from distance education programs and projects*" without however having launched any large scale training based on a distance basis concept.

According to this representative, in 2015, the Ministry organized a 'mass speed training' for 50 000 teachers, and another 60 000 in 2016. The *Sectoral Plan for Education*, designed in

cooperation with the Global Partnership for Education was officially launched in 2017 is expected to be operational by 2022. Non-available at the time of this research, various press articles mention on one hand that it contains measures to improve the training model of teachers, in order to reach by 2030 Goal 4 of the Sustainable Development Goals: ‘Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all’. (Rahaga 2017; Global Partnership for Education 2017; Ministry of Education Madagascar 2017).

Summary of chapter 1

This first chapter exposed the evolution of teacher recruitment policies, their underlying rationale and impact on the overall structure of the teaching workforce in Sub-Saharan Africa. The increase of contractual teachers and decrease of student performance has stimulated the debate on factors influence on the latter. Research results on the ‘education function productivity’ are not always well-accepted, but show that when it comes to student performance, difficult to measure teacher characteristics (e.g. as pedagogical practices, competences and motivation) are more determinant than observable characteristics (e.g. number of years of training). As a result, both academics and policy makers sought to identify training schemes capable to influence on these ‘non-observable’ factors, whilst taking into account the reality of lacking resources in many Sub-Saharan countries. Teacher-centered, practice oriented teacher training implemented in a hybrid manner (distance and face to face) are discussed as desirable objective the hitherto traditional, cost-intensive and ineffective training models.

Considering the need for a new type of training both in terms of competences to provide and its organizational model, technology and in particular mobile supported teacher training is presented as promising solution: The increased diffusion and adoption of mobiles phones in Sub-Saharan Africa is considered as opportunity to reduce costs and fill the lack of both human and material teacher training resources; the expected virtues of its introduction in training schemes (e.g. collaborative dynamics, motivation) are presented as corresponding to those which ultimately act on student performances.

Finally, this chapter has had a close look at the case of Madagascar, which is representative of both the Sub-Saharan teacher training challenge and continents’ mobile sector boom. This

chapter allows to comprehend the in the following chapter presented context of pilot projects which attempt to implement mobile teacher training, notably the IFADEM project in Madagascar.

Chapter 2: The implementation of mobile teacher training: Approaches and grey zones

After a recall of the background of recruitment policies and their consequences on teacher training needs in the African region, the previous chapter has exposed the reasons why mobile phone supported teacher training is increasingly considered as promising solution. Via an extensive literature review the infrastructure and development context as well as expected benefits of mobile teacher training were analyzed. Remaining challenges and need for additional research were exposed. Finally, the case of Madagascar, a case representative of the ‘Sub-Saharan teacher challenge’ and country of the here analyzed case study, was presented in detail. The objective of the following chapter is to provide a comprehensive overview of recent mobile teacher training projects, their communalities in terms of approaches and contributions as well as grey zones that deserve further research. While the low number of implemented projects is already a finding *per se*, the review shows moreover that existing mobile teacher training pilots have had so far common approaches but lack a medium-term approach: Once the pilots are terminated, ongoing or newly generated usages and practices are *terra incognita*.⁸ Finally, one pilot project will be presented in detail in this chapter. The IFADEM project in Madagascar constituted the ground for field research. It provided a large set of data which were subsequently exploited in various studies with a longitudinal approach and are presented in chapters 5, 6, and 7.

Overall, this chapter shows that, while the identified contributions of this pilot are in line with research expectations and findings, the emergence of non-prescribed and hybrid usages both for training and other purpose suggest that there is room for further research on the sustainable contributions of mobile teacher training.

1. Concrete examples of mobile teacher training projects in Africa and other developing countries

When looking for ongoing or previously implemented mobile teacher training projects, four African projects could be found: ‘MoMath’ in Senegal, ‘English Teacher’ in Nigeria, ‘ICT Bites’ in Tanzania and a mobile teacher training study implemented within the national ZATEC training project in Zambia. This is a rather low number that contrasts with the high number of articles discussing mobile technology teaching and learning. In order to enlarge the exploitable data-sets, it appeared interesting to include in the analysis two pilots from Asia, focusing on similar challenges and contexts as those encountered in their African counterparts. Each project was reviewed towards five themes: 1) rationale and objective of the project 2) organizational framework 3) project implementation, role of the mobile phone and type of content 4) reported impact and challenges 5) follow-up and / or up-scale-up activities. The following section is crucial to understand current project tendencies and approaches, as well as remaining research grey zones.

1.1 Mobile teacher training examples from Africa

1.1.1 Senegal – “MoMath”

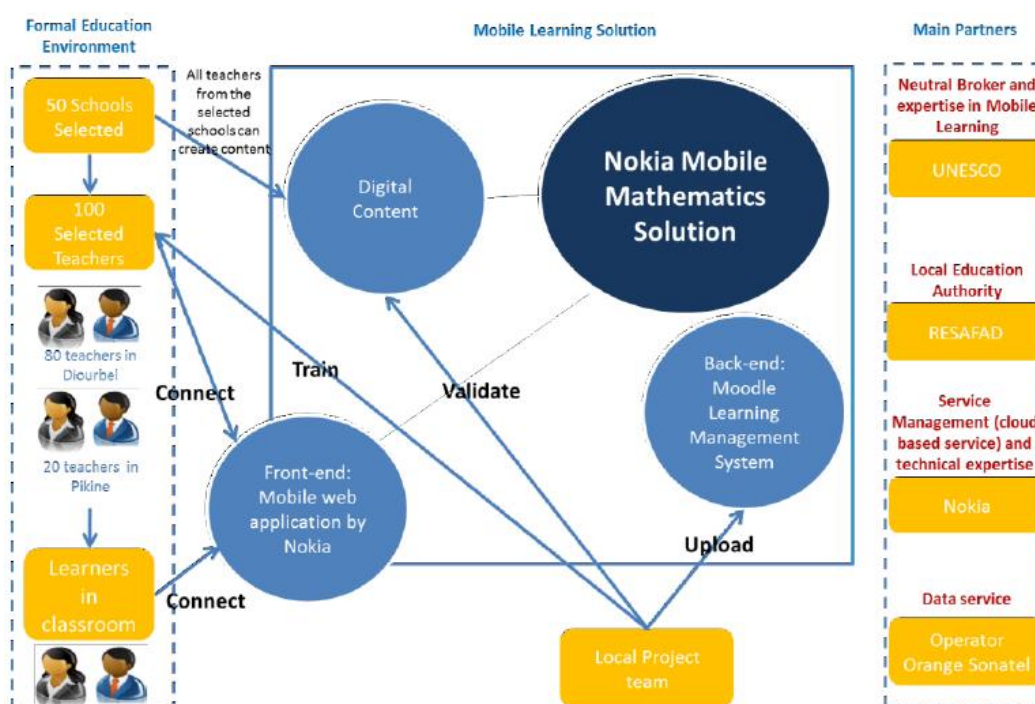
➤ *Rationale and objective of the project*

MoMath is a mobile teacher training project which has been implemented from 2012 to 2013 in Senegal. Like many countries in Africa, Senegal has, after primary education became cost-free in 1995, implemented a policy of contractual teacher recruitment in order to solve their teacher shortage problem and decrease the overall payroll. While the country managed to lower the pupil teacher ratios (49:1 in 1999, 33:1 in 2011), it appeared that only 15% of pre- and primary school teachers – both civil servants and contractual teachers – met national standards and competencies. According to research from 2016, even those teachers who had

⁸ It is important to recall here that by mobile teacher training are understood initiatives that aim to provide teachers with additional skills and expertise in view of improving the quality of their instruction; these projects differentiate from initiatives testing the use of mobile phones by teachers in the classroom and, as part of their activities, provide teachers with a dedicated training on how to use an application or resource available on the mobile phone in the classroom.

participated in the official 6 month pre-service training did not feel that this training prepared them sufficiently and adequately for their tasks (UNESCO 2016). The high amount of primary school students who complete their cycle without acquiring fundamental skills in basic numeracy is considered as one consequence of this lack of trained teachers. (Akyeampong et al. 2013) In parallel, the penetration rate of mobile phones has constantly increased, reaching 94% in 2012, year of the project launch.

Figure 21: Implementation and role distribution in the MoMath project Senegal



Source: UNESCO / Nokia 2014

In this context, the MoMath teacher training project was implemented in Senegal from October 2012 to August 2013, choosing a mobile supported approach in order to *a)* reinforce teachers' skills in Mathematics and Sciences and increase their knowledge of the curriculum; *b)* improve the student learning outcomes in Mathematics and Sciences and increase their engagement in the subjects; *c)* improve communication within the school community; *d)* reinforce the local implementation team's ICT skills in mobile learning (institutional capacity building); *e)* promote a model of a new type of teacher development towards other teacher training institutions in Senegal and influence national/state policy making on teacher development.

MoMath built on the implementation of MoMath South Africa, where the platform had been tested for distance learning, without focusing however on teachers. In the Senegal version of the project, the beneficiaries of the project were 100 primary school teachers in 50 schools and their pupils. According to the evaluation report, two-thirds of the participant teachers owned a basic cell phone, two out of ten even a smartphone. Several individuals had reported to possess a computer and almost half of participating teachers accessed the Internet primarily from home.

➤ *Organisational framework*

Sponsored and supported by Nokia, the project was implemented under the supervision of UNESCO headquarters, implemented in cooperation with the programme RESAFAD⁹, the teacher training institution of Dakar, as well as a telecommunication operator, Orange-Sonatel.

➤ *Project implementation, role of the mobile and type of content*

Teachers received mobile phones and participated in training sessions during which they were introduced to the very basic functions of the mobile phone. They worked on the content of the platform and were trained how to use the MoMath platform in class. The platform was the core of the project and accessible by both teachers and students via the mobile phones. While all participating teacher had received a mobile phone, participating school were also provided with additional phones to be used by students under teachers' supervision. The subject-oriented content (mathematics) was designed together with selected teachers, who adapted it to the national curriculum (Fengchun et al. 2016). Students were supposed to connect to the mobile phone and enter lessons organized in categories (e.g. theory, examples, exercises and tests) (Figure 25). Participating teachers could also take part in the lessons, but were mainly supposed to enter the platform to track and monitor their student's activities. Through the platform, teachers could see the learners' levels in weekly activities and compare them with other learners. The platform allowed teachers to send reminders about exercises and homework for the next lesson. The mobile platform was also used as a motivational tool: After reading the theory topics, students earned points with practice exercises and tests. In addition, it was used to enable the collaboration and communication among teachers and students: Through the platform, participants could send and receive messages.

➤ *Reported impacts and challenges*

The project conducted an evaluation via a baseline survey at the start and a project close survey. It also collected the logs into the platform during a seven weeks period and analysed these statistically. Details on the methodological approach were however not provided. Within

all available logs, the evaluation could not distinguish between usage patterns of teachers and students. In its conclusion, the evaluation reported that the pilot project had led to higher awareness of teachers when it comes to accessing the internet from mobile phones, and accessing online Maths and Science support programs, but that teachers did use this type of tools rarely. In comparison, using the mobile phones for personal purposes, e.g. downloading videos and songs, was more often reported than using the phone to access internet for teaching. In this regard, the conclusion of project evaluators seems to be slightly ‘over positive’: According to them, the *“increased usage of ICT, even when not strictly education-related, is usually positive as teachers become more familiar with using ICT. In time, this can work towards lowering resistance to using it for educational purposes”* (UNESCO 2017, p.7). This feeling of slightly deluding conclusions is reinforced when they finally conclude that *“participant teachers felt less positive about the project at the end of the project compared with their perception at the start”* (*ibid*, p.8). Still, the evaluation referred to multiple positive impacts: Teachers reported that the use of the mobile phone as training and learning tool was exiting, enjoyable and motivating. According to the evaluation, it also improved teaching quality and methodology, which was a frequently mentioned impact. According to the project, the biggest impact was a higher interest in and understanding of ICT and the internet among teachers. Reportedly, the use of the mobile phone for educational purposes could have been higher if teachers had received more training on the use of the mobile phone. Finally, the fact that only 15 teachers out of 100 took part in the close survey was interpreted as lack of buy-in of the project among teachers. The latter was in turn explained by a lack of participation of teachers with regards to organisational aspects of the training, e.g. asking them if workshop dates would suit their schedules.

➤ *Follow-up activities and scale-up*

When we contacted the project implementers in 2016, it could be confirmed that there was no intention to organize a large scale teacher training initiative based on the findings of this pilot, or any other follow-up activities. Subsequently, information on medium-term impacts of the training or on the usage of the received phones later on is not available.

⁹ <http://www.resafad.net/>

The project did not focus on teachers as only beneficiaries, but used mobile phones to provide both teachers and students with additional skills. Indeed, the teacher training component of the project is rather passive – teachers are trained how to use the mobile phone for their lessons and can, in parallel, improve their skills too, but the content is *per se* not designed solely for them.

The evaluation shows that the lack of mobile literacy skills is indeed an issue, even among teachers who possess a phone and are expected to be familiar with its function. Given this low mobile literacy level, it is not surprising that increased awareness was the first and dominating impact observed. The fact that the collaboration was only free via the application and platform, and that this was particularly regretted by participating teachers is an interesting aspect: While the project did not use the mobile as collaborative tool, it was naturally perceived as a potential facilitator of collaboration.

1.1.2 Nigeria –‘English Teacher’

➤ Rationale and objective of the project

Education quality is a concern in Nigeria. According to international organisations like UNESCO, a lack of qualified teachers is one of the reasons for the lack of performance among students. The mobile teacher training project ‘English Teacher’ sought to tackle this issue and was implemented in Nigeria from May to December 2012. The objective was to address the issue of insufficient English proficiency, the national language of instruction, among Nigerian teachers, as well as their difficulties to manage large classes and their lack of pedagogical skills. While collaboration was not explicitly mentioned, the introduction of mobile technologies in their training was also expected to impact positively on their ability to use ICTs and build a sense of community (UNESCO 2017).

The beneficiaries of the project were 50 teachers working in 50 different primary schools in the Federal Capital Territory of Nigeria, a state that encompasses the nation’s capital Abuja. Most teachers in the pilot group were women between the ages of 30 and 40. Five master teachers oversaw the 50 classroom teachers.

➤ *Organizational framework*

The project in Nigeria involved four core partners: UNESCO, which was responsible for the project; Nokia, which provided the platform and technical support, as well as the British Council, in charge of the content development, and the Nigeria Teachers' Institute, in charge of the local organisation of the training.

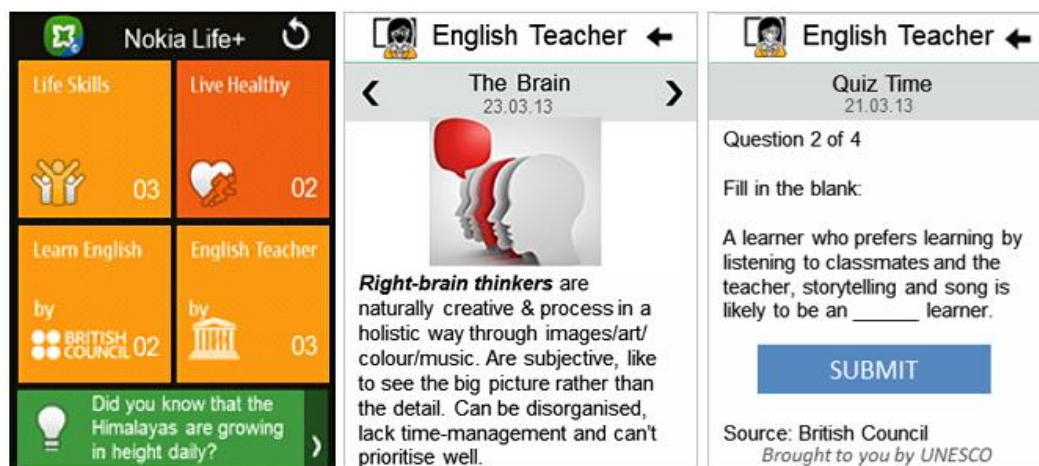
➤ *Implementation, use of the mobile phone and type of content*

At the beginning of the training, all participating teachers took part in an initial training seminar organized with the National Teachers Institute and the British Council. All participants received a Nokia mobile phone with pre-loaded SIM cards.

Participants received training on how to access and use the mobile learning service. In addition to the initial training completed in May 2013, three additional meetings were held with teachers of the pilot group. The purpose of the meetings were to allow teachers to discuss questions, trouble shoot technical problems and share examples of how they translated pedagogical tips, provided as part of the training, into classroom practices.

Teachers in the pilot group were organized into five groups, each overseen by a master teacher. Master teachers spoke regularly to teachers in their respective groups and provided on-going technical and pedagogical support. Teachers in each group also supported each other and met regularly to discuss ways to apply the pedagogical concepts they learned.

Figure 22: Nokia Life + examples of informative and exercise message



Source: Nokia / UNESCO 2016

The main expectations towards the introduction of a mobile phone and content in the teacher was to use the mobile phone the content on the Nokia Life + platform to encourage teachers to learn independently. The objective was also to improve their practices through the provision of knowledge and enhancement of reflection on their teaching practice. When accessing the platform, teachers could activate the service ‘English Teacher’.

Every day, teachers received via the platform quiz messages of 50 to 100 words (Figure 22). These messages were labelled according to the categories ‘information’, ‘resources’, ‘hands on activities’, ‘review’, ‘summary’, ‘quote’, or ‘reflection’: While some messages were purely informative, on subject or methodologies, others were motivational or asked teachers to organize activities, or reflect on practices, e.g. how to handle large and multi-grade classes. Individual messages were sometimes accompanied by one image or graphic.

➤ *Reported impacts and challenges*

The project conducted baseline and completion surveys, partially undertaken by a consulting firm external to the project. According to the evaluation, teachers declared that the project exceeded their expectations, and the evaluation concluded that there were significant shifts in teachers' beliefs in the personal impact of the mobile learning service. Furthermore, the evaluation found that participants of the pilot could improve their English teaching skills and that the reported frequency of ICT use for both general and teaching specific purposes, increased considerably over the course of the project.

It is interesting to note that, according to the evaluation, teachers appreciated the messages containing concrete ideas for the lessons rather than abstract pedagogical advice. When referring to the claim that practice oriented training is needed, the mobile phone appears to confirm those research findings – discussed in chapter 1 – which present it as a tool making a practice oriented training easier. Another particular interesting finding mentioned in the evaluation is the fact that teachers reported the creation of communities of practices. According to their declarations, the project had increased their use of the mobile phone for making/receiving calls, sending messages, and communicating via websites and social media. Furthermore, the lack of mobile literacy was reportedly a significant challenge – also identified by the literature – but it was also reported that teachers provided support to each other in this regard during the training sessions.

Finally, the identification of an organisational challenge is particularly interesting as it provides insight on how the mobile technology was approached by organizers of the project: The data plan provided on the sim cards were calculated for the use of the platform only; teachers however used the phone for other purposes and exhausted their data plans, paying for their expenses themselves. Even more interesting is the fact that despite the end of free credit towards the end of the pilot, teachers did reportedly not drop-off the training and continued to participate; covering again the costs related to professional and private mobile expenses themselves. In other words, the project had introduced the mobile phone as a pure training tool and did not foresee (nor encourage) the private usage that spontaneously emerged: The mobile phone was planned to be a training tool only but ultimately it played a hybrid role.

Other infrastructural and technical issues were reported, confirming again the findings of the research literature. Firstly, connectivity was a problem. The lack of stable connectivity did often teachers prevent from reading their messages; indeed, the issue of the platform was that the messages on the platform had to be retrieved, and were not, as in the case of SMS, directly send to the phone user. In other words, the message would not arrive once the teacher would be again in an area with network coverage. Secondly, the batteries were insufficient for an increased use of the mobile phone, and teachers had to purchase external batteries as their own cost.

➤ *Follow-up activities and scale-up*

As the platform was not available after the end of the project, the service was migrated to an HTML website hosted by the British Council. This platform allowed teachers then to receive the messages as soon as they had sufficient network coverage. Training was provided again to explain how to access the new platform via their mobile phones. According to the provisional evaluation report, teachers continue to receive support from project partners and master teachers. However, when contacted, organizers reported that due to organisational changes among project partners, it was not possible to know if there had been any activities or new usages since the end of the training.

The impact of mobile teacher training is found as positive immediately during or after the training, but similar to the project in Senegal, none of the organizers were able to provide information on the usages or effects after the end of the pilot project. Again, research on medium-term effects was not included in the project design.

1.1.3 Tanzania – ICT Bites

➤ *Project rationale and objective*

In 2007, the net enrolment ratio was 97.3%, and UPE (Universal Primary Education) hence almost achieved. In the meantime however, the country faced also a shortage of qualified secondary teachers and unsatisfying performance among secondary school pupils. With regards to mobile diffusion, there were about one out of four individuals in possession of a mobile phone in 2009, year of the launch of the pilot project ICT BITES (Nykvist 2010).

Presented at the SITES 2009 conference, the objective of the project ICT BITES (ICT-Based In-Service Teacher Education for Secondary School Teacher in Tanzania¹⁰) was to improve the secondary school teacher performance by providing training on pedagogy and subject specific education. More precisely, according to the project description on the conference website, the project aimed for the achievement of three overarching goals:

- to exploit the interactive potential of ICT in the provision of modern education theory and practice via distance education programmes,
- to use available infrastructure and media: Develop models for communication and distribution of learning material for different technical environments (broadband, VSAT, mobile phones, CD/DVD, memory cards, etc.),
- to exploit other possibilities of the new global world of information and communication: Support teachers to handle the challenges of using e-resources through knowledge sharing, networking and collaboration for improving teaching.

The project sought to provide in-service teacher training and focused on so called ‘licensed Teachers’, i.e. teachers with only a few weeks of formal teacher education. 19 project participants were chosen among licensed teachers enrolled in an education program run by the Open University of Tanzania.

¹⁰ <http://sites.google.com/site/ictbites/>

➤ *Partners*

The project was initiated by the Ministry of Education and Vocational Training in Tanzania, funded by The Swedish Program for ICT in Developing Regions (SPIDER) and run by the Open University of Tanzania.

➤ *Implementation, use of the mobile phone and type of content*

Course materials for three complete courses were prepared, both for mobile phones and for a Moodle learning management system. The material included texts, quizzes and media files and mid-range mobile phones with functions like Internet access, Java capability and the ability to play media files. On each phone a book reader software was installed and the complete course material for the three courses was downloaded on to the memory cards.

The project focused on the use of open access resources: On the memory card, learning materials were installed and downloaded from the internet during the project. These materials were study guides in text, study guides in voice format, narrated slide shows, as well as auto-corrected quiz with answers sent by SMS and movie clips with related materials.

The 19 teachers participated in introduction training in January 2009. During this meeting 11 out of them received a mobile phone. Throughout the training, teacher trainees could use the phone to access training related information and communicate with each other.

➤ *Reported impacts and challenges*

In December 2009 an evaluation of the pilot project was made conducted. 15 out of 18 teachers took part in group discussion, and each teacher filled an anonymized questionnaire. The conduction of baseline survey at the beginning of the project was however not reported. According to the blog post of a representative of the Open University Tanzania, the following impacts of the project were identified. Firstly, respondents reported that the introduction of mobile phones in their learning process had favored collaborative mechanisms: They used the phones to send e-mails and SMS to other trainee students. The report even mentions the creation of a 'network'. More generally, when showing their mobile learning content to colleagues in their schools, they showed great interest. Several teachers reported sharing mechanisms – the training impacted hence in a certain way even on non-participants. Overall,

respondents reported several times that the mobile phone highly stimulated their enthusiasm and willingness to collaborate. Collaboration dynamics were reported to be sometimes constrained due to costs of communication and data.

The phone was also identified as facilitating their learning process, more precisely the access of information within this learning process, e.g. in form of internet searches through the mobile phone, sharing learning material with and from other sources, e.g.; through Bluetooth, e-mail and messenger. In terms of content, teachers regretted that there was no encyclopedia available on their phone. Interestingly, the quiz content was considered as extremely motivating and presented as one of the most beneficial features of the training. The learning process was also facilitated with regards to physical constraints: The mobile phone was considered as practical learning alternative when teachers found themselves in a setting where a study guide was too big to handle, e.g. on the bus. Similar, the possibility to listen to the audio material via earphones was considered as practical when working in a noisy environment, and overall, audio files were preferred to text material.

In terms of challenges, the small screens size, the absence of a mentor to manage and enhance collaborative learning processes and the absence of pre-paid cost plan or advantageous conditions for the use of the mobile phone were regretted.

➤ *Follow-up activities and scale-up*

Reportedly, the project was not well accepted among lecturers of the Open University, which was interpreted as reason why there was no follow-up research was conducted or a scale – up implemented. Officially, the latter was however considered, as shows the title of the last chapter “*results discussion and suggestions for scaling up of project*” (Nykvist 2010, p. 3). Hence, this lack makes it again impossible to analyze if and to which extent these teachers have continued to use their phones for their learning process, e.g. through the teacher network which was mentioned as key contribution of the project.

1.1.4 Zambia - Use of mobile phones in national teacher training program ZATEC

Finally, another attempt to test the use of mobile technologies in distance teacher training deserves to be mentioned. According to a report edited by Burns, including various examples of mobile usages in developing countries, the Zambian Teacher Education College (ZATEC) has used cell phones as a support in its print-based distance education program (Burns 2011).

Unfortunately, no primary data and information on training modalities (e.g. exact dates, amount of teachers concerned) could be retrieved and a former responsible couldn't be reached. No traces of follow-up activities or scale-up intentions could be found. However, the by presented usages of mobile phones appears still very interesting for this research, as it can be, at least, interpreted as a sign of interests in the potential of mobile technologies for teacher training.

The training, designed to certify teachers with the so called *Primary Teachers Diploma by Distance Learning* after two years, was funded by USAID. Twice a year, teachers would meet in face-to-face sessions lasting two weeks. During the first session, teachers received printed training material and assignments to send back to a mentor. In addition, the report describes that teachers in rural areas were organized into groups. Each group received a fixed cellular terminal and a Motorola C-113 mobile pay phone that teachers were allowed to use also for personal calls, and also allowed to use it to generate income: Devices were kept in teacher resource centers, and center as well as teachers could also sell talk-time cards and talk-time minutes on this phone. With the generated income, the cost of communication with the received devices could be covered. Among the (scarcely) information on impacts of this test figure similar impacts as reported by the previously exposed pilot projects, particularly with regards to the possibility to collaborate with a supervisor and peers: *“Cell phones enabled lecturers to provide better academic support and counseling to student-teachers in rural areas and allowed them to contact a knowledgeable resource who could answer their questions immediately. Finally, teachers were able to communicate and consult with one another using cell phones”* (Burns 2011, p. 109).

Overall, this introduction of mobile technologies was reported to be easily implemented; *“teachers needed little training in the use of cell phones”* (ibid), which can be interpreted as a sign that teachers were mostly familiar with the tool. With regards to reported challenges, Burns reports that teachers regretted that they could not communicate as often as desired with supervisors and peers, because of organizational issues: the calling schedule was not planned and mentioned in the printed material. Other obstacles to communication and collaboration were reportedly due to a lack of network coverage.

Again, the lack of information on further outcomes of this test can be considered as evidence *per se*, particularly when considering the lack of follow-up research on the previously mentioned projects: There is an overall lack of long-term approach when it comes to testing the use of mobile technologies in teacher training.

1.2 Not the same but similar? Mobile teacher training examples from Asia

While there is a clear lack of analyzable mobile teacher training projects within the African continent, the review has allowed identifying two teacher training pilots in other countries with a similar context in terms of development: The ‘Capacity Building of Rural Female Teachers’ project in Pakistan and the TQI-SEP project in Bangladesh. As we can see in the following, their focus and approach has similarities with those projects in African countries, confirming that identified benefits, challenges and grey zones are not an Africa-specific matter.

1.2.1 Pakistan – Capacity Building of Rural Female Teachers

➤ *Project rationale and objective*

The project ‘Capacity Building of Rural Female Teachers in Early Childhood Care and Educational Teaching Methodologies through Mobile Phones’ has been launched in a challenging educational context: 58% of children in primary school age are out of school and the amount of teachers who have received a training is extremely low, particularly among early childhood educators: The nation’s teacher-student ratio can possibly reach 1:1000 (UNESCO 2015a).

The goal of the project was to exploit the benefits of mobile phones in view of increasing the capacity of rural female teachers through pedagogical training that would ultimately allow students to improve their speaking, listening and writing skills. More generally, the project aimed to design an innovative and affordable model of teacher development that would possibility be replicable in “other regions in Pakistan and elsewhere” (ibid, p.1)

Beneficiaries of the project were 150 female rural teachers working at so called ‘junior model schools’, which are part of the pre-primary education system and enrol children from age three to primary school entry. These teachers were selected in 75 different schools in five

areas rural areas of Pakistan as well as the urban area of the Islamabad Capital Territory. Teachers were in their thirties and in charge of 21 to 50 students.

➤ *Partners*

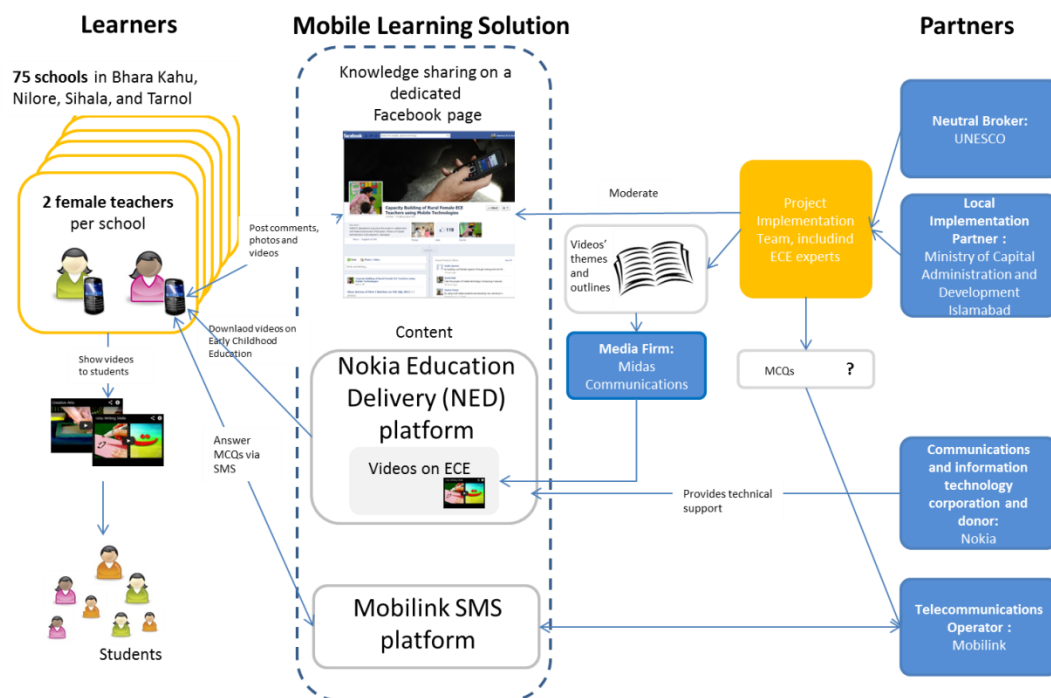
Similar to the projects conducted by UNESCO in Nigeria and Senegal, the Pakistan project was implemented in cooperation with the local Ministry and teacher training institution, which were in charge of supervising and conducting the training. Also associated to the project were a firm for content digitization, the IT corporation Nokia and a network provider, Mobilink. While Nokia provided the NED platform, heart of the project, Mobilink provided SIM Cards and a special communication plan for participants.

➤ *Implementation, use of the mobile and content type*

The project decided use of mobile phones in order to “*introduce a new and affordable model of teacher development that, if successful, can be emulated in other regions in Pakistan and elsewhere*” (UNESCO, 2016, p.1). The key characteristic of this project was its focus on video content. Each participant was given a free mobile handset (Nokia Asha 311) through which they could access and download 20 educational videos on the Nokia Education Delivery (NED) platform.

Among the 20 videos, 12 videos were designed to be shown and used in classrooms with students for activities such as creative arts and basic mathematical concepts. The 8 remaining videos exclusively focused on teachers and aimed to improve their understanding and practices of early childhood education. All videos were in teachers mother tongue (Urdu) and open educational resources (OER) under a Creative Common License. Teachers were free to share, adapt and modify the videos. At the beginning of the project, teachers were organised in 5 groups of 30 teachers. Each group took part in a three-day training workshop on the mobile learning tools chosen for the project, and on how to use the videos. More precisely, teachers received during these face-to-face sessions awareness training on the importance and needs of Early Childhood Care and Education and current policies, plans and interventions in Pakistan in this area. Teachers were provided with practical training on how to implement early child hood education lessons (Figure 23).

Figure 23: Implementation and role distribution - Capacity Building of Rural Female Teachers in Early Childhood Care and Educational Teaching Methodologies through Mobile Phones



Source: UNESCO / Nokia 2016

Throughout the pilot phase, teachers followed planned schedule that determined when they were supposed to watch a video. The same day, they would receive a multiple choice question related to the video content, sent by the implementation team via the Mobilink quiz platform. After one day, teachers would receive another SMS with the correct answer. The goal was to evaluating teachers' understanding and motivating them throughout their training process.

Finally, the project encouraged teachers to the mobile phone to share their work a dedicated Facebook page (e.g. videos they added or photos of activities conducted based on the videos).

➤ *Impacts and challenges*

The evaluation report built on the baseline and 'end of project survey'. It analysed the declared impacts on practices¹¹ and concluded that the project did indeed influence on the practices: teachers reported that they had adopted a more student centred practices in class, would adapt the lessons according to specific demands, and that they had expanded and

¹¹ Information on survey methods were not provided in the report and could not be retrieved

innovated their pedagogical repertoire which was previously limited mostly to written activities.

With regards to the use of the mobile phone, participants reported to use it both for professional and private purposes. More precisely, teachers reported that they shared educational information with their peers (download and transfer music and videos) but also access the internet for entertainment purposes.

The project was reportedly unable to assess the exact amount of times an individual would watch the videos, but could identify a regular use of Facebook, which served as collaborative platform, accessed via the mobile phones. Participants used the Facebook page to share pedagogical tips with the members of the community: *“Serving as a common digital space, articles informed by educational theories were aggregated on the page from various sources. Original articles were also written to incite discussion amongst the teachers”* (UNESCO 2015a, p.11). Furthermore, the page was also used to share administrative information and trouble shoot technical problems.

Finally, teachers affirmed that the impacts they observed on their teaching practices during the pilot project would be sustainable, and that they would continue to use the mobile phones to *“gain more knowledge”, “facilitate learners in a better way”* and cultivate the habit of *“searching supportive material from net to make teaching effective and versatile”* (ibid, p.9).

Similar to other projects described, unstable network coverage and internet connectivity was a major hindrance in this project.

➤ *Follow-up activities and scale-up*

The evaluation report does underline the declarations of teachers ensuring that they have sustainably changed their practices, and the overall description of the project justifies the introduction of mobile phones with a possible view of replicating the training model to other areas. However, no follow-up activities were designed or planned. It is hence again not possible to know how usages and impacts of the pilot have evolved throughout the last years.

1.2.2 Bangladesh – Mobile teacher training study within the TQI-SEP project

➤ *Study rationale and objective*

The study ‘Innovative Information and Communication Technology in Education and its Potential for Reducing Poverty in Asia and the Pacific Region’ is an ADB (African Development Bank) funded initiative. It was conducted from April 2006 to October 2007.

Like the previous presented projects the study tackles the issue of not adequately qualified teachers: According to the project report, in 2005 – year of the study launch – over 84% had a bachelor’s degree, but 57 % of them had scored in the lowest of three categories of passing grades, or did not take the degree examination. Also, 50% of secondary teachers had no professional pedagogic training, but subject specific background (humanities or social sciences studies).

The ADB conducted study complemented the existing ADB-funded Teaching Quality Improvement in Secondary Education Project (TQI-SEP; 2005–2011). One of TQI-SEPs objectives was to provide via the Continuous Professional Development (CPD) program in-service professional training to all serving teachers in secondary schools. Given that teachers were requested to be present during the 14 days face-to-face and subject-based training program, TQI-SEP representatives recognized that this led to difficulties for teachers, particularly in rural and remote areas, as they had to leave their home, school and other obligations.

In light of this educational context and given the increasing amount of mobile phones among the population – in 2007, there were approximately 23 mobile subscribers per 100 people, tendency increasing (BTRC 2007) – , the purpose of the introduction of mobile phones was to explore innovative strategies to serve these disadvantaged areas. This included distance learning and the application of media and information technologies, in order to inform TQI-SEP of the feasibility of using this model to scale-up access to quality in-service training.

➤ *Partners*

Funded by the Asian Development Bank, the study design was developed by a working group composed of the *NGO RTI International* and *iEARN* (through the local counterpart, *bEARN*), and representatives of the TQI-SEP.

➤ *Implementation, use of the mobile phone and type of content*

Beneficiaries of the project were 20 Bangla and Mathematics teachers in 10 different schools of the Barisal region in southern Bangladesh. Participants had some, but not very advanced experience with mobile phones: 16 possessed their own mobile at the training start, two teachers had access to a computer, but only one had experience with e-mail. They were mostly familiar with regular phone calls and sending and receiving SMS and only a few had already taken picture with a phone.

The implementation team equipped these teachers, as well as two subject trainers and a training coordinator with Sony Erickson P990 phones, which were chosen because of the large screen, the video function and the possibility to conduct conference calls with two individuals in the meantime. The phones were intended primarily to enhance communication, motivation, and delivery of multimedia content. Participants received also two months of free phone credit from the Grameen phone network.¹²

During the first two months, participants were able to use the phone service for free. In addition, the training coordinator and subject teachers receive one laptop to share for administrative purposes, to create electronic materials to send to the teachers, to send messages, and to browse the Internet for learning resources.

A blended approach to distance teacher training was adopted “*in order to maintain a focus on training quality and reduce dependency on the technology (and ultimately failure of the*

¹² Bangladesh is well known for founding the microcredit concept through the Grameen Bank, which expanded to the telecommunication sector in the 1990s (through the NGO Grameen Telecommunications). In this model, the bank lends money to purchase a mobile phone, which the buyer then uses to sell phone services within the village, charging on a per-call basis. This model has spread to parts of Africa in recent years as an effective means of improving livelihoods of the rural poor.

project if the technology failed)” (Pouzevara et Khan 2007, p. 24). This approach consisted in combining print-based learning materials with a face-to-face orientation workshop and later synchronous, on-demand voice communication as well as synchronous SMS text messaging and video and photo sharing. In parallel, the project also organized school-based group discussion activities.

The equipment was handed over to the participants during the orientation workshop held in June 2006. During this workshop, participants were trained how to use the newly received mobile phones and the phone supported in-service teacher training materials. The workshop was held to provide opportunities for simulation, group discussion. Moreover, participants filled out a questionnaire which was not only used as pre-test but allowed later to revise the material content.

During the following six weeks, the 20 teachers completed each module by following the training manual. Weekly teleconferences had been scheduled during the workshop. The trainees were responsible, with the support of their head teachers, for managing their own learning and scheduling the peer discussion sessions.

➤ *Impacts and challenges*

Based on pre- and post-tests, interviews, as well as a log sheets in which each participant was supposed to write down the daily usages of the mobile phone, an evaluation was conducted. It concluded that mobile supported distance teacher training can be as effective as face-to-face training for several reasons. Partially focusing on the perception of teachers, it reported overall satisfaction and benefits of using mobile phones in distance training for the following reasons:

The mobile phones reportedly allowed them to access the training content from their workplace or at home, allowing them to stay where they lived and worked. This effect, at first sight not of educational matter, was reportedly the most important aspect of the mobile for the teacher training. The evaluation report underlines that the mobile phone *per se* was not the most important factor, but the consequence of its introduction:

“In fact, if anything, this study actually dispelled much of this mythology by showing that the technology was actually the least important aspect of the distance-mode

training—the most important and significant change was the fact that the distance training mode allowed teachers to remain in their schools and with their families during the training period, which increased motivation to participate in the training while also allowing them to immediately apply what they had learned”

(Pouzevara et Khan 2007, p.39).

Furthermore, there was positive impact on collaboration. The introduction of mobile phones in the training process allowed teachers to be in touch with their trainer and peers from other schools more frequently. Ultimately, this reportedly also fostered an overall feeling of collegiality, enhanced by the need to work together and provide feedback, and considered the phone as useful for problem-solving processes.

Furthermore, positive impact on the relationship and collaboration with non-participating colleagues were also reported, including increased face-to-face interaction:

“The experience has generated interest and enthusiasm on the part of participating teachers, other subject teachers, and even neighboring schools, who inquire about the process and use of new technology. Comments from participating trainees indicate that they have discovered a learning community within their own school, and realized that they can learn through group discussion and self-directed methods.”

(Pouzevara et Khan 2007, p. 9).

Overall, the introduction of mobile phones was perceived as modern and exiting approach, motivating the teachers more than traditional training approaches. Teachers appreciated the possibility to follow-up easily on the tasks they had given teachers.

The analysis of pre- and post-tests led to the conclusions that content-knowledge gains were equivalent to teachers who had taken part at the same time in the traditional face-to-face training. Furthermore, head teachers in schools of participating teachers reported that trainees did apply the learned teaching methods in the schools.

In terms of constraints and challenges, insufficient mobile technology literacy was reported in some cases, as well as lack of network coverage.

➤ *Follow-up activities and scale-up*

From the start, the study did not plan for follow-up activities or phone supported activities in view of a possible scale-up of the teacher training project. Indeed, teachers had to handle back the phones they had received.

However, an entire section within the conclusion of the evaluation report underlines the need to conduct further research in order to take into account the evolution of usages and effects over time. More precisely, the report concluded that medium-term research would be beneficial in view of comparing long-term effectiveness of the training between teachers who had taken part in the mobile supported training and those who were part of the traditional face-to-face training scheme. The need to conduct medium-term research is also considered as useful in order to understand the evolution over time of the excitement and motivation reported by users, the mobile supported trainer feedback mechanism, and how different models of phones would over time lead to different effects. Here, the report regrets that “*given the short training period and large learning curve, this study could not adequately assess the value of different features of the phone (synchronous and asynchronous voice, video, text*” (Pouezevara et Khan 2007, p.11).

The study identified various hypothesizes that need follow-up research in order to be verified, but when asked, report authors confirmed that none had been conducted or planned.

1.3 Mobile teacher training pilots: Common approaches and unanswered questions

Through an overview on existing mobile teacher training projects and an in-depth analysis of the IFADEM pilot, case study of this dissertation, this chapter has firstly shown the overall lack of evidence of implementation, contrasting with the large amount of literature in the area of mobile technologies and education in developing countries. While the low number of projects makes it difficult to formulate generalizable conclusions, there are however communalities that need to be underlined. The large majority of mobile teacher training projects reported positive impacts of the phone when it was used for practice-oriented training or as a tool for retrieving information and resources.

In this regard, these projects seem to confirm the expectations of mobile teacher training favoring the improvement of teaching practices. When part of the pilot, the use of quiz questions were appreciated for its motivating impact on teachers, reminding them they were taking part in training and providing instant or almost instant feedback. This feature appears to be particularly interesting with regards to issue of intrinsic motivation in distance teacher training settings, as described by researchers like Hartnett (Hartnett, George, et Dron 2011).

When implemented, a SMS quiz or message-based system was easy to use despite the overall lack of mobile technology literacy. The latter was reportedly an issue in all projects. This shows that despite acquired phone familiarity, the introduction of a phone in training context is not always smooth. Technical and infrastructural constraints also negatively impact the use of the phone was (e.g. display size, network coverage).

The review has also shown that mobile supported teacher training projects have led to collaborative usages of the phone: via voice, SMS or messages exchanged via an educational platform. In several cases, particularly in the case of IFADEM pilot, the creation of ‘teacher networks’ or ‘communities of practices’ were reported – even if this was not the initial objective of the project. Overall, mobile supported teacher collaboration appeared to be highly desired and spontaneously pursued by participants. This finding is in line with expectations among educational stakeholders and the research community but deserves further research – particularly with regards to the sustainability of these collaborative dynamics.

Similarly interesting, practically all projects observed practices that underline the mobile and hybrid character of the phones. Both private and work related usages were reported, in both private settings. Even the need to pay for private usage – and in some cases, even the training - did not necessarily prevent participants from these usages and translates the perceived value-added of the phone in the eyes of teachers. These quasi systematic hybrid usage indicates that mobile phone are, at least in the cases analyzed here, tools which were socially embedded in teachers’ lives. They were independent from the pilots’ structure – they appear hence more easily sustainable than those closely related to the training structure or goals.

However, when project implementers of these projects chose mobile phones, devices that were initially not designed with educational applications in mind they did so considering it as

a an educative, training tool only, focusing for example on the use of an educational app or platform.

The question of sustaining contributions and usages is however unanswered, if asked at all. An analysis to which extent these projects lead to sustained practices and effects or research on how observed practices may evolve was not conducted by any of the pilots; when mentioned, it figures in recommendations part of the evaluation project but was not planned initially. The underlying reasons for this lack of scale-up and follow-up are certainly complex, and will be partly addressed in chapter 8 (WHO et ExpandNet 2011; Hartnett, George et Dron 2011). The fact remains that, metaphorically speaking, the years following the end of these mobile teachers training pilot projects remain *terra incognita*, the question ‘which and how do contributions evolve?’ stays unanswered.

2. IFADEM Madagascar – implementation, first findings and remaining questions

The ‘IFADEM’ (French acronym for ‘Francophone initiative for distance teacher training’ *Initiative francophone pour la formation des maîtres*) teacher training pilot figures among the few mobile supported teacher training initiatives which have been implemented in the past. It was partially piloted and designed by the telecom provider Orange, which hosted the PhD position underlying this research. As this implied both the facilitated access to the field, involved actors and data-sets, and in light of the difficulty to access other field and projects, the IFADEM project was selected as main research ground for this dissertation. In the following the project rationale, context and implementation will be presented. The key conclusions that were retrieved at the time the project ended, in June 2013, and unanswered questions will be discussed. Then, the nature of available data-sets and their implications for further research will be exposed.

2.1 The IFADEM pilot: presentation and implementation

2.1.1 The global IFADEM initiative and pilot in Madagascar

IFADEM has been initiated in 2006 by development organizations: l’Organisation Internationale de la Francophonie (OIF) and the Agence Universitaire de la Francophonie

(AUF). The overall objective of the initiative is to “*improve teacher’s competences and teaching skills, both in language and non-language fields*” (IFADEM 2016).

Prior to the Madagascar edition, IFADEM had been initiated in and in partnership with seven countries: Benin, Burundi, Côte d’Ivoire, Haiti, Niger, and the Congo (DRC). The organized training projects were in some cases distance-based, and systematically included self and tutored training schemes.

According to the project’s website and to interviews with project stakeholders, the first, overall goal of IFADEM is to improve basic education in francophone developing countries through the provision of in-service teacher training. It reportedly does so by building on existing organizational and administrative structure of the country, involving the national entities in charge of the training, follow up and evaluation of teachers. IFADEM reports to systematically reinforce the capacity of local actors, e.g. experts in charge of content development, tutors, pedagogic-councillors, inspectors, managers of the Ministry of Education. Also, this local approach includes the creation of a national steering committee, nominated by the Ministry of Education. Supported by IFADEM, this steering committee is supposed to manage the operational, administrative and pedagogical aspects of the teacher training project. This support consists in accompanying the design of the training scheme, which includes tutored self-training and involves the use of internet (IFADEM 2016).

According to the same sources, IFADEM projects reportedly always seek an agreement with national authority in order to allow participants to obtain an official recognition of their training with a possible positive impact on their career (e.g. a salary increase). Communalities among all IFADEM projects are the material support in form of provision of dictionaries, grammar books, audio-files and the construction of telecentres in the target areas. The reported rationale behind the construction of telecentres is the provision of pedagogical resources and the facilitation of administrative tasks; teachers take part in a short training how to use the resources in the telecentre (e.g. computers).

In light of the previous presented development and educational challenges the country faces, Madagascar appeared to be an ideal candidate for the implementation of an IFADEM project and was selected for an IFADEM pilot in 2008.

However, shortly after the start of the design phase for a Malagasy version of IFADEM, the political crisis of 2009 broke out. Similar to a large amount of development projects, IFADEM was directly affected by the crisis. One consequence of this crisis was the suspension of Madagascar from the Organisation Internationale de la Francophonie, main implementing actor behind IFADEM. Hence, Madagascar became *de facto* ineligible for an IFADEM initiative. However, given the advancement of the project design, the *Agence Universitaire de la Francophonie* decided exceptionally to support the implementation of a smaller version of the initial project in Madagascar and ‘label’ it still as an IFADEM initiative.

Due to the political crisis, the organizational team had changed and the main interlocutor of the project was finally the INFP (Institut National de Formation Professionnelle, in English: the national teacher training institute) instead of the Ministry of Education. Orange Madagascar was in charge of providing the mobile phones and technological support and worked here closely with the Orange R&D department in Paris (Orange Labs). The *Agence Universitaire de la Francophonie* provided the coordinator of the project and the coordinator of the content design team.

Ultimately, the objective of the project did not change though, and remained aligned to the systematic goal of all IFADEM initiatives: the improvement of teachers’ pedagogical competences for the organisation of French lessons, and the improvement of their own French skills in order to actually be able to teach French *in* French. In addition, the project sought to serve as test project with regards to potential benefits of mobile phones within a distance based teacher training and introduced mobile phones as training support.

2.1.2 Target locations and profile of beneficiaries

The project took place in four school districts of the rural region Amoron’I Mania (Figure 24). Ambositra, the regional capital, as well as Fandriana, Ambatofinandrahana and Manandriana. Ambatofinandrahana and Manandriana are particularly rural and isolated due to poor roads, making their access long and hazardous.¹³ Furthermore, electricity is almost inexistent and

¹³ Their isolation and difficulty was a problem for the field research conducted for this dissertation: for logistic and security reasons, it was not recommended that a *vasaha*, a european stranger, would travel to these locations. See the chapter on methodological approach for more details on how this problem was contoured.

mobile network coverage less developed than in Ambositra or Fandriana (Ratompomalalala et Rakotonanahary 2013).

Figure 24: Amoron'i Mania region in Madagascar – target region of the IFADEM pilot



Source: Le Quentrec, 2014

This isolation impacts on the French level of both teachers and students, as found by the qualitative study based on interview conducted with training participants:

“The poor condition of the roads and the slow progress of communications did prevent the reintroduction of the French language in the daily life of rural areas: children and parents do not understand French which isn't part of their lives, none speaks it correctly, not even the teacher”

(Ratompomalalala et Rakotonanahary 2013, p. 124).

The isolation is also characterized by a lack of infrastructure, e.g. banks which in turn comes with a security problem. Bandits, locally called ‘dahalos’ regularly attack these inhabitants, as they are aware that the population keeps their valuables and income at home.

Figure 25: Target region of the project: Amoron’I Mania and the districts of training participants



Source: SRAT, 2011

Teachers reportedly got attacked on their way to school, are less willing to work in these areas and feel that this situation impacts on their ability to properly prepare and conduct lessons. Furthermore, the lack of transportation systems directly impacts on their teaching. Given that teachers have to buy their own materials, and the long travel to the nearest shops discourages teachers to buy these (ibid).

➤ *Socio-economic characteristics*

Among these districts, 436 teachers and 22 tutors were selected (Table 5). The majority (77%) of participants were from Ambositra and Fandriana. When looking at their socio-economic characteristics, the following can be ascertained: 75% of participants were civil servants, compared to 25% of contractual teachers. This proportion is not representative of national averages, which are composed mainly of non-civil servant teachers (i.e. contractual teachers and FRAM teachers). Around 56% of all participants were women, which is hence fairly representative of the gender distribution among primary school teachers in Madagascar, estimated to be composed in 2012 by 55% of women (UIS 2015). Women were overrepresented in Fandriana and Ambositra, the more ‘urban’ areas, which is a common

observation in Sub-Saharan Africa where female teachers are less often present in rural areas (Bennell et al. 2007).

Table 5: Socio-economic characteristics of participants (teachers only)

Number of participants	435	
Civil Servants	75 %	
Men / Women	44%	56%
Range of age	50 – 55	
BEPC holders	84%	
Baccalaureate holders	10%	
% of individuals from Ambositra and Fandriana	77%	
% of participants from Ambatofinandrahana and Manandriana	23%	

The older (+50) participants are also mostly in these areas, while the majority of young participants are in the rural areas: This is easily explainable by the fact that career starters rarely chose their assignment, and progressively try to be transferred to more attractive – less rural – areas (UNESCO et al. 2009) The average age of participants was 52 years, with the youngest participants being 27 and the oldest 60 years. This is not representative of the national average, which can be explained by the fact that the project chose civil servants, a minority today in Madagascar. The majority of the workforce today is composed of other than civil-servant teachers in their thirties with 4 to 10 years of experience, FRAM teachers have often less than 3 years of work experience (CONFEMEN, PASEC 2017).

Furthermore, the majority of participants hold a BEPCS/CFEPCES (junior secondary school diploma / first cycle of secondary education); only 10 % hold a *baccalaureate* degree. When comparing the distribution of degrees with the sample of PASEC data 2012, this is almost representative of national averages: PASEC found a slighter higher proportion of individuals with a baccalaureate (around 15%). However, it is known highly qualified teachers are under-represented in rural areas, who perceive the latter as rather unattractive areas (Bennell et al. 2007; Mulkeen 2005).

IFADEM chose among pedagogic councilors 22 individuals who would be both beneficiaries as well as trainers of the project, endorsing the role of tutors (Figure 26). In comparison to teachers, these tutors were younger (on average 47 years old) and more educated: All tutors have obtained at least the baccalaureate. Only a minority of tutors were women (36%).

➤ *French skills*

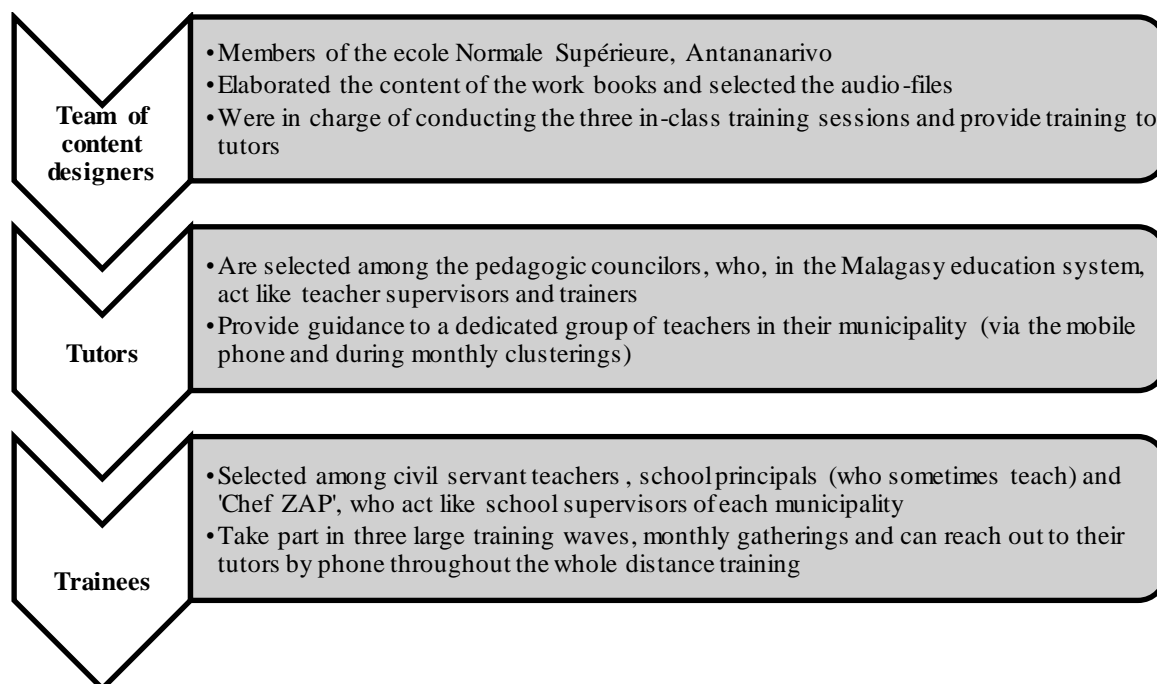
The participants did not take part in a test in view of assessing their initial French skills. Instead, 36 primary school teachers in Fort-Dauphin had taken part in a French test in 2010, during the design process of the training content. One of the final evaluations in 2013 concluded that the profile of these teachers (rural and isolated area) are « *probably valid / adaptable* » to the profiles of participating teachers (Le Quentrec et Gire 2013, p. 18). According to this test – focusing on oral and written comprehension and expression, as well as language structures – teachers had an A2 level as defined by the International Centre of Pedagogic Studies (CIEP). In other words, their French level could be considered as being at an intermediate elementary level, equivalent to a secondary school level.

At the launch of the project, experts of the Agence Universitaire de la Francophonie and the Ecole Normale Supérieure Antananarivo observed that tutors had a better level of French. The limited French skills of teachers however explain why explanations and exchanges had to be often in Malagasy, particularly with regards to the functioning and use of the mobile phones.

➤ *Possession of mobile phones and use of radio and television*

All 22 tutors already possessed a mobile phone prior to the project launch. When it comes to teachers, 66 % declared that they already possess or had possessed a mobile phone. 18 had never possessed a mobile and 16 % didn't provide information regarding this question, asked within the baseline survey. Both teachers and tutors declared that radio is the most important electronic equipment for them: 9 out of 10 possessed a radio. However, teachers rarely possessed televisions or a private access to electricity. In contrast, these were widely present in the households of tutors.

Figure 26: Trainers and trainees of the IFADEM project: role in the school system and in the project



2.1.3 Phase of content development 2010 - 2012

From 2010 to 2012, a dedicated team developed five workbooks in cooperation with French experts. This team was composed of academics, 2 trainers from the INFP, 1 pedagogic councillor, 3 secondary school French teachers and two academics / researchers. They were supported by a French expert of linguistics and French as Foreign Language, playing the role of coordinator and corrector.

The workbooks focused on the following themes and practices:

- Workbook 1: Linguistic unblocking of students: Focus on psychological and linguistic techniques to encourage students to talk in French;
- Workbook 2: Pronunciation: Focus on techniques that help students to pronounce the sounds of the French language, the intonation and rhythm of the language;
- Workbook 3: The necessity of teaching grammar and vocabulary;
- Workbook 4: Oral and written comprehension and expressive lecture;

- Workbook 5: Written comprehension: preparation of written expression;

2.1.4 The training scheme

Tutors were chosen among the pedagogic councillors in order to build on the existing administrative hierarchy. More concretely, eight trainers, supported by the *Ecole Normale Supérieure* in Antananarivo and French experts, trained twenty two pedagogic councillors for their role as tutors. Each of them was in charge of a group of teachers composed of 13 to 37 teachers (average 20).

The **training of tutors** took place in July and August 2012. The training focused on the content and the methodology of the workbooks. Furthermore, tutors learned how to use the internet and, during a half-day lasting training, how to use the basic functions of the later distributed mobile phone: Calls, SMS, Radio, MP3 player (Le Quentrec et Gire 2013).

The actual **teacher training** (Figure 6) core of the project took place between August 2012 and April 2013 and consisted in:

- **3 large cluster meetings** every three month during the school holidays with all participants from the same district regrouped in a dedicated training wave (individuals from Ambatofinandrahana and Manandriana were merged in one training wave). Each time, trainees were introduced to a new workbook and the first session was used for mobile usage training;
- **9 (monthly) group meetings** of teachers with their tutor for Q&A sessions and collective work on the workbooks. This scheme was chosen in order to avoid the abandon of trainees because of a feeling of solitude and isolation “*mayor sources of failure in distance training programmes*” (Le Quentrec et Gire 2013, p. 12);
- **Ongoing, autonomous training** supported for the first time in an IFADEM initiative by both paper-based and digital resources on a mobile phone.

The mobile phone was introduced in this training scheme to “*enhance the pedagogical support provided by tutors and allow teachers to communicate with each other*” (ibid).

More precisely, the phone was used for:

- Free **communication** with tutors and peers; communication with other non-training participants at their own expense;
- Daily reception of a **quiz question** in relation to the workbooks. Answers had to be given by pressing key 1, 2 or 3 on the phone. Solution and explanations were sent out automatically at the end of the day;
- Provision of **audio-files** (songs, short stories, pronunciation) pre-registered on the audio-file and in relation with the workbooks.

At the very first meeting, teachers and tutors received the ‘pedagogical kit’, which included one of the two available models of the phone, a grammar book and dictionary, a notebook and a pen, as well as the workbooks of the training. During this very first meeting, teachers were provided with general explanations concerning the training scheme. With regards to the content of the training, the team in charge of designing the workbooks explained the first and second workbook during the first meeting. Workbooks 3 to 5 were presented during the second meetings. During the last meeting, participants went through all workbooks and took part in the theoretical evaluation. Each of the clustering meetings took place in a telecentre, and participants stayed there for three days together, as the location was too far from their homes. Travel and accommodation expenses were covered by the project.

Figure 27: Implementation process of IFADEM Madagascar



After the end of the training – and hence the end of the daily SMS quiz and monthly meeting – teachers were allowed to keep their phones and training material, but the pre-paid communication plan that had allowed them to call their tutors and peers ended. Similar to the

previously presented mobile teacher training pilots, no follow-up activities were planned, designed or conducted. Again, recommendations for a possible scale-up figured in the internal and external evaluation report but did not lead to any type of further research.

2.2 Two key-findings and new questions

As part of the pilot evaluation, the project organizers analyzed the use and contributions of the mobile phone during the training, using qualitative and quantitative data-sets (see chapter 4). In the following two particularly interesting findings with regards to the current state of research will be presented. These are 1) hybrid usages of the phone for both training and non-training related purposes 2) the creation of a mobile supported teacher network.

Herby, the evaluation and analysis of the pilot confirms some of the expectations on the potential use of mobiles during a teacher training pilot. Furthermore, the fact that these contributions were partly non-prescribed indicates that there are phone usages providing an added value but which have not been considered by the pilot. Non-prescribed usages can also be interpreted as spontaneous appropriation of the phone, suggesting that these usages are relatively independent from the overall training structure and hence less affected by the end of the pilot.

All in all, this shows again the importance of analyzing how contributions evolve and generate over time; as the latter is source of information on the sustainable potential of mobile teacher training.

2.2.1 Hybrid and non-prescribed usages

The project evaluation was conducted in 2013 and based on questionnaires, interviews with participants and the analysis of phone usage data retrieved via a pond in all Alcatel phones. The evaluations were conducted by a representative of the Ecole Normale Supérieure Antananarivo, a team of external evaluators composed of experts in mobile learning, as well as researchers from Orange. Key conclusions of these analyses were the use of the phone for both professional and private purposes. Several usages and contributions were found as non-prescribed.

➤ *Prescribed and efficient use of the phone as teacher training tool*

In terms of phone communications, the evaluation found the 40% of calls and SMS sent-concerned training participants only, and among these, a large majority concerned teacher-to-teacher communications only. This shows that the phone was not only used to be in touch with the tutor, but also served to communicate with peers, as hoped by the pilot. Teachers reported to call each other to clarify training content that had not understood during the monthly meetings, verify a quiz answer, ask a question regarding the workbook or simply exchange training related information. Overall, voice was preferred over SMS communication.

However, the amount of communications varied significantly among participants. A quarter of all participants cover over 68% of communications, showing that there are some individuals who were particularly involved in the training. The evaluation classified individuals in three categories of phone users: rare phone user (35% of participants), intermediate phone user (40%) and frequent phone users (25%). It was concluded that, all things being equal, satisfying network coverage is the most discriminant factor: a teacher with unsatisfying network coverage has ten times more chances to be a rare user of the phone.

Also impacting on the phone was familiarity with phones prior to the training start: The lower, the likelier a teacher would be using the phone rarely during the training. Individuals from Ambatofinandrahana and Manandriana were those with the lowest amount of frequent phone users – their isolation, lack of infrastructure and lower number of contacts was found to be one of the key challenges for teachers in the area.

Particularly useful and efficient was the use of the phone for the delivery of daily quiz questions: Over 50% of teachers took part in the quiz campaign. This participation was found to be affected by the degree of already acquired familiarity mobile phone and access to electricity, as individuals lacking without could not reply when they could not charge their phone. The quiz revealed to be an added value of the phone for the learning process of pedagogical practices. The higher the participation in the quiz campaign, the better the final theoretical and practical test results of participants. Similarly, it was found that teachers appreciated much the use of the audio-files. According to the pond in the Alcatel phones, 75% of these participants listened to the audio-files. Also, according to the interviews, a lack of mobile technology literacy did in some cases make the retrieval and listening to audio-files difficult.

➤ *More non-training related usages than reported?*

In contrast with these training related phone usages, the evaluation found also various usages which showed that the phone was not only a training tool for participants, but of added value in their daily, work and private lives.

Firstly, the amount of communications with non-training participants – at hence payable by trainees –, is considerable. 70 % of IFADEM participants have used the phone to communicate individuals who were not trainees, and the volume of non-participant communications increased throughout the training period. Communication peaks around Christmas – both concerning training and non-training peers – indicate that the phone occupied a social role during the training. Again voice based communication is preferred to the SMS when it comes to non-training related communications.

Besides being a tool for training and non-training related communications, the versatile role of the phone is manifested as participants reportedly listen to the songs, the radio, used the photo function to distract themselves, as well as the calculator and in some cases, the voice recorder function. This variety of usages, even if not measured in terms of number of times used, raises important questions: In which context these functions have been used? Are there usages that dominate? Which of these contributions sustain and evolve over time?

These questions appear even more interesting as non-prescribed usages of the audio-files in the classroom could be identified. Indeed, these audio-files, intended initially for teachers'

self-training, were finally used by many teachers during the lessons. More precisely, they were used to correct the pronunciation of students, attract their attention and motivate them. It appears hence possible that there are more usages which had not been reported or revealed by participants, or new usages which have emerged since.

2.2.2 A teacher network structured by training dynamics

The 2013 evaluation used social network research methods to exploit the Call Detail Records of participants. The evaluation showed that they have formed mobile supported groups interconnected to each other. This finding confirms overall research expectations and the projects goal to reduce the isolation of participants. A mobile supported training network was in place during the period of the training thanks to the introduction of the mobile phone. More precisely, it appears that the observed mobile supported relationships are constructed according to ‘real’ relationships which find their dynamics of cohesion in the groups organized for the training.

The analysis of communication logs revealed indeed that these groups mostly share a common geographic space, i.e. meaning that communities are mostly composed of individuals from the same geographical district, but not necessarily from the same schools (Le Quentrec et Gire 2013). The proximity of tutors to each community is interpreted as a sign that more than only being geographical proximity, it is the monthly meetings with a tutor which have allowed participants to reinforce and create new relationships; relationships which become visible in form of mobile communications among individuals. Tutors happen also to be those who have the highest number of contacts in the network, which appears coherent with their prescribed tasks during the training and their role as intermediary. This shows that the mobile phone was used by them to fulfill their role of distance supervisor, and that they play an important role during the training and within the network.

However, while each of those who had the same tutor – but were not necessarily trained in the same monthly training groups – can be found in a common community, it is interesting to note that the teachers communities within the network do not correspond to the monthly training groups. The contrary would have meant that the number of observed communities is

equivalent to the number of monthly training groups. This shows that the tutor role is certainly important, but not the only reason of cohesion and relationship building.

Indeed, tutors practically form their own group (18 out of 22 tutors can be found in a single community). Their inner-group relationships are denser among each other than those relationships with teachers surrounding them. This can be explained by the need to frequently exchange information with regards to the training, but also be related to other professional missions and practices – it has not be recalled that in addition to their tutoring activities, they were still regular pedagogic councilors.

The analysis of density among the teacher communities has revealed to be uneven: Density of relationships is much higher among those communities located in Ambositra and Fandriana. The emitted hypothesis is here that the mediocre network coverage and lower technical skills impacts negatively on the ability of participants in Manandriana and Ambatofinandrahana. Moreover, the evaluation refers to Larivière's and Pénard's work, indicating not only that mobile phone communications are mostly used to communicate with *near* individuals, but also that the perception of an added value of the phone depends on the amount of possible interlocutors to contact. Participants in these regions are minorities among IFADEM participants, hence they have less IFADEM contacts and fewer mobile communication in general, because of the network coverage (Pénard 2002; Rivière 2001). Furthermore, it appears that beside geographical proximity and sharing the same tutor, factors like the diploma, age, gender and in one case the possession of the smartphone are found to possibly influence on community building within the IFADEM network.

While the evaluation could identify the presence of a mobile supported teacher network during the training, the fact that the structure and patterns of this network were training oriented creates uncertainty about its longevity. More precisely, this brings up the question whether trainees continue to find added value to collaborate in the medium-term, at their own expense and without external stimuli.

2.3 Available datasets: Limits and potential

The IFADEM project was presented in detail as it provided the main ground for this research. More precisely, 9 different datasets were produced by project evaluators. These provide

notably information on participants' characteristics (e.g. socio-demographic and school-administrative characteristics, IT literacy skills) as well as information on the perception of the training modalities and the content, the use of the phone and reported impacts on practices:

- Administrative data-set: Information on career and degree levels;
- Pre-project and post-project questionnaire: socio-economic characteristics, mobile usage and training experience;
- Data from the multiple quiz platform: Degree of participation and number of correct and wrong answers;
- Data from the usage observation pond in the Alcatel phones: Frequency of use of audio-files, radio and mp3;
- Theoretical and practical training evaluation results;
- Call Detail Records (CDR): Date, Time and duration of communication; Number of out and in-coming calls, type of call partner (training related or other), type of communication (SMS or Voice);
- Call Detail Records: Also known as *Station Message Detail Recording* (SMDR), CDRs provide details on all incoming and outgoing calls.
- Creation of additional variables: classification of rare, moderate and frequent phone user;
- Interview report: Interviews with individuals from each user category on phone usage and training experience;
- External evaluation report: Perspective on organizational matters and tools;

These data-sets provided a rich ground of information for this dissertation, but – in addition the ethical constraints in some cases, and which will be addressed later on – a few limits and weakness exist. Given that the data sets have ultimately influenced on the choice of the

methodology underlying this research, their weaknesses and potential needs to be exposed. Details about each data-set (containing information, retrieval context) and retrieval context can be found in chapter 4 on methodology and methods.

2.3.1 Some weaknesses....

➤ *Lack of representativeness of the Malagasy teaching workforce*

The majority of the beneficiaries are civil servants. This is not representative of national standards, which was later criticized in the final evaluation. Indeed, the national average of non-civil servant teachers is constantly growing and was estimated to compose 73% of all primary school teachers in 2012 (Cour et Rakoto-Tiana 2013; CONFEMEN, PASEC 2017).

Neither representative is the average age of participants (52 years, with the youngest participants being 27 and the oldest 60 years). The majority of teachers are now contractual or FRAM teachers, who are in their thirties (CONFEMEN, PASEC 2017). However, when it comes to the subsequent representativeness of professional skills, an important factor in this study, the data set remains fairly useful. Civil servant and FRAM teachers severely lack professional development training. It appears safe to say that they are 'equal' in this regard.

➤ *Absence of initial skills test*

One of the most significant weaknesses of the data sets, and hence the methodological approach of the evaluation, is the absence of baseline pedagogy and language test with all, or at least a selected group of participants. The local implementation implementing team has conducted a French test with 35 rural primary school teachers in Fort-Dauphin in east Madagascar, arguing that their French level was similar to those of future participants (Le Quentrec et Gire 2013). Unfortunately, the lack of information on the initial level of actual participants, and the absence of a control group made it impossible to conduct a test-based measure of the impact of the training on skills and practices right after the training.

➤ *Unclear or biased answers in the satisfaction questionnaire*

Both the interviews with former participants in the field, as well as the for this dissertation conducted statistical analysis of the questionnaire answers have progressively lead to the impression that there some answers in the final satisfaction report must be considered with caution:

This is illustrated in the case of the question *'I used the phone to inform myself or organize myself'*. The answer had to be given in form of a Likert-scale ranging from strongly disagree agree to strongly agree. The report summarizing the satisfaction questionnaires concludes that 9 out of 10 participants have used the phone to inform themselves.

There are reasons to think that the data from this question is not exploitable *ad hoc*: Firstly, the notion of 'informing yourself' lacks clarity. It is not explained if informing means here using the phone to seek information concerning e.g. political news, private matters, or to obtain school or content related information with from a colleague or the school district – an entirely different usage of the phone. Also, the inclusion of two activities in the statements makes it impossible to later identify if the phone was hence more used for organizational purposes (of school related matters? personal matters?) or information matters.

To a lesser extent, interviews and statistical analysis of the questionnaire reinforce the impression that the answer is not exploitable. During the interviewees conducted with former participants for this dissertation, those who continued to use the phone systematically reported diverse usages. These usages included informing about work and educational content, and reporting individuals appeared to be overall more familiar with the phone. In contrast, those who had stopped to use the phone did not report this type of usage and were less familiar with the phone. However, the subsequent hypothesis that this question would statistically be associated with later activity level (still using / not using) had to be rejected ($p < 0.05$ at Parsons's Chi-square test). It is also possible that respondents felt that answering that 'informing' and 'organizing' were desirable answers, and that they did want to report positive usages in the questionnaire that was intended for the donor of their phones, Orange, containing the firm's logo on the first page.

This type of socially desirable bias is often observed issue, reported when self-reporting questionnaires are used and already observed in research on the evaluation of pilot projects in developing countries (Mortel et F 2008; Diallo et Thuillier 2004; Gregson et al. 2002).

Social desirable bias also seems to apply when looking at to the degree of agreement with the following statements: '*I lend the phone to family and friends*', '*I could use the audio-files*', and '*I used the phone for private conversations with tutors*'. The literature as well as the interviews conducted during the four field missions indicate that sharing mobile phones is a very common practice. Still, only a very small (28 out of 420) number of answers agree with the statement that they lend the phone. The report summarizing the questionnaires interprets this as a sign that the phone is a professional tool and hence not lendable to other people (Le Quentrec et Gire 2013). However, both the literature review on the very common practice of phone sharing (Street et al. 2015). Furthermore, the interviews conducted throughout the three years of research indicate rather that while some teachers indeed preferred to keep their phones carefully to themselves, several teachers reported sharing it practices. The overall impression dominates that they felt not to be supposed to to lend the phone, distributed for the training purposes..

Also, the evaluation report of 2013 found discrepancies with regards to the questionnaire answers indicating that only 4% of respondents had difficulties to use the audio files of the training, contrasting with declarations made in the interviews. During the interviews conducted in 2013 with the samples of each user group, only 9 out of 18 declared to be able to use the audio files without any problem, four found it difficult and one wasn't able at all to use the files (Le Quentrec et Gire 2013). In the evaluation report this discrepancy is explained by an "*exaggeration of shown enthusiasm*" (p.24), teachers wanting to please their donors. It is also supposed that the overall difficulties to use the phone were under-declared, particularly with regards to the ability of replying to the quiz question (ibid).

Similarly, it appears also plausible that teachers felt private conversations with a tutor were not something to report in a questionnaire evaluating a professional experience. This possibility had already been evocated in the evaluation report (Le Quentrec et Gire 2013) and interviews confirmed this impression.

➤ *The intimidating perception of Orange as sponsor and evaluator*

For this dissertation, field research and local interviews were conducted respectively two, three and four years after the end of the training (cf. methodological design and approach, chapter 4.) When these interviews were set up, the first individuals were told that a researcher ‘researcher sponsored by the operator Orange’ would come to interview them. They remembered that Orange was one of the organizing stakeholders of the project and the institution which donated their phones, and remained fairly shy in the beginning. During the first interviews, these participants had difficulties to speak freely and class observations seemed (and were later confirmed to be) like exceptional replications of a ‘typical IFADEM lesson’. Obviously, individuals were reassured that they were interviewed and observed by a researcher who was interested in their *experience*, and not an Orange representative who come to evaluate their IFADEM skills 2 years after the end of the project. Having noticed how intimidated teachers were, it was requested for all following interviews and observations to be presented by the translator and local administration as PhD student from the *Ecole Normale Supérieure* in Paris and did never refer to Orange as sponsor of the PhD research. The presence of a person acting as translator¹⁴, who had also been part of the Malagasy project team, was also at the beginning of each interview an aspect intimidating the interviewees, despite her high popularity among participants. Indeed, she had spent much time with the trainees and a friendly relationship with many of them. She explained each time in Malagasy that her presence was only due to the fact that she knew the schools and the project, and that interviewees could be reassured that she was not here to evaluate project outcomes.

2.3.2and potential for further research

Despite these constraints, the potential of the available datasets is tremendous for further research. The data-sets are large and diverse, resulting from the survey and providing information on characteristics, training activities and mobile phone usages. Combined with the availability of secondary data in form of internal and external evaluation reports, these

¹⁴ Lolona Rakotovolala, from the Ecole Normale Supérieure Antananarivo

data-sets are a highly interesting starting point for research on the use of mobile phones for teacher training and perceived and observed practices after such a training.

A key added value of this research and datasets however consists in the possibility to go back to the field, to meet former participants and access their current communication logs. A medium-term analysis of contributions and practices appears possible. More precisely, this access to longitudinal data offers the possibility to trace back in the past training or individual related factors that prevent or support contributions which are observed or declared later. This is a promising aspect; given that mobile teacher training is a relatively recent research field, dominated by references to mostly expected or short-term contributions, resulting often in 'best practices' conclusions with questionable long-term or even medium-term validity. Indeed crucial from a development policy perspective, these datasets provide the possibility to shed light on a current grey zone: sustainability of mobile teacher training.

Finally, the CDR of former training participants are the possibly most salient data set with regards to the methodological approaches and areas of research they offer. Rarely exploited, the possibility to combine CDR with old and newly retrieved qualitative datasets allows not only analyzing factors contributing to ongoing communications made with the former training phone. It also provides the potential of analyzing the relationships of actors through the patterns of their communications; i.e. research the existence of a mobile supported network, two years after the end of the training, its dynamics and organizational framework. Given that teacher collaboration is one of the most mentioned and expected contributions of mobile teacher training (see chapter 1), this research potential deserves to be further exploited.

Summary of chapter 2

The second chapter of this dissertation has shown that the few mobile teacher training pilots which have been implemented in the past reported positive impacts of the phone, provided it was used for the training of professional practice or as a tool for enhancing an information and resource retrieval process. Confirming partly researchers' expectations, the pilots also showed that the phone was efficiently used as trigger of extrinsic motivation, e.g. through SMS that encouraged teachers throughout their training process. Another common finding was the emergence of collaborative teacher networks or 'communities of practice', a particularly interesting finding in light of its non-prescribed character. Similarly, various non-

prescribed usages of the phone, both in the professional and private sphere of trainees, could be found among reported findings of these pilots.

In contrast to these positive contributions, a lack of familiarity with the phone, indicating the importance of appropriation, as well as poor infrastructures – impacting on the latter? – was found to be an issue.

Also, all pilots are characterized by a striking contrast: On one hand, sustainably and scale-up is presented as desirable and intended, on the other hand, it doesn't seem as it is *de facto* planned, and medium-term evaluations or follow-up activities are absent.

Finally, this chapter has also exposed in detail the IFADEM pilot, its key findings and resulting questions, as well as and its data-sets. The project will serve as main case study for this dissertation. Despite existing weaknesses in terms of available data sets, this project provides an extraordinary possibility to conduct a medium-term study with a longitudinal approach, tracing back evolutions from the training period to two years after the end of the pilot. As put by Kukulska-Homa, it appears indeed indispensable to find ways to track the evolution of uses over time, taking into consideration “*the unpredictability of how devices might be used; and that usability issues should be tracked over a longer period, from initial use through to a state of relative experience*” (Kukulska-Hulme 2007, p. 11).

PART II
**Research question, theoretical framework
and methodology**

Chapter 3: Research question

Analyzing mobile supported teacher training in Sub-Saharan Africa: Which contributions on teacher practices and usages? How to analyze them?

In light of the worrisome situation of education in many Sub-Saharan countries, the research community and policy makers agree that it is necessary to analyze and identify teacher training models which are in line with the needs of education systems in Sub-Saharan Africa, both in terms of quantity and quality. In that sense, it is acknowledged that teacher training schemes must be realistic and realizable with regards to financial and resource constraints of governments. Moreover, these schemes must enable both the existing and up-coming teacher workforce to acquire those competences which have been identified as being relevant for student performance.

Within the debate and research on the range of possible training schemes, mobile phones are increasingly discussed as a useful teacher training tool in African countries, particularly when introduced as part of a distance training model. Similar to the massively growing adoption rate of mobile phones in Sub Saharan Africa, the past years have witnessed the development of a substantial body of literature on training and learning with mobile devices, and a surge of conferences pertaining to mobile learning research.

Referring mostly to their ubiquitous, easy-to-adopt and low-cost characteristics, research on these initiatives indicates that, on the short-term, the introduction of mobile phones can potentially put in place process in which teacher learn both autonomously and in a collaborative manner. It also indicates that by doing so, teachers could acquire both curriculum relevant content and the so called ‘21 century skills’ - which they can then supposedly transfer to their students.

These high expectations contrast however with a lack of substantial evidence on outcomes of these training models. Mobile teacher training is still a fairly unknown territory: more research is needed in order to identify and understand its contributions on teachers’ practices.

This is not only true for contributions on teacher practices within the school and the classroom, but also practices pertaining to the management of administrative workload or within their private, personal sphere. This task is certainly challenging, the lack of evidence being one of the reasons why the number of systematized mobile teacher training pilots in Sub-Saharan Africa is low.

When identifiable, another issue of existing pilots is that they have been fairly small-scale, both with regards to the number of beneficiaries and the duration of the training: Given that pilot projects are *per se* designed as a short-term experience, also because of financial and organizational constraints, they lack a medium-term perspective and are not accompanied by follow-up evaluations over time. If evaluated, they were so with a focus on outcomes observed during the pilot or the test of competences acquired at the end of the pilot project. This approach limits the range of observable contributions.

Indeed, in particular when it comes to educational phenomena as the acquisition of competences or appropriation of practices there are contributions and changes which need to be considered but operate only over time - and must be analyzed over time. This is particularly true for teacher training schemes that involve the use of technologies, even if these are already well diffused among the population. Indeed, per definition, experience and appropriation is correlated to time and in turn, affects the outcomes of experience. Hence, a longitudinal analysis is necessary in order to understand in which areas and to which extent mobile teacher training lead to new contributions, e.g. once the training has ceased or consolidates those that have emerged during the training phase

In a reverse perspective, looking at the medium-term contributions allows analyzing to which extent the training experience itself determines and influences the different types of identified contributions – or if there are other underlying but non-training related factors.

In any case, the identification of medium-term contributions appears also necessary from a development policy perspective: It shall enable the design of teacher training projects that are from the start medium-term and sustainability oriented, providing further insight on those competencies that may be enhanced or developed in a sustainable manner through mobile teacher training approaches. Here, it is important to research to which extent external

constraints pertaining to the development policy sector may influence on the design, implementation and ultimately sustainability of outcomes of a pilot project.

From an operational perspective, knowing that training pilots and their evaluation depend mostly on non-governmental funding, the analysis of sustainable contributions on teacher practices may also allow to identify instruments for future training models that can sustain financially, once the 'pilot funding' has ceased.

In light of these issues, the here conducted research, based on the case study of the IFADEM on mobile teacher training, was framed by the following research questions:

- Which areas of contribution can be observed in the medium-term, once all financial and organizational stimuli have ceased?
- Are there contributions concerning teachers' way to teaching, collaborating or organizing work – related tasks? Which role plays the phone in former trainees' life, and what do these usages tell us about the appropriation process?
- How do contributions evolve and develop over time? Are there contextual, experience and / or technology related factors influencing on this process?
- Which are the current expectations and constraints of project implementers towards mobile teacher training pilots and how do these perspectives and discourses influence pilot implementation?

Chapter 4: Theoretical framework, design and methods

1. A social constructivist approach to technological determinism, appropriation and technology based innovation in developing countries

The analysis of contributions related to a mobile supported teacher training can be made through multiple theoretical lenses which come often along with their own ideology and methodology. In the case of this dissertation this research was guided by an approach that shall allow to “*move beyond the deterministic assumption that technologies possess inherent qualities, and are therefore capable of having particular “impacts” or “effects” on learners, teachers and educational institutions if used in a correct manner*” (Selwyn 2016, p.68). Willing to adopt a critical approach towards technological determinism and to consider the social account of technology, the here adopted perspective and methodology is led by social constructive approach of analyzing technology use and appropriation, and framed by theories like activity theory, communities of practice, actor-network and social network theory. As will be exposed in the second section of this chapter, the methodology – a triangulation mixed methods research – selected as appropriate in light of the research question is grounded in these theories.

1.1 Technology determinism

Technological determinism has been widely explored in the field of science and technology studies. It is defined as a reasonable and well accepted belief that technology shapes society in some way. Considered by many as ‘common sense’, various researchers like Avgerou and Selwyn identify different ‘levels’ of technology determinism. They distinguish *nomological accounts* (i.e. there is an inevitable technological order based on laws of nature), from *normative accounts* (i.e. technology is unquestioned, questions about efficiency and productivity replace political and ethical questions about use) and the *unintended consequences account* (i.e. it recognizes willful, ethical, and social actors but suggests they

are simply unable to anticipate all of technology's effects). Even if the degrees of determinism are different in terms of strength, none of these positions does question the causal power.

In each of these considerations, the nature of technology itself is considered as more or less neutral.

The latter has been criticized, particularly in the area of ICT use for teachers: Cuban for example has criticized the determinist assumptions in educational policies, leading to the acquisitions on a massive scale of technology, based on the assumption that it will cause improvements in learning outcomes and teaching efficiency. Cuban illustrates how teachers struggle to integrate these resources into their practice, often marginalizing technology use so that any effect that it might have had is minimized. This, he argues, is a perfectly sensible coping strategy on the part of teachers expected to use technology that they did not ask for.

Like an increasing amount of work that does not adopt a model in which technology is determinant, this dissertation is grounded in theories like activity theory and actor-network theory. A short summary of each of these theories and their technology approach will be exposed in the following.

1.2 Activity theory applied to educational technology research: A focus on the development process of contributions and appropriation

Activity theory has been used to study the design and implementation of learning supported by technology in various communities of practice (Cobb, McClain, Lamberg, & Dean 2003). Activity theory seems a suitable framework here: The research focuses on the learning and outcomes of learning involving technology introduction in three communities (teacher community, and teacher – tutor community, trainees – non trainee community), and is interested in the how experiences, reflection on experiences allows for the transformation of practices (Engeström 1987).

Activity theory is known as cultural-historical activity theory, it seeks to understand learning in terms of people's intentional actions within social settings (Oliver 2011). The unit of analysis is often described as a triangle, composed of a subject (a person) working towards an object (an objective) using a tool, within a given context (e.g. community, rules, division of labor).

The central role of tools and the fact that this concept allows to develop detailed understanding of specific cases has made the theory popular, particular for researchers conducting case based research in the field and seeking to explore cases of technology use in a systematic way (Issroff et Scanlon 2002). The attention given to the context confers a strong explanatory power to this theory, but also explains why it has been criticized for its weak ability to predict outcomes.

According to this approach, all human experience is shaped by the tools and sign systems that we use (Nardi 1996). In the case of technology, the unit of analysis within activity theory is not the individual, nor the technology alone, but the use of the technology within the context. Overall it is argued that the whole phenomena should be studied and a holistic analysis conducted instead of taking out technology out of the context (Barab et al. 2002). Hence, conclusions about technology *per se* cannot be drawn; claims about technology can only be made in a contextualized manner. However, given that this approach considers that the properties of the technologies do not determine, but still contribute in some way to the outcome of activity, our research is still partly situated in what Oliver describes as the “technicist camp” of theories with a social account of technologies (Oliver 2011, p. 378).

Moreover, activity theory appears also to be a suitable frame for this research and the willingness to analyze contributions with a medium-term perspective. Activity theory takes into consideration the development of contributions over time, considering that “*tools, or as they are more commonly referred to today, technology, [...] meet needs and serve purposes yet simultaneously create new needs and purposes. [tools] develop over time, they are appropriated from other contexts*” (Murphy 2013).

➤ *Appropriation*

Simultaneously interested in the appropriation of knowledge, practices and tools, this research adopts the appropriation of knowledge concept that draws on the developmental theories Vygotsky, adopting both a cognitive and social-constructivist views of learning (Vygotski 1978).

Moreover, considering that technology takes only a secondary role and acknowledging the importance of development over time, this research adopts an activity theory grounded perspective on appropriation:

As mobile technologies can be used for private or business purposes, and because individuals have often a prior experience with mobile technologies, the linkage between adoption and appropriation of mobile technologies should be taken into account at the theoretical level. The uses developed at the individual level, outside the organizational environment and before entering the organization or a system, can influence organizational usage and the processes of appropriation at the organizational level.

In sociology, researchers agree on defining appropriation as the development of new, altered usages (Certeau, Giard, et Mayol 1990; Bachelet 2003; Méadel et Proulx 1998) Appropriation is considered as the gap between the initial meaning and objective of a tool or device, and the actual actions and usages performed with the tool.

Researchers agree also on the definition of appropriation as

- use of a tool through techniques, usages and rules that allow the individual to be actor and in the centre of the action
- usages which are situated among a range of possibilities: Appropriation is a form of 'decision to act'

This concept implies that individuals are driven by intentionality, willingness, desire and attribute a sense to the technology they use. Time, and hence duration is an inherent part of the appropriation process. The gap between the initial meaning and altered usages is created over time.

Carroll, who researched the appropriation process of mobile phone, also underlines the importance of differentiating between pre- and post-adoption and regret that so far, in research on technology appropriation, there has been little attention paid to the temporal dimensions of adoption (Carroll et al. 2003).

In addition, context is crucial as it structures the activity of the relationship between the individual and the tool – and is itself affected by the activities that lead to the appropriation. These activities are the personal experiences of the individual when using the tool and are considered as ‘personal investment’, as ‘incorporation’ of the tool. They also build on the personal, previous experiences of individuals.

Similar to sociologist, communication scientists consider that technology appropriation equals a cognitive and technical integration of a tool into a own culture in which the individual develops his or her own, individual usages, which come along with a transformation of the tool (Theureau 2011). Appropriation is seen as a social integration, and influenced by the characteristics and goals of individuals who act accordingly, in a dedicated context:

"The act of appropriation is revealed, not in relation to the interface itself, but external to this relationship, within a combination of disparate and complementary elements. This set of actors within the cognitive environment of the user are associated to the users' search of optimization and rationalization of their practice."

(Cotreaux et Jacques 2004, p.9)

In summary, appropriation is here defined as both a social and individuating dynamic.

1.3 Perspectives on the nature of the technology supported innovation process in developing countries

Research on communication technologies, including the use of mobile technology, involves assumptions concerning the nature of communication technology supported innovation and the way such innovation contributes to development. Research for this dissertation was built on two assumptions:

Innovation is considered as locally embedded process

- Communication technologies are approached as enabler of *progressive transformation*, achieved within the existing international and local social order.
- The combination of both perspectives results in the perspective that ICT can improve life conditions, but that the process and form is worked out locally.

These perspectives are widely present in current research on technology and development (Avgerou 2010). A short summary of these concepts will be provided in the following:

➤ *Locally embedded innovation*

Research on ICT and development (ICTD) involves assumptions concerning the nature of ICT innovation and the way such innovation contributes to development. The research of this dissertation is based on the assumption that technology, and in particular mobile technology, not necessarily do, but can contribute to the improvement of socioeconomic conditions in developing countries (Mann 2003; Sahay 2001; Walsham, Robey, et Sahay 2007). It is line with studies that aspire to the realization of perceptions of desirable world orders, such as Sen's theory of capabilities (Kleine 2009; Zheng 2009) or the United Nations' Millennium Goal vision of eradicating poverty (Gilhooly 2005).

However, the development potential of technology is not *per se* taken for granted. A nuanced perspective is adopted here; perspective that is considered by researchers as Avgerou consideration of the nature of the ICT innovation process in developing countries as socially embedded action:

The social embeddedness perspective takes the view that *“the development and use of ICT artifacts in developing countries concern the construction of new techno-organizational arrangements in the local context of a developing country”* (Avgerou 2010, p.4).

It contrasts with perspectives that consider ICT innovation in developing countries as a process of knowledge diffusion which is transferred from advanced economies and adapted to the conditions of a developing country. This perceived transferability is built on the assumption that the material and cognitive entities that comprise technologies and its associated practices are independent from social circumstances.

The socially embedded innovation research approach finds this assumption too simplified and misleading, and focuses on the embeddedness of ICT innovation in the social context of various organizational settings: It is a social constructed entity that has to be locally analyzed. More precisely, it focuses on those capacities nurtured in local settings and developed unfolding of innovation efforts.

Furthermore, it focuses on what is locally meaningful, desirable, or controversial, and on how technology innovation and organizational change can emerge – or be hold back – among local social dynamics.

These local dynamics are crucial as they provide a purpose to ICT innovation. The course of action of this innovation is shaped by local actors and the way they make sense of this innovation and accommodate it in their lives (Avgerou 2002).

This social embeddedness approach is theoretically grounded in social theory such as actor network theory (ANT) and seeks to develop a theoretical capacity for addressing questions concerning the way specific categories of technologies. Social actors clusters are formed, do shape each other, and ultimately lead to particular socioeconomic outcomes.

This approach contrasts with efforts to develop a best-practice model. Instead, the idea is rather to develop an analytical capacity to guide context-specific analyses of practices in other developing countries with different systems and practices. Recently, this approach has been applied to study the development of standards sensitive to local contexts in developing countries (Braa et al. 2007).

➤ *ICT and development as socio-economic improvements through locally situated action*

Directly linked to the concept of appropriation and the importance of *sense*, this research takes into consideration a concept on socio-economic improvements that Avgerou qualifies ‘discourse’ which considers ICT to contribute to improving life conditions, based on processes of improvements being worked out primarily locally:

“Its core argument is that socioeconomic change should make sense to the local people, so they feel comfortable with the processes of change. There may be obstacles in the harnessing of the developmental potential, stemming from historically-developed social orders, such as overcentralized public administration and authoritarian hierarchies, but the belief expressed in this discourse is that these can be addressed with empowering democratic ICT policies and appropriate professional practices, such as user participation.”

(Avgerou 2010, p.10)

The influence of global actors, e.g. international organizations and their ideologies is acknowledged and considered with caution. The perspective is also considered as rather pragmatic. As Avgerou puts it, *“technologies and methods transferred from technologically advanced societies do not work. Local improvisations are necessary to close the gap between theory and actual developing countries’ conditions”* (ibid).

➤ *Theory of action*

Developed by Burt, the theory of action implies that opportunities and orientations of individuals are influenced by the structure of a network (Burt 1982). It further considers that social network structures are reproduced by the actions of members. Also, Burt’s, theory of action considers that norms and values are generated by the network and that actors orient their actions accordingly (Adler, Grümayer, et Schmidt 2010).

Here, the embeddedness of individuals in social structures can be approached through three perspectives:

Resources, such as information and knowledge, are exchanged in the relationships among individuals (by asking for advice, collaborating, or helping (Borgatti and Ofem 2010; Burt 1992).

The idea that individuals are independent is discarded. Individuals are seen as interdependent because they are embedded in social structure. Changes at a single level will have consequences for a higher-order level and vice versa (Burt 1982).

In sum, the social network studied in this dissertation provides opportunities for, but also constrain, the actions of individuals and organizations. This concept again refers directly to the concepts present in actor-network capital as well as the theory of social capital.

➤ *Actor–network theory*

Actor–network theory (ANT) has been developed within Science and Technology Studies and explores how individuals work with things in order to sustain social processes (Oliver 2011). More precisely, ANT assumes that social practice involves networks that consist of things working together, and argues that successful social practice is the result of “*a process of ‘heterogeneous engineering’ in which bits and pieces from the social, the technical, the conceptual, and the textual are fitted together*” (Law 1992, p.380). These “*bits and pieces*” might include people, technologies, materials, processes, and so on and are considered as actants. No distinction is made between humans and materials.

Like activity theory, it aspires to a holistic unit of analysis, considering the network as a social achievement, and does not make claims about decontextualized parts. Within this analysis, it focuses on the manner networks are formed and sustained rather than reasons why they are formed (Law 1997). By doing so, ANT ‘avoids the debate’ of the previously exposed technology determinism, as it does not attempt to analyze the cause, but looks at the ‘what happened’. In this regard, technology can be asked what role it played in the success – or failure – of social processes, but not *if* the network per se was caused by the technology.

In this tradition it is possible to ask questions about technology, to explore how it affects the actions of others, emphasizing how it has been socially constituted, and how it involves delegated or translated actions (e.g. Waltz 2006). In this regard, the question about technology

is not if it works or on what it impacts, but how it works in in specific institutions as part of successful practices. There is no “*single thing*” such as technology; on the contrary, technology can be framed in various ways. As put by Enriquez in a study on the use of blackboards,

“...could it be more than one thing, and instead, many things simultaneously: a driver of change, a virtual environment, a tool, an approach? [. . .] What it is always in relation to other people and things, and it always tells where it is working.”

(Enriquez 2009, p.397)

Willing to not technology not as operating on a causal model, the for this dissertation mobilized perspectives and methods seek to do what an increasing amount of authors recommend “*doing educational research by drawing attention to a different way of conceptualizing the technologies we apply, evaluate and study*” (ibid, p.386).

1.4 Social network theory

Given that in this dissertation, the genesis of collaborative networks are researched among possible medium-term contribution of the IFADEM training and both process and result of an appropriation process, social network theory provides an important framework for the research conducted for this dissertation. It is also a theory which comes along with specific methods. In the following the contents and purposes of social network research will be exposed, and an introduction in key concepts, indispensable for the comprehension of the study results (chapter 7), provided.

➤ *Content and purposes of social network research*

According to social network researchers Stegbauer and Häussling “*even though social network research does not have a uniform theoretical orientation and methodology, it involves a ‘thinking in relations’ mindset that ultimately leads ultimately to new insights into social processes*” (Stegbauer et Häussling 2010, p.2).

It is commonly considered as an overarching paradigm used in the various branches of social science. Social sciences have enriched which has enriched the mindset progressively: The focus doesn't lie anymore only on isolated persons and their characteristics but on actors and their relationships. It is considered that perceptions, decisions, actions and social processes are shaped because of and within social networks (Adler, Grümayer, et Schmidt 2010).

Hence, social networks are defined as providers of resources for actors (nodes), organizations of collective experiences and are either enabler or obstacles to actionability. The relationships – also called ‘paths’ in social networks – create an infrastructure for exchange and communication processes (Diaz-Bone 2013).

Multiple themes have been analyzed within a social network, e.g. social phenomena like

- prestige
- social influence and social selection
- the spread and diffusion of innovation, including in teacher networks
- diseases, and substance use

as well as the small-world phenomenon also known as “six degrees of separation” (K. A. Frank, Zhao, et Borman 2004).

These concepts consider, similar to what can be found in Burt’s Theory of Action, that the network influences the action of its members, and are often approached through what is called the ‘theorems of structural analysis’ (Adler, Grümayer, et Schmidt 2010; Wellman 1988). According to Wellman, there are five theorems in the area structural analysis:

1. Structured social relationships provide better explanations than personal characteristics of system members.
2. Norms are generated from positions (in the sense of location) of individuals within a structures system of social relations. Social actions do not happen in accordance to norms, as norms are themselves generated by their structural embeddedness within networks.
3. Social structures determine the behavior (in the sense of operation) of dyadic relationships. Hence, dyadic relationships cannot be considered in an isolated context, but always within their context. The network is supposed to provide a supportive and sustaining environment for these dyadic relationships.
4. The world is composed of networks and not of groups: Networks are not only composed of dyadic relationships but host also entire networks. In contrast to groups, networks are not separated from the outside. Network research intends to explain hence complex relationships, e.g. highly heterogeneous societies.

5. Structural methods can complement and replace individual methods: the further elaboration of network research methods is considered as desirable, particularly that focus on a holistic approach of network analysis.

➤ *Social networks and social capital*

As this dissertation seeks to analyze the nature, and the origins of contributions of mobile supported teacher training, including on teaching practices like collaboration, the concept of social capital is here crucial. Scholars refer often to the concepts of social capital theory in order to explain why social network perspectives are helpful to understand human interactions. Indeed, both concepts are directly related. According to social capital theory

“...social structure, or the web of relationships among individuals, offers opportunities and constraints for the exchange of resources. Individuals may tap into the resources that are available in the social structure in which they are embedded and leverage these resources to achieve individual or organizational goals.”

(Moolenaar 2012, p.10)

According to Moolenaar social capital theory is used to think about the potential of social structures for acquiring resources, contrasting here with social network theorist who seek to understand patterns in a social structure and wish to reveal those mechanisms that are responsible for its social capital outcomes (Moolenaar 2012; Burt 1982).

➤ *Centrality: A key concept within social network research*

In the *Handbook of Network Research*, Mutschke (2013) has elaborated, amongst others, a detailed overview of measures that are used as indicators of the degree of importance and prominence of an individual within a social network and presents the notion of centrality as the key concept in this area (Mutschke 2010). According to Mutschke, research indicates that there is *de facto* no universal definition of centrality. This is because of the multiple perspectives on the definition of ‘importance’ and the fact that the measures are both originally from contrasting orientations: Graph theory and Matrix algebra. However, Mutschke ascertains that all centrality measures have two basic, commonly accepted communalities (Mutschke 2010, Borgatti et Everett 2006).

Firstly, centrality is a structural attribute: It provides information on the degree of involvement of nodes with regards to the existing relationship within the network. Hence, the centrality index is dependent on the structure of the whole network.

Secondly, centrality measures imply that each node is attributed a numerical value which is calculated and evolves according to the centrality level of each node. As explained by (Freeman 1978), this numeracy allows comparing actors with regards to their respective structural position and, subsequently, allows for the identification of the most central actors. According to Mutschke, among network researchers it is “*commonly accepted that centrality measures reflect a nodes’ possibility to influence interaction processes within the network, also called ‘network flow’*” (Mutschke 2010, p.365). Those actors have a position allowing them to influence other actors and are hence considered as central actors.

In the following will be exposed the three key categories of centrality (degree centrality, closeness, eigenvector centrality) before defining then the concepts of prestige, a type of centrality particularly useful in the case of directed graphs as the one available for this research.

➤ *Degree centrality*

Degree centrality measures the amount of direct ties of an actor with their surrounding actors. Based on this measure, an actor is central if they have a large amount of direct contacts, allowing for interaction with a large amount of other actors within the network. According to Mutschke and Freeman, the large amount of contacts equals the potential to interact with a

large amount of network members (Mutschke 2010; Freeman 1978). Degree centrality is however “only a local measure as it takes into consideration the immediate environment of an actor” (Mutschke 2010, p. 365).

Within directed networks, it is possible to differentiate between out-degree and in-degree values: While the out-degree equals to the amount of out-going (in the sense of reaching out to) ties, the in-degree value measures amount of the in-coming ties.

➤ *Closeness*

Closeness refers to the proximity of a an actor to all other present actors of the networks (Mutschke 2010). It is based on the calculation of the geodesic distance between nodes (Newman 2005). The measure of closeness of each actors allows to “*calculate a measure of inequality in the distribution of distances among all actors and express ‘graph centralization’ relative to that of the idealized “star” network*” (Hanneman et Riddle 2005a, p.1). Actors are considered as close if they are separated only by short paths from others actors in the network. Closeness is commonly considered as one measure that refers to power of influence and level of independency (Freeman 1978): The closer an actor to the majority of the network, the quicker the actor can influence on the network and the less the actor depends on other actors to reach their peers. Closeness is an inverse measure of centrality: the larger the score, the more distant an actor is.

➤ *Betweenness centrality*

Betweenness is a measure of network centrality that counts the paths between actors and the extent to which an actor will lie on paths between many other actors of the network. Actors with a high betweenness centrality value lie on paths between many others and may thus have some influence over the spread of information across the network. Mutschke explains that the more the actors appears to be on the path of other actors, “*the more they occupy an interface position and maybe even a cut point position in between otherwise unconnected areas, the more central they in terms of the betweenness centrality*” (Mutschke 2010, p.370).

There are multiple measures of betweenness centrality with the most widely used being the one proposed by Freeman, counting only the shortest path “*and thus appropriate to cases in which information flow is entirely or mostly along such paths*” (Newman 2005, p.52).

Another approach to betweenness centrality is the focus on flow betweenness: It counts all paths that carry information “*when a maximum flow is pumped between each pair of vertices*” (Newman 2005). Newman criticizes however that neither of the two presented cases are realistic as they count only a subset of possible paths and assume a kind of optimality in information transmission that necessarily would go through the shortest paths or maximum flow.

➤ *Eigenvector centrality*

Eigenvector centrality is often considered as natural extension of degree centrality (Bonacich 2007). Focusing on the eigenvector centrality of a network member means looking for the most central actors in terms of the ‘global’ or ‘overall’ structure of the network, and to pay less attention to patterns that are more ‘local’. The Eigenvector centrality value calculates the centrality of an actor according to the centrality of their direct and indirect relations (Mutschke 2010; Kaye et al. 2014). In a nutshell, an actor tied to other actors, who again have a multitude of central relationships, will be considered as more central than an actor tied to a multitude of actors tied to many, but non-central actors.

When a network is composed of clusters and groups, looking at the eigenvector centrality allows assessing how much an actor interacts with other ‘connected’ or highly interactive members of the group, if he tends to interact with outliers and less active members. Eigenvector centrality can be useful in providing a snapshot of how group members interact, as the eigenvector scores of different members or subgroups may indicate the degree to which they have formed strong relationships with other influential or active members in the group (Doran, Doran, et Mazur 2011).

In the case of information networks, eigenvector centrality implies that information traffic will not necessarily follow the shortest path, as individuals may want to share information along multiple paths. It assumes that “traffic is able to move via unrestricted walks rather than being constrained by trails” (Ferriani, Cattani, et Baden-Fuller 2009 citing Borgatti et Everett 2006).

➤ *Prestige centrality*

In social network research, prestige is a concept used for centrality measures that concern directed ties and are hence only measurable in networks that are composed of ties that are either in-coming or out-going (cf. in-degree and out-degree centrality). Literature refers often to the concept of ‘choice’ or ‘feedback’, in the sense that an actors is elected by others and in

a position to provide resources (e.g. information) (Mutschke 2010). The concept of prestige is based on the perspective that an actor ‘elected’ by many nodes receives more attention than others of the network.

An actor can have a high degree value – a large amount of ties to other actors – but a low prestige if the ties are mostly outgoing and not in-coming. With other words, more than only assessing the embeddedness of an actor within the network, prestige measures focus on the inequality between actors (Mutschke 2010; Jansen 2006).

The concept of *proximity prestige* focuses also on indirect ties and defines the proximity of an actor according to the distance between an actor and all other actors of the network. On the contrary of the similar looking closeness centrality, the measure doesn’t count the sum of all distance but the average length of path: this allows to identify ‘prestigious’ actors even in un-directed networks (Mutschke 2010; Burt 1982).

A further concept of prestige is rank prestige: In this case, the prestige of an actor takes not only into consideration the question to which extent he is ‘elected’ by many actors, but also the question to which extent he is elected by actors who are themselves considered as prestigious. Rank prestige is hence the weighted sum of in-degrees that an actor ‘receives’ from other actors (Mutschke 2010).

2. A ‘mixed methods’ methodology research design

In light of the research questions and the theoretical framework of this dissertation, a mixed methods approach was chosen as most suitable methodology. More precisely, a triangulation of methods was chosen in order to identify the natures, origins and underlying dynamics of contributions of mobile supported teacher training through a pluralistic lens.

In the following will be exposed the concept of mixed-methods research design, followed by a detailed presentation of the methodological implementation process.

2.1 Definition and rationale of mixed method research within this dissertation

Since the 1980, the interest in mixed methods research has been increasing, driven by the demand for greater methodological pluralism and ability and in response to the “*increasing complexity of research problems, the legitimization of qualitative inquiry, and the need for more evidence in applied settings*” (Creswell et Clark 2010, p.50).

This pluralistic approach suggests that the researcher accepts the viability of combining several positions and approaches within a research query process. Creswell and Plano explain the increasing popularity by

“...the complexity of our research problems [which] calls for answers beyond simple numbers in a quantitative sense or words in a qualitative sense. A combination of both forms of data provides the most complete analysis of problems. Researchers situate numbers in the contexts and words of participants, and they frame the words of participants with numbers, trends and statistical results. Both forms of data are necessary today”

(Creswell et Clark 2010, p.21).

Tashakkori and Teddlie define a mixed study as the collection or analysis both quantitative and/or qualitative data in a single study in which the data are either collected concurrently, sequentially or are given a priority and involve the integration of data at one or more stages in the process of research (Tashakkori et Teddlie, 2003).

Creswell, Plano and Clark (2007, p.5) consider mixed method research as both a methodology and as a method.

- as a *methodology*, it involves philosophical assumptions that guide the direction of the collection and analysis and the mixture of qualitative and quantitative approaches throughout the research process;
- as a *method*, it focuses on collecting, analyzing, and mixing both quantitative and qualitative data in a single or series of studies. Its premise is that the combination of

approaches provides a better understanding of research problems than either approach alone.

For this dissertation, a triangulation mixed methods approach was used. Greene, Caracelli and Graham consider that a triangulation mixed methods design works best when the “*status of the different methods—that is, their relative weight and influence—is equal and when the quantitative and qualitative study components are implemented independently and simultaneously*” (Greene, Caracelli et Graham 1989, p.259). As summarized by Morse, the aim of choosing this approach was *to obtain and analyze different but complementary data on the same topic* (Morse 1991, p.122). This choice is both driven by the willingness to exploit to the fullest the available data – sets and the rare opportunity to retrieve new ones of both qualitative and quantitative nature and different temporalities. More importantly, for this dissertation the mixed method approach appeared to be particularly suitable in order to conduct research on the medium-term contributions of a mobile supported training network.

➤ *A data set facilitating a mixed method approach...*

As presented earlier in the presentation of the IFADEM pilot (chapter 2) the evaluation of the pilot has led to the production of nine different datasets, of both quantitative and qualitative nature and covering the periods of 2012 to 2013. These secondary data sets were completed by the retrieval of primary data, also of qualitative and quantitative nature and covering the periods from 2012 to 2017 (Table 6).

While the possible benefits of combining these different natures of data as well exploit the potential of their different temporalities, it was also in some cases their weakness and limitation that made a mixed-method approach necessary.

The interviews with former training members were indispensable both during the exploration phase and later, when particular subjects were analyzed. However, the effect of possible social desirability bias in some cases needed to control by analyzing quantitative data. This was also true in reverse, e.g. for the analysis of the post-pilot questionnaire results: 5 questions appeared to be possibly influenced by social desirability or not exploitable because of lacking clarity what the question actually meant. Here, interviews were necessary to control and fill lacking information.

Also, the evaluation and interview reports did not allow concluding on the personal perceptions of their authors, i.e. organizing stakeholder, regarding the overall dynamics behind pilot projects and possible outcomes.

Table 6: Type of data-set and period covered by the data

TRAINING PERIOD (2012 – 2013)		POST-TRAINING PERIOD (2014 – 2017)	
Quantitative	Qualitative	Quantitative	Qualitative
Administrative data-set: Information on careers and degree level (N=458)	Interview report 2013, (Summary of Interviews with 18 individuals from each user category on phone usage and training experience)	Call Detail Records (CDR): Date, Time and duration of communication; Number of out and in-coming calls, type of call partner (training related or other), type of communication (SMS or Voice); (N=458)	Interviews with former IFADEM participants (N=45)
Pre-project survey: Socio-economic characteristics, mobile usage familiarity (N=458) Post-pilot questionnaire: Feedback on training and mobile experience (N=436)	External evaluation report: Evaluation of project organization, content and impact. (Lethuillier et al., 2013)	Social network data base (N= 171)	Interviews non-participants (N=13)
Theoretical and practical training evaluation results 2013 (N=435)	Evaluation report on the use of the mobile during the training (Orange)		Class – observations (N=10)
Phone user category (N=458)			Interviews with organizing stakeholders (N=14)
Quiz participation (N=436)			Ego-Network analysis interviews with network members (N=30)
Call Detail Records (CDR): Date, Time and duration of communication; Number of out and in-coming calls, type of call partner (training related or other), type of communication (SMS or Voice); (N=458)			

Interviews needed to be conducted so that interviewees could speak freely, ‘confide’ themselves in an anonymous manner. More generally, the analysis of factors influencing significantly on contributions could not rely on one type of data-set only, e.g. statistical analyses were necessary in order to complete declarations during and impression generated by the interviews, and interviews necessary for the comprehension of ties among former participants.

➤ *... and suitable methodology with regards to the field of research*

As exposed earlier, hitherto available empiric or experimental evidence of medium-term contributions of mobile supported teacher training is often rare and / or weak (Baran 2014; Burns 2011). While this means that this research has not only the aim to shed light on some grey zones, it implies also that there are many fields of contributions that can potentially be undisclosed.

Facing this open field of possible paths to follow, an analysis based on either solely quantitative or qualitative approach would mean to risk excluding from the beginning contributions and related mutual explanatory factors behind these contributions. This is particularly true in light of the fact that appropriation dynamics, and the analysis of educational phenomena like contributions on teachers’ practices constitute core field of interests in this dissertation.

Also, the analysis of contributions means to study multiple areas in which they can possibility operate. In the case of mobile supported teacher training, these areas are both of quantitative (e.g. communications) and qualitative nature (e.g. innovative usages) and - sometimes even both (e.g. collaboration).

Moreover, the conduction of a longitudinal study appears necessary because this research seeks to identify change and contributions and because these involve and are driven by an appropriation process of a technology and a particular experience in the past. Indeed, innovation, particularly in activity theory, is usually studied through a longitudinal lens (Rogers 2003).

The fact that the available and retrievable data-sets were of different temporalities allows tracing back observed contributions: Variables of different natures could be accessed at

multiple temporality points, which allows analyzing to which extent they inform and complement each other. This provides an extraordinary opportunity to respond to the here asked research question.

Finally, the conduction of a mixed method approach appear particularly clear and necessary when willing to study contributions in the area of teacher collaboration, and deciding to do so through a social network approach. Mathematical development and user-friendly software for visualizing and measuring have led to advances in quantitative Social Network Analysis, allowing to map and measure networks by simplifying social relations into numerical data, where ties are either absent or present. However, there having been a growing number of voices calling for the use of qualitative methods to complements these methods, as “*they bracket out questions of crucial importance to understanding the kinds of human interaction networks studied by social scientists*” (Edwards 2010, p.2). Given that networks are both structure and process at the same time, they go beyond the categorization of either quantitative or qualitative phenomena.

Hence, this study will not only analyze from a quantitative perspective the structure of ties among former IFADEM participants – and whether these ties are organized in a network form – but in addition, the adoption of qualitative approaches. For example through ego-network analyses that complement the quantitative analysis. This shall allow considering the issues that relate to the construction, variability as well as the underlying dynamics of the social ties among teachers two years after the pilot end.

2.2 Sampling, methods and ethical considerations

2.2.1 Qualitative and quantitative sampling

The purpose of sampling is to gain access to participants who are perceived to be of theoretical interest. Both quantitative and qualitative research shares the characteristic of seeking to provide a sample which will address the research question, but each approach tends to favor those sampling methods fitting best their overall philosophy (Davies 2014).

Moreover, non-probability sampling is an often observed method in qualitative research as the researcher tends not being focused on representativeness but rather more concerned with depth of knowledge, usually from a smaller number of participants (Patterson 2013). This was also the case of the qualitative strand of this study. As the whole population (458 individuals) could not be interviewed, a criterion-based purposive sampling approach was used to identify the 45 former training participants and 13 individuals who had not taken part in the IFADEM pilot. Criterion sampling involves selecting cases that meet some predetermined criterion of importance (Patton 2001, p. 238). During the first interviews series in 2015 and 2016, the sample was composed so that there were individuals from each of the participating districts, from every participant category (teacher / tutor / Chef ZAP) and from each of the user categories (rare user / intermediate user / frequent user). For previously cited privacy reasons, and given that the interviews revealed mostly contributions in the area of practices and usages, the sample presentation focuses on their role and not the district of participants. The criterion selection for interview with the control group was the belonging to the same district as the ones concerned by IFADEM.

In the case of the social network analysis, the criterion for the selection of the 26 interviewees selected was the appurtenance to groups. At least one individual from each group which had been identified by the social network algorithm was interviewed (for sample characteristics see Table 7).

In light of the research question, no sampling criteria were chosen for the quantitative strand: The sample was hence composed of the whole population to be studied, i.e. composed of all participants. Given the retrievable in each dataset (N ranging from 425 to 458 depending on the data set; some questions had not been filled out in the in 2013 distributed 428 questionnaires).

458 individuals build the sample of individuals appearing as active in the CDRs during the training period. When considering only the direct beneficiaries of the training, the teachers, the sample is characterized by a domination of civil servants, a slight majority of women, and only a minority of BEPC holders. Individuals are mostly from the semi-rural areas Ambositra and Fandriana, less than a third from Ambatofinandrahana and Manandriana (for sample characteristics, see Table 8).

Finally, in the case of the interviews with organizing stakeholders (study 4 – chapter 8) the sampling criterion was the previous or current involvement of a stakeholder in the design, funding, organization or evaluation of pilot projects mobilizing technology in a teacher training project. Interviewees were conducted at their work station in Europe and the USA, as well as per skype. Given the low number of this type of project, and the full anonymity they were ensured, the sampling information given here provides only their role and the type of organization they work for (for sample characteristics, see Table 10).

2.2.2 Qualitative methods: Semi structured interviews and observations

The advantage of semi structured interviews is the personal and direct contact with interviewees, enhancing the flow of information and leaving room for the generation of conclusion that may not have been initially expected (Fisher et Geiselman 2010; Van Teijlingen 2014).

The conduction of the interviews were based on the prior elaboration of an interview guide, which aimed to comprehend

- teachers' everyday life (family and work context, infrastructures, daily challenges)
- the role of mobile phones in their private and professional lives
- the perceived impacts of the training feedback on the training content and organization (interviews with IFADEM participants only)
- the purpose of communication and collaboration as well as roles within the teacher network (interviews with IFADEM participants identified within the network only)
- in the case of organizational stakeholders: perceptions on pilot project success and scalability factors (interviews with organizing stakeholders only)

A majority of question was prepared, but additional questions were intuitively added throughout the interviews when the discussed subject seemed to respond to the research objectives. All interviewees were assured full anonymity, and had to be reassured that this interview was not an evaluation of remaining skills two years after the training. Interviewees

were supported by a researcher from the ENS Antananarivo who stepped in when interviewees had difficulties to respond to questions or were, mostly at the beginning, too shy to do so.

These interviews were conducted with former IFADEM participants in March 2015 and April 2016, as well as with teachers who had not taken part in the IFADEM training but lived and worked in the same schools or districts (April 2016).

All interviews were conducted at the respective school of teachers and school directors. In the case of former tutors, interviews were organized at the local school administration (CRINFP).

In some cases – depending on the availability of the teacher – the interviewees were followed or preceded by the observation of a lesson. Each lesson was observed through three lenses: infrastructure of the school, pedagogical practices, and language skills of teachers.

➤ *Coding and interpretation*

Interviews were transcribed and coded with the software NVIVO. Content analysis, which implies the categorization of data and sub-themes, was used to analyze the transcriptions. This approach was, already during the reading of the transcriptions, accompanied by a reflexive process of each of the respective research areas. This process started from the beginning of the first transcription, allowing to “*focalize progressively each interview*” (Maxwell 1999, p.140). Lessons were partially or entirely filmed, and key observations transcribed.

2.2.3 Quantitative methods: Descriptive and analytical statistics

A both confirmatory and exploratory approach was chosen for the analysis of participants' Call Detail Records. Confirmatory, as guided by the findings from the interviews: the purpose was to confirm dedicated findings as well as intuitions that emerged throughout the interviews but could not be confirmed by the qualitative approach. Exploratory, as to a large extent, the analysis was not guided by assumption of the structure underlying the dataset.

The analysis was based on two data-sets, which were merged in order to conduct a multivariate analysis. The first data set was composed of the answers of the pre- and post-pilot surveys and covered 5 thematic areas:

- socio-economic characteristics of participants (9 questions),
- participants' opinion regarding the tri-annual training meetings (6 questions),
- participants' opinion regarding the tutoring and the distance training experience (15 questions),
- participants' opinion regarding the training materials and impact on their practices in class (20 questions)
- participants' previous mobile and technology experience, their opinion regarding the use of the mobile phone during the training (17 questions).

The second data – set was composed of the Call Detail Records of each participant. Retrieved from the telecom provider Orange, the following records could be analyzed:

- Call Detail Records during the training (October and November 2012, as well as March, April, May and June 2013),
- Call Detail Records after the training (March, April, May, June, October, November and December 2014).

More precisely, the availability of these Call Detail Records allowed to retrieve each outgoing and incoming communication made and received by participants, and to differentiate between voice and SMS communication. Disposing of the telephone number of each participant, it was hence also possible to differentiate between training participant communications and communications towards non-participants. Each participant had agreed at the beginning of the training that their CDR could be used for research.

While the extraction of communications logs from the CDR was conducted with the software Python, data were analyzed using SPSS. Results were first analyzed alone and then converged with the qualitative data.

➤ *Choice of statistical tests*

Considering the on-going use of the phone for communications as a contribution, a descriptive approach was followed by the performance of inferential statistical methods.

Firstly, an enumerative approach of communications was adopted in order to describe, show and summarize the data-sets and to characterize the extent of on-going communications after the end of the training. A univariate analysis was applied, meaning that the frequency, distribution, tendency and dispersion of communications (voice or SMS, type of call partner, and work station of communicants) were analyzed; findings were informed by the findings from the qualitative study.

In order to obtain a basic picture of the interrelation of variables which had either emerged as important during the interviews or were identified during the univariate analysis, these variables were then displayed in contingency chart.

Subsequently, inferential statistics were applied in order to test the significance of association between two variables which had emerged as important via the qualitative study or as a result of the enumerative analysis. The purpose of this approach was analyzing the actual process which created these results (obtained by the qualitative / enumerative analysis which had led to the emergence of intuitions) and to infer factors that favor these contributions.

More precisely, willing to explain the effect of variables on the outcome variable representing the contribution ‘development of sustainable phone usage’, a dichotomous outcome variable (‘uses the phone’/ ‘no longer uses the phone’) was created.

Intuitions had to be verified by the performance of Chi-square tests. Pearson’s Chi-square test is the most commonly used type of Chi-square significance test. When wanting to know if “*frequency of cases possessing some quality varies among levels of a given factor or among combinations of levels of two or more factors*” a Chi-square test is appropriate (Preacher, 2001). The main goal of a Chi-square test is to show whether there are significant differences between the populations being tested (Gravetter et Wallnau 2009).

In this case, Chi-square tests were used to determine if there were significant differences (among those within the category ‘uses the phone’/ ‘no longer uses the phone’) between

- variables representing individual characteristics
 - gender (male or female participants)
 - degree (BEPC / Above BEPC)
- variables representing infrastructural characteristics
 - school district (Ambositra / Fandriana / Ambatofinandrahana / Manandriana)
 - familiarity with mobile phones at the beginning of the training (yes / no)
 - access to electricity (yes / no)
 - Network satisfaction during the training (satisfied / unsatisfied)
- variables representing training related attributes
 - phone user category during the training (rare / intermediate / frequent user)
 - degree of quiz participation during the training (rare / intermediate / frequent)
 - communications towards other training peers (transformation of the continuous variable into a dichotomous variable after identification of a threshold: Below / beyond 2h45)
 - calls towards a tutor during the training (transformation of the continuous variable into a dichotomous variable after identification of a threshold: Below / beyond 8,3 minutes)
 - role during the training (teacher / tutor)
 - attributed training wave (1 / 2 / 3)
 - type of model (basic / feature phone)

The performance of Chi-square tests provides multiple values, among which two are particularly important indicators: Phi ('p-value') and Cramer's V. The p-value allows

identifying *if* there is statistically significant association of variables. Starting from the null-hypothesis that there is no association, a p-value close to 0 suggests that there is a statistically significant difference and that the tested variables are associated. A p-value of above 0.05 indicates that the null hypothesis of independence has to be accepted (Dorey 2010).

Provided the association is significant, a look at Cramer's V is useful as it allows comparing the *strength* of this association: Cramer's V equals 0 when there is no relationship between the two variables, and generally has a maximum value of 1, regardless of the dimension of the table or the sample size. In social science research, the following classification is commonly used:

- a *weak relationship* is present if Cramer's V is less than plus or minus 0.10
- a *moderate relationship* is present if Cramer's V is between plus or minus 0.10 and 0.25
- a *strong relationship* is present if Cramer's V is greater than plus or minus 0.25

In order to model the relationships between those variables which had been identified to be significantly associated with the outcome variable (ongoing phone usage) were then analyzed, and to ascertain the effects of the respective modalities on the outcome variable, binomial logistic regressions were performed in an 'iterative' manner. First, the odd ratios of predictive variables were considered respectively. Then a model was created that allowed identifying those factors that, all things being equal, are key for the contributions, meaning continuous usage of the phone.

Finally, in order to represent and confirm visually the previous findings, both multiple correspondence analysis and an inferential statistics decision tree were performed.

- Multi correspondence analysis is a multivariate technique useful when analyzing complex, multiple and diverse variables. It allows "*showing if a relationship exists and how variables are related, and offering statistical results that can be seen both analytically and visually*" (Costa et al. 2013). Practically, the outcome from correspondence analysis is a graphical display of the rows and columns of a contingency table that is designed to permit visualization of the salient relationships among the variable responses in a low-dimensional space. Such a representation reveals a more global picture of the relationships among row-column pairs which

would otherwise not be detected through a pairwise analysis (Sourial et al. 2010). In this study, the MCA allows for the confirmation of findings obtained both during the qualitative study as well as the hitherto performed statistical tests.

- Inferential statistics classification tree analysis is part of the ‘decision tree’ methodology, developed in the 1960 and popularized by Breiman (1996). It is frequently used in data analysis and allows for establishing classification systems based on multiple covariates or for developing prediction algorithms for a target variable. More precisely, they can be used to predict a quantitative variable (performance of a ‘regression tree’) or a qualitative variable (‘inferential classification tree’) using either a quantitative or qualitative predictor variable. This method classifies a population into branch-like segments that construct an inverted tree with a root node, internal nodes, and leaf nodes (Song et Lu 2015). In a first step, the sample is divided in two through the use of one of the predictors $x^1, x^2 \dots x^P$. This step is reiterated for every generated subset. As exposed by Saporta (2011), this type of method corresponds to a descending classification with predictive purpose operating by selection with variables: each class must be the most homogeneous possible with respect to y . The division of subsets is made so that each new class will come along with on average improved homogeneity (Saporta 2011, p.488).

In the case of this study, an inferential decision tree was not used to identify predictor variables – this type of approach would have been interesting in the case of larger sample – but to represent visually the association and the underlying process of variables. The performance was conducted with the open source software *R* and with technical support from Mehdi Khaneboubi, senior lecturer at the University of Cergy-Pontoise. The later presented tree is the result of the CHAID function, which uses a Chi-square test in order to evaluate the validity of a dedicated variable in the segmentation.

2.2.4 Social network analysis methods

The analysis of peer to peer communications, and interviewee’s declaration indicated the presence of a network of former IFADEM participants. The networks’ nature and processes

needed to be analyzed in a social network approach combining a pluralistic methodology. As social network analysis remains a rare field in mixed methods research on teacher training, a detailed presentation of the here applied methods will be provided. The underlying concepts of social network methods are indeed indispensable for the comprehension of the study results (chapter 7).

➤ *Analysis of structures, patterns and processes of the network*

As commonly accepted in social network research, the following terms will be used synonymously: Graph and network; Node and actor; Tie and relationship (Stegbauer et Häussling 2010).

Social networks are visualized through matrices and graphs. While matrices are mostly used in order to enable calculations, we focus here on display characteristics of graphs, a common visualization tool of networks. Three visual aspects of a network are to be considered for a network analysis. Networks are composed of nodes, which can be qualified as actors, organizations or events. The second visual aspect is the quality of the relationship in between these nodes, e.g. their symmetry. The characteristics of the whole network structure are another visual aspect that can be analyzed: It enables, for example, the analysis of a density of a network (Adler, Grümayer et Schmidt 2010).

The network analysis, whose theoretical framework has been exposed earlier in this chapter, was conducted in three steps: First, a step focusing on the structure of the network, a second step looking at processes and dynamics, and as a third step, the conduction of interviews including an ego-network approach in form of interviews with network members.

Gephi, open source software for social network visualization was chosen for the visualization and analysis of the former IFADEM participants' network. The most comprehensive presentation can be found on the dedicated website:

“Gephi is a tool for data analysts and scientists keen to explore and understand graphs. Like Photoshop™ but for graph data, the user interacts with the representation; manipulate the structures, shapes and colors to reveal hidden patterns. The goal is to help data analysts to make hypothesis, intuitively discover patterns,

isolate structure singularities or faults during data sourcing. It is a complementary tool to traditional statistics.”

(<https://gephi.org/features/>)

The possibility to retrieve the Call Detail Records which cover the period after the pilot ended, allowed retrieving for each still ‘active’ participant the number of call to former training members. Here, the software python was used to extract, for each former training participant, all call partners who had also taken part in the training. A dataset composed of nodes (each individual) and their respective nodes (call partners) was then created with the open software R, and uploaded to Gephi. Various functions were then used in order to generate graphs whose visual specificities allow interpreting the structure. The concept and purpose of each function are detailed (Annex 1).

Group research is an important part of social network analysis. Looking only at the group as a single structure allows identifying social mechanism on which the group is based and through which it sustains. Additional interest in group research lies in the potential of generalization: Group and sub-group analysis allows gaining a better understanding of the whole network. Täube explains this bottom-up approach, which considers that social organizations are formed of hierarchical groups. The superior groups are the result of the tendency of the expansion of inferior groups. For those who want to understand the often complex social structure of the network as a whole, this concept recommends studying small groups and their structure (Täube 2010; Hanneman et Riddle 2005a). According to Granovetter, studying sub-groups allows also to qualify the network, and its strength, through the analysis of aspects like the duration, intensity of ties, as well as their purpose, e.g. exchange of services (Granovetter 1973).

In contrast to this bottom-up approach, there is also a top down approach to network analysis, which was adopted in the case of this study. Looking first at the network as a whole and identify then substructures that are denser than the whole network allows identifying what Hanneman calls weak spots or vulnerabilities: This approach allows to “*think of dynamics that operate at the level of group-selection, and to focus on the constraints under which actors construct networks*” (Hanneman et Riddle 2005b, p.170).

➤ *Qualification of ties: Qualitative interview series including an ego network analysis*

The analysis of the network as generated by Gephi was combined with a qualitative approach, a so called ego-network analysis based on interviews with network members. The purpose of the latter was to provide in depth explanations for the patterns and dynamics highlighted in the graphs. Each participant of the ego network consulted a list with names of their group respective network group in order qualify their ties by using three instruments inherent to ego-network analysis: *Name generators*, *name interpreter* and *density questions*.

- *Name generators*: Individuals were asked who of these group members they know and if there were other training participants that should be on the list. If so, these were added.
- *Name interpreter*: Individual were asked to indicate
 - since when (prior to the training or since the training) they know the indicated individuals,
 - whom they would consider as colleague and whom as a friend,
 - whom they identify as having occupied the position of leaders during the training.
- *Density questions*: Questions concerning the relationships in-between the contacts.

Individuals were asked to talk in detail about their experience with other group members during the training sessions, the type of interactions in-between the indicated training participants and to which extent these relationships have evolved since the end of the training. The questions were structured according to the themes

- teacher collaboration,
- leadership characteristics,
- expected characteristics of tutors,
- mostly used phone functions and

- perceived impacts of the training experience in general.

As indicated in the sampling method, interviewees for the ego-network analysis were selected among two pre-established list of former participants.

- A list of individuals with a high degree centrality (high number of connections) and
- a list of individuals who, according to the call detail record analysis, were not using the phone anymore.

Interviews were conducted at the central administration of Ambositra and each interviewee received an indemnity to cover the fees they had to advance for the transportation to the interview location. The interviews were conducted in French and when needed translated by a Lolona Rakotovo, a researcher with experience in mobile teacher training from the *Ecole Normale Supérieure* (ENS) of Antananarivo.

➤ *Interpretation of the ego-network interviews*

Later on, the Qualitative Data Analysis (QDA) Software NVivo was chosen in order to interpret the interviews. As for the previous qualitative study, the reading of the interview transcript was accompanied by reflexive coding for each of the respective research areas. This process started from the beginning of the first transcription, which allows to “*focalize progressively each interview*” (Maxwell 1999, p.140).

With regards to the ego-network interviews, the following approach was chosen: Each qualified tie was scored, in order to assess the main nature of ties within each group. For example, a former IFADEM participant who is – according to the by Gephi generated social network – part of a group composed of seven other people had the possibility to reach up to

- 7 out of 7 *former colleague scores*
- 7 out of 7 *friendship scores* indicating the number of individuals of the group they are friends with (independently if they knew each other from before or met during the training)

- 7 out of 7 *new colleague* scores: All ties which had not been marked as relationships which had found their origin already before the training started were considered as ‘new colleague’.

Despite the lack of ‘scores’ for every group member, these selected ego-network interviews with at least two members from each group allowed identifying to which extent group building and cohesion can be explained by factors as for example the training experience, long existing relationships, and to which extent these types of relationships influence the contributions from which network members benefit.

2.2.5 Ethical considerations

The access to call detail records was certainly a rare and rich source of information, but subject to certain ethical issues: While CDRs analysis is increasingly seen as potential for research in developing countries, e.g. in order to gain insights into detailed behavioral and geo-demographic patterns that are currently unobtainable in most of the developing world, their access raises indeed ethical and privacy concerns. The GSMA is critical to supporting the ethical use of mobile phone data in emerging economies for numerous reasons, the strongest being the lack of personal data legislation in these economies (Centre for International Analytics 2016). Indeed, it was this lack of legislation that, after the agreement of participants in the first place that their communications could be exploited for research purposes, made it possible to retrieve the Call Detail Records: This allowed to conduct a highly information rich mixed method social network analysis. Ironically, shortly after the end of the analysis of the data-sets, in July 2016, Madagascar adopted its first law on data protection (Association Francophone des Autorités de Protection des Données Personnelles 2015; *Loi N°2016-029 - portant code de la communication médiatisée, séance du 13 et 14 Juillet 2016*)

Conscious of the exceptional and sensitive character of these data and anxious to respect the participants of the study, every effort was made to respect their privacy when presenting the conclusions of the analysis. Systematically, each interviewee was guaranteed full anonymity in the output of this research. This explains also why interview transcripts were anonymized a posteriori, and the video recordings of the lessons not disclosed. Moreover, while the findings mention the different districts, differences at the micro-local level (villages) have not been

presented; given the small number of participants in some villages, this would have meant lifting their anonymity.

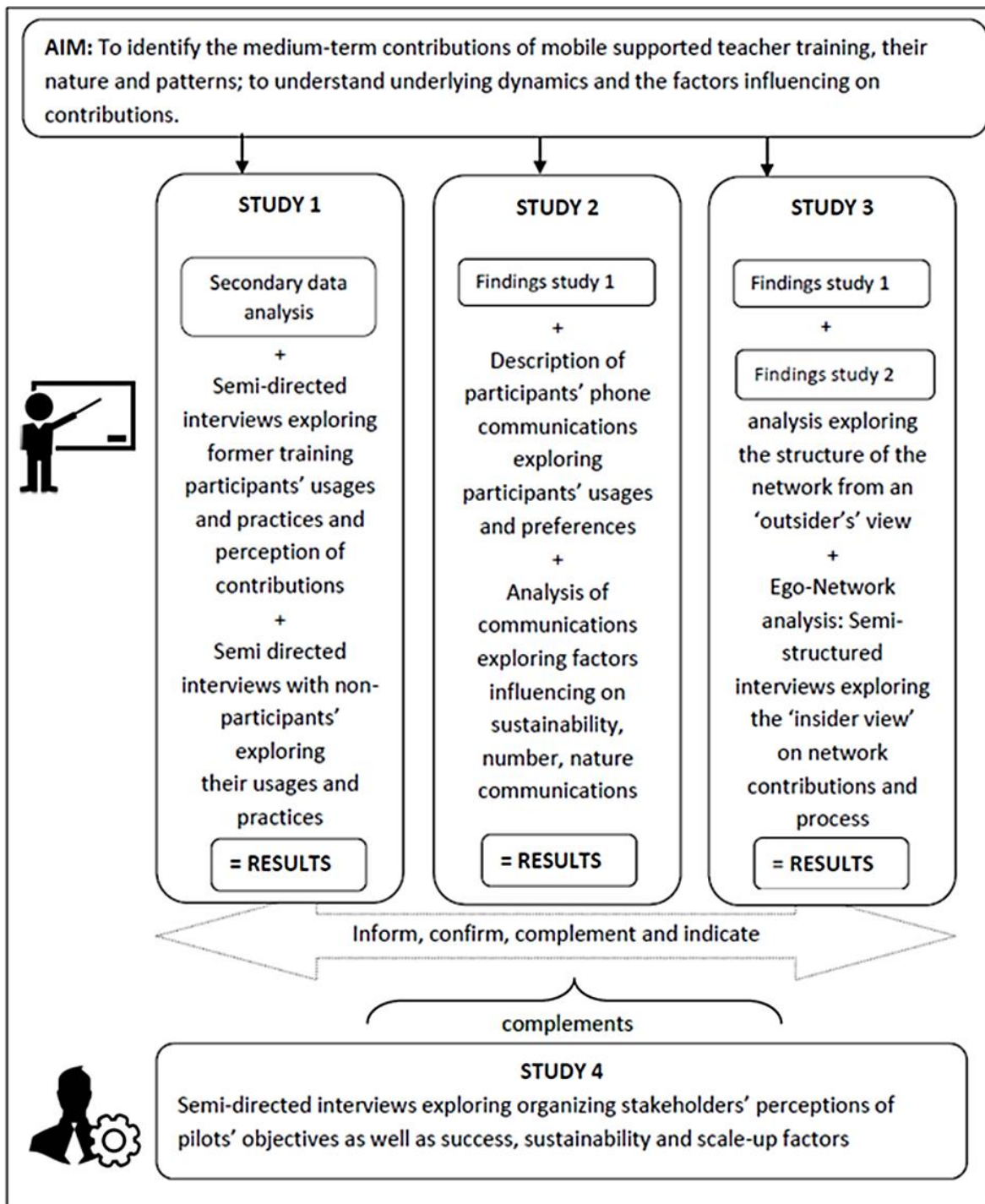
2.3 Research process – 4 studies

A traditional sequential design would either be explanatory – use of a qualitative strand to explain initial quantitative results – or exploratory – use of a quantitative strand to test and generalize initial qualitative results (Creswell & Plano Clark, 2011, p. 71).

The dissertation employs a design which includes both exploratory and explanatory phases: Starting with an exploratory phase, the findings on declared and observed contributions of the training, led to the finding that a statistical analysis of participants' CDR would be useful. The qualitative finding allowed to structure the analysis of these statistical analyses, and also informed it. Subsequently, both the findings from the first qualitative study and the findings from the statistical analysis allowed comprehending the origins of contributions. They allowed also understanding how they relate to an appropriation process which seems to be the key factor of sustaining contributions. Given that teacher collaboration figured among the key contributions of the training, it was decided to conduct a social network analysis. The latter used both qualitative and quantitative methods and its result complemented and informed further the previous studies.

Finally, these three studies were put in juxtaposition with the qualitative analysis of stakeholders' perception on contributions and success factors of training pilots, allowing in the meantime to combine the micro-level findings from one, specific pilot with a broader, more generalist perspective (Figure 28).

Figure 28: Mixed-Method design process



2.3.1 Study 1: Exploratory identification of declared and observed contributions

After the consultation of the pilots' website and the evaluation reports, it was decided that semi-structured interview would be an appropriate tool in in this phase, combined with, when teachers were available, class observations. A total of 58 interviewed individuals provide the key research ground of this study (Table 7).

Table 7: Roles of interviewed participants / control group (teacher, school principal, former tutor or Chef ZAP); N=58

Date of interview	Teachers	School principals	Former tutor	Chef ZAP	Total
March 2015	7	5	6	1	19
April 2016 (control group)	10	3	x	x	13
January & April 2017	10	6	3	7	26

While the study allowed to identify only traces of the goals (improvement of pedagogical practices and French skills) because of obstacles interrupting the consolidation of an appropriation process. In contrast, the study could identify among former participants a wide range of non-prescribed contributions of the IFADEM training.

A majority of these contributions involved the ongoing use of the mobile phone, at users' own expense, and are situated in both the private and work (administration / pedagogy) sphere of former trainees. The study identifies strong embeddedness of the phone in daily communication processes and indicates the presence of ongoing, mobile supported connections between former participants.

Reportedly, the appropriation process of the phone becomes visible through the consolidation and development of new mobile supported practices, embedded and influenced by the life and work context of individuals. The appropriation process is driven by intrinsic motivation and contributions fulfill the need of knowledge acquisition, relatedness and autonomy in the sense of higher independence.

The study indicates a need to analyze further mobile supported usages like communications through a quantitative approach (study 2), as well as the patterns and processes pertaining to reported ongoing collaboration through a social network approach (study 3).

2.3.2 Study 2: Identification of communication preferences and factors affecting sustainable phone usage

Among the key findings of the qualitative study figured the socially embedded role of the phone in the life of former trainees as well as mobile supported ties among those who had participated in the training. Hence, it appeared indispensable to analyze users' Call Detail Records. This allowed extending the studied number of individuals to the whole population of the training, as communications made by all training participants could be counted and analyzed (Table 8).

Table 8: Socio-economic characteristics of the population (quantitative sample)

N	435	
Civil Servants	75 %	
Men / Women	44%	56%
Average age	50 – 55	
BEPC / Baccalaureate holders	84%	10%
% of individuals from Ambositra and Fandriana	77%	
% of participants from Ambatofinandrahana and Manandriana	23%	

The study allowed confirming and refining the findings of study 1 and permitted to identify further contributions of the teacher training IFADEM. The mobilization of descriptive and analytical statistics revealed that almost 50% of former trainees continue to use the phone at their own expense. These individuals are mostly from areas which are known for a fairly satisfying access to mobile network coverage. They are among those who had been highly engaged during the training period. It could also be confirmed that mobile and distance communication is a well embedded contribution within former participants' life; SMS and voice communications are not random choices but are influenced by the context and purpose of communication, reflecting another side of the appropriation of the phone. Subsequently the use of analytical statistics allowed identifying the key factors that influence on the appropriation process and ultimately the chance of participant's to figure among those who develop sustaining usages. An inextricably related, two-step process as combined key-condition for sustainability could be identified: All things being equal, individuals having access to a

satisfying network coverage have high chances to develop continuous phone usages because they can exploit the on network depending phone functions and experience the training phase in a positive and constructive manner: i.e. connect with trainees and tutors, take part in the quiz. The network coverage is a pre-requisite for rich appropriation of the phone. The training period acted like an intensive 'kick-off' phase during which they discovered together, in a collective and connecting experience with other trainees, the benefits of appropriating the phone for private and professional usages. After nine months this appropriation process is strong enough to overcome obstacles like costs. As indicated by the qualitative study, the motivation to fulfill needs related to knowledge acquisition, relatedness and autonomy is for a large number of individuals a driver behind mobile supported communications.

The study revealed that a limited proportion of individuals distinguish themselves from the others by particularly regular mobile contact with former peers, adding up to the findings from the qualitative study which had indicated the sustainability of mobile supported collaboration among former participants. Considering this a key finding, it was decided to conduct a social network analysis of these connections (study 3).

2.3.3 Study 3: A Social network analysis of former IFADEM trainees

The qualitative study had, amongst others, allowed to inform the quantitative analysis of former training participants' Call Detail Records, and the quantitative study complemented the findings on declared contributions by adopting a communications focused perspective.

It led to the confirmation and identification of contributions in both professional and private sphere, as well as the identification of underlying factors through statistical methods. Finally, both studies indicated a strong rationale to conduct a social network analysis, in order to research one of the key contributions of the pilot: mobile phone supported connections among former IFADEM trainees. It was hence decided to analyze all those who happened to be still in contact by phone with a former training member.

Table 9: Sample characteristics of individuals studied in the network analysis

N	185	
Civil Servants	100%	
Men / Women	38%	61%
Average age	50 – 55	
BEPC / Baccalaureate holders	86%	11%
% of individuals from Ambositra and Fandriana	96%	
% of participants from Ambatofinandrahana and Manandriana	4%	

While the previous studies could ascertain their existence, and interpret their intensities, the social network study allowed comprehending the structure and processes within these connections. More precisely, through the analysis the structure as a whole, followed by a qualification of ties through an ego-network approach, it was possible to identify a stable, well connected network of former trainees; both structures and processes indicate the presence of a organized network conducive to innovation and collaboration. The structure analysis confirms the findings of the previous studies: telephone network coverage is a pre-requisite and influences network membership, group building and roles within this network of former participants. The social network analysis confirmed also the influence of the training experience on roles among the network of former participants. The collaborative character and the overall sustainability of the network is found to lean on key actors who directly contribute through professional and personal attributes to its functioning and purpose, i.e. by ensuring efficient information flow and by encouraging innovation. By ascertaining the genesis of a social collaborative community and through the analysis of members' motivations to be part of this network in the first place, the social network study allows to adopt a different perspective on the appropriation process initiated during the training and factors for sustaining contributions.

2.3.4 Study 4: The perceptions of organizing stakeholders on success, sustainability and scale-up factors

The first three studies of this dissertation have approached the question of medium-term contributions of mobile supported teacher training through a lens that focused on concrete practices among former participants, notably teachers, and the underlying appropriation process over time. The identification of progressively evolving contributions has shown the utility of adopting a longitudinal perspective on contributions. The richness and wide range of identified contributions reinforces the impression that the short-term approach of pilot projects is indeed problematic and too restrictive. This finding led to the decision to conduct a shift in perspective, and to approach the question of sustaining contributions and underlying factors through the eyes of organizing stakeholders, i.e. those who fund, organize and evaluate mobile teacher training (Table 10).

Table 10: Roles of interviewed project stakeholders (N=16)

Type of organization	N=16	Role / Job title
International Organization	6	Project assistant, chief project manager, programme director, Head of unit
Private Sector	2	Chief researcher, Department director
Ministry (in the project country)	3	Chief of department, Project coordinator (2)
Non-Profit-Organization (NPO)	3	Project manager, Chief project manager, Deputy director
Self-Employed	2	Consultant

The interviewees with these stakeholders focused on their perceptions of success, sustainability and scale-up factors, and their expected contributions of (mobile) pilot projects.

The study revealed that the interviewed stakeholders perceived themselves as actors with a limited power of influence and as part of a '*competitive project pilot business*', exploited for political reasons and hence accompanied by timely, organizational and financial constraints. The perceived pressure and tensions seemed to be directly related to their perception of success and desirable outcomes. These appear to be located not on the micro-level among

project beneficiaries, but rather at the project partner level in the field (e.g. partner ministry): project strategies are not only influenced, but directed towards partner institutions.

Ultimately, these institutions are perceived both as goal and possible threat; their instability increases short-term vocation of pilots. Human and financial resources appear unavailable for the medium-term as the medium-term does not correspond to a demand and medium-term contributions are not rapidly marketable. Stakeholders' descriptions of these tensions reveals further the presence of a double discourse: There is confrontation of a 'desirable' discourse composed of what Leal (2007) describes as development policy buzzwords, colliding a predominant, practical and technical oriented discourse concerned of project dictated imperative. Both discourses appear genuine, but the lower moral value of the second explains why it comes along with the first.

The four studies combined allow for a better understanding of the nature of contributions pertaining to mobile teacher training and the factors influencing these contributions. These factors are of infrastructural nature, take place during the appropriation process but also seem to be external, i.e. in from of external constraints.

PART III

Study Results

Chapter 5 – Study 1: *Looking for traces*: Reported and observed contributions of a mobile teacher training pilot

The first chapter of this dissertation has shown that in light of the challenge of recruiting an increasing number of teachers, combined with the challenge of finding a way to provide new and in-service teachers of all statuses with core competences, mobile supported training models increasingly appear as interesting and realistic solution. However, as exposed in the second chapter, the high number of research on expected educational benefits contrast with the lack of concrete evidence in Sub-Saharan Africa. Willing to identify and analyze the contributions of mobile supported teacher training on the medium – term, and to adopt a longitudinal and pluralist perspective on these contributions, a qualitative study was implemented. The IFADEM mobile teacher training provided the case to be analyzed. After the end of the pilot in June 2013, no-follow up or any kind of return to the field was organized, and no analysis on ongoing, new usages or contributions of the training conducted. Locally, there was neither a team officially in charge of the pilot, but through some key contacts obtained through Orange; contacts with former organizing stakeholders at the AUF (Agence Universitaire de la Francophonie) and Orange Madagascar in Antananarivo could be established, who in turn set up the interviews in the field.

As exposed in the methodological framework of this study both interviews and observations conducted in order to identify contributions such as perceived by or observed among former training participants.

➤ *Methodological implementation process*

The first field visit and interviews were conducted in April 2015 organized with an exploratory approach: The objective of this first round was to identify if and in which sphere (professional or private) of former trainees the training may have led to sustainable contributions. This visit was followed by three subsequently organized missions in March 2016 as well as January and April 2017. Each interview was conducted using the same interview guide, which allowed not only to progressively increase the size of the sample but

also to refine progressively the focus of the interviews in accordance with the research question: the identification of contributions and their underlying dynamics.

Firstly, it shall be noted that even though preponderance of ideas and concepts are in the following quantified with regards to the recurrence within interviews, the main objective of this study was to shed light on declared contributions and usages via qualitative approach.

Table 11: Interview sample characteristics – Role (teacher, school principal, former tutor or ChefZAP)

Month of interview	Teachers	School principals	Former tutor	Chef ZAP
March 2015	7	5	6	1
April 2016 (control group)	10	3	x	x
2017	10	6	3	7
Total	17	11	9	8

The youngest interviewed had around 8 years of service while the most senior teacher had been served for 38 years. Among IFADEM participants, besides the pedagogical days organized by the schools during holidays, only 3 teachers declare that they have participated in training delivered by the *Alliance Française* on French pronunciation and how to teach French. In contrast, former tutors – pedagogic councillor – had, as expected, higher qualifications: All were at least in possessions of a *maîtrise*, equivalent to a first year of two years master degree.

The control group had similar qualifications, but interestingly they were more trained than the IFADEM group, mentioning provided either by the ministry and external stakeholders. These training initiatives focused on language or mathematical pedagogic practices and implemented by the Ministry of Education and or international organisations: *MAPEF* training Ministry of Education); la ‘*mallette* – (Mathematics, Ministry of Education - UNESCO); not to be confounded with another project with the same name ‘la Mallette – (French, Ministry of Education, French Development Agency); ‘*échantillon pédagogique*’ (SOS Child Village and UNESCO), self-paid training at the Alliance Française.

All IFADEM interviewees were civil servants; among the 17 individuals from the control group, 2 were FRAM teachers.

In order to encourage interviewees to speak freely and not feeling evaluated, they were ensured full anonymity, a part from their school district and function in the school. All agreed that their interviews would be recorded.

1. Limited achievement and sustainability of project goals: Lack of comprehension, support and motivation

1.1 French skills: Higher motivation, but contrasting declarations and observations when it comes to the actual improvements

As exposed earlier in the project description (Chapter 1), the improvement of French skills was jointly with the improvement of pedagogical practices the main goal of the IFADEM project. However, no baseline tests were conducted with the IFADEM participants in order to evaluate their initial French skills at the beginning of the pilot. During the process of preparation of these interviews, this absence of development of a progress indicator – which could potentially allowed to measure progress over time, during and after the pilot – appeared fairly surprising as it was subsequently difficult for evaluators in 2013 to assess to which extent one of the two aimed for contributions had been achieved. The literature review raises the question if the short-term approach of pilots may be possible explanation for this absence in case of the IFADEM pilot, or if these tests had even be ‘voluntarily forgotten’, indicates the underlying, ‘hidden’ presence of other pilot goals? This type of hypothesis were later formulated and analyzed in another qualitative study, whose results are exposed in chapter 8.

In their final evaluation from 2013, the lack of baseline tests meant that evaluators had to rely on self-reported estimations during the surveys, as well as on their observations when interviewing participants after the end of the pilot.

In their 2013 evaluation report, evaluators found “*suspicious*” the extreme high rate of participants who had indicated in the questionnaire that the training had contributed significantly to their French skills (Le Quentrec et Gire 2013, p. 153). Evaluators suggested a bias of social desirability. The following proportions were hence considered with caution: Almost all interviewees indicated that they would teach more often in French than before the IFADEM training, and besides a few exceptions, all indicated that they improved their overall

French pronunciation thanks to the audio-files; all reportedly improved their capacity to pronounce sounds in French that do not exist in Malagasy.

The external evaluation of 2013 suggests that the contributions of the training on French skills were exaggerated. It ascertained that participants' French skills remain low: They observed that the majority of observed tutored meetings are held in French, and that many tutors had difficulties when organizing written activities. According to this external evaluation, tutors had still not the minimum level (B2) required for teacher training.¹⁵ When it comes to teachers' skills, they ascertain that a large majority of teachers had decided to answer the survey questions, written in both French and Malagasy, in Malagasy. This was interpreted as a sign that teachers' were still not comfortable with writing French.

When, as part of this dissertation, interviews were organized respectively 2, 3 and 4 years after the pilot, the impression of a gap existing between the indicated level in the questionnaires and the actual contribution in the area of French skills was reiterated.

Interviewees were asked which kind of impact they could observe since the project. It was deliberately avoided to ask directly a French-skills related question in order to increase the chance that teachers would identify the most important impact for them, instead of referring to the impact they had identified as project goal or perceive as desirable. All responded that they "*have the impression*" that they speak better French. Interestingly, when asked to elaborate further, interviewees referred mostly to the acquisition of "*self-confidence*" and "*higher motivation*" than to knowledge or skills acquisition. Moreover, they also refer more often to emotions, e.g. their existing "*fear*" of speaking French during the lesson, and how the training had helped them to reduce it. Similarly, when former tutors were interviewed these indicate also that have observed "*higher motivation*" among these teachers after the training. Again, improvement of actual *skills* (pedagogical practices, French) is not evocated as observed impact. As shown in the following quote, motivation is cited first, before adding – suggested by the interviewer? – that actual French skills had improved, too.

EvLC: *What did impress you most during the training?*

¹⁵ Defined by the Common European Framework of Reference for Languages (<https://www.coe.in>)

Tutor: *The motivation of teachers. Now they dare to express themselves during the French lesson, this wasn't the case before.*

EvLC: *Do you mean, their French skills improved or that psychologically, they have higher self-confidence speaking French?*

Tutor: *I'd say...both.*

Assuming that there is some progress, and that the training has contributed to improved French skills, the post-pilot interviews indicate that this French level remains very low: The majority of interviewed teachers needed a translator to assist them during the interviews, both for translating answers and translate or clarify questions. No spontaneous talk was possible, teachers had significant difficulties to compose entire sentences or use the past tense. Verbs were often not conjugated. The following example allows a good comprehension of the level of practically all interviewees.

EvLC: *What did change for you, which impacts do you observe since IFADEM?*

Teacher: *In class. Me, explain in French, and the students understand.*

These low skills, even after the training, were indirectly confirmed by interviewees themselves when asked for their opinion on the training: Both teachers and former tutors declared that the level of French in the workbooks itself was far “*too complex*” for them and their colleagues, and that the training period was “*too short*” to make significant progress in French.

Finally, the observation of lessons could confirm the impressions from the interviews and the by interviewees reported difficulties: During the lessons, teachers were using very short and simply structured sentences (subject-verb-complement), mostly already written on their notes or in the workbook they used. Questions were formulated also in a similar simple manner, and students had to answer often only by a single word, e.g. *yes* or *no*. No ‘spontaneous’ talk, exchange or group discussion could be identified. Overall, the observation of these lessons created the impression that, 2 years after the training, teachers were avoiding practices that implied the use of more sophisticated language skills, which they don’t have.

The impression that the pilot contributed only in limited manner to the improvement of French skills was reiterated when lessons of the control group were observed: between them and the IFADEM interviewees, no difference could be ascertained.

A possible explanation for this limited improvement is indirectly provided by interviewees when they expose what they particularly appreciated during the training. All referred systematically to the audio-files, and how much they appreciated it for its potential of improving their French pronunciation. As they were enthusiast about the files, they explained that they regretted the limited number of files on their phones. It appeared indeed that the limited number of audio-content and the impossibility to download or share new contents ultimately created some lassitude and lower usage of the progressively very well-known files. In light of their positive experience with the audio-files, and the development of various usages of the audio files – exposed in the subsequent sections – it seems that potential of phone for French skills improvement was somewhat underexploited.

With other words, the interview created the impression that the existing contrast between the actual French skills of interviewees and their enthusiasm for the audio-files incarnates a missed opportunity: Provided that the phone had been used differently, and with a long – term perspective (i.e. possibility to renew audio-files), it seems that ‘improved French skills’ could have figured among contributions. Given that this is a hypothetical assumption, the qualitative study could not conclude that the pilot had contributed to better French skills among former participants, be it on the short or medium-term.

1.2 Pedagogical practices: traces of IFADEM practices, exploration of new usages

Besides the improvement of French skills, the IFADEM project sought to improve teachers’ pedagogical practices when organizing their lessons. The evaluation attempted identifying the impact of the training on practices through theoretical assessment organized during the last training wave, followed by a practical examination in form of & observed lesson a few weeks after the end of the training. 433 participants (tutors excluded) took part in the theoretical tests and 429 in the practical assessments. For each assessment, teachers could obtain up to 50 points. At least 50 points out of the total 100 had to be obtained in order to pass the tests. Only 9% (41 individuals) failed.

As for the self-estimation of progress in French skills, the answers of the questionnaire dealing with the impact on pedagogical practices seem to indicate a very – exaggerated? – positive impact estimation: Basically all participants indicated that they ‘apply now IFADEM methods’, have acquired ‘improved language teaching skills’ and now ‘know which activities to organize in order encourage students to speak more during the French lessons’. Equally high were the proportions of teachers indicating that they have acquired the skills to ‘conduct oral comprehension and reading activities in class’ and had now the ‘skills necessary to prepare a lesson or help students who find themselves blocked during an exercise’. In contrast, and similar to what could be observed in the case of French skills, the external pilot evaluation of 2013, conducted by academic experts, concluded that there were limited contributions of the pilot in this regard: According to their report, all observed teachers “*tried to follow the steps of the lesson*” as they had been taught during the training but “*sometimes without mastering the objectives*” (Lethuillier, Jaillet, et Jarousse 2013, p. 32). The evaluation ascertains further that teachers used, as learned during the training, didactic training materials like posters during the lesson. However, given that the elaboration of these materials was found to be of highly demanding and time consuming for teachers, evaluators expected that “*these efforts won’t last if the purpose and usage of didactic materials doesn’t continue to be enhanced...*” (ibid, p. 32). They add that even though “*there was appropriation of the methods during the training [...] the issues related to the work books, which are not adapted to teachers’ skills, do not allow to guarantee that there will be a stabilized appropriation of learned pedagogical practices* (ibid, p.38). In a certain way, the external evaluators appeared to conclude that the design of the pilot did jeopardize itself, by chosen an approach and materials which made it ultimately difficult to contribute to the project goal.

1.2.1 Pedagogical contributions appear to be exceptional and difficult to sustain

Once again, the interviews conducted during the fieldwork research for this dissertation confirmed the contrast between in the questionnaires declared and observed practices and ascertain a limited appropriation of the pedagogy taught during the training.

Interviewees were asked if they had noticed changes and contributions among their teaching practices since the IFADEM training, and if yes, of which kind. Almost all respond affirmatively, declaring that their teaching practices are now based “on those pedagogical

principles that have been taught during the training” by tutors and in the workbooks, the concept of the pedagogy was not exposed. When asked to describe how their IFADEM oriented practices differ from previous practices, interviewees referred to the characteristics of these practices, as well as to consequences. They explain that the now employed pedagogy is more “concrete”, “clear” and would lead to more participation among students:

EvLC: *Which type of evolutions [do you observe since the IFADEM training]?*

Teacher: *More concrete...the methods. The approaches with steps – very clear. Before there was only recitation. After the training, it becomes more concrete.*

Spontaneously, interviewees add that the IFADEM project experience contributes to the preparation and organization of their lessons. They explain that they have learned to set up a lesson in accordance with a previously prepared lesson plan, containing the different pedagogical steps of a lesson (e.g. how to organize a grammar rule during a French class):

EvLC: *Do you think that IFADEM had some impacts on you, the teachers?*

Teacher: *Because (...) we have seen the steps to follow in order to teach the sub-disciplines... it's easier for the teachers.*

Interviewees seem to associate ‘concrete’ with the learned pedagogy because of the didactic materials that the pedagogy recommends to use.

Picture 1: Example of didactic material used by a former IFADEM participant



Source: April 2015, district of Ambositra: A former IFADEM participant sitting next to the material she bought and prepared for the lesson on hygiene: A poster with activities related to hygiene, and products like a towel and a scrub (on the table)

Cited and during lessons observed materials were very mostly posters on which the teacher had drawn images to explain the content of a lesson. Pupils had to describe the figures or sentences on that poster, e.g. the different activities that are related to the subject ‘hygiene’ (Picture 1). In some cases, teacher brought materials, e.g. toothbrushes to illustrate a French lesson on hygiene activities.

While teachers declared on one hand that they were convinced about the utility of these materials, several declarations seem also to confirm the concerns expressed by the final evaluators: Interviewees explained that the production of materials was too expensive for them, complained about the lack of financial support for their preparation and how this altered their motivation to use this type of material.

In one case, a teacher who due to organizational issues could finally not be observed, declared after the interview how disappointed she was as she “*just had bought the materials for the IFADEM class!*”, and then indirectly asked for a reimbursement of the materials she seem to have bought for the observers. This type of situation reinforced the progressively emerging

impression to assist to class observations forecasting ‘exceptional’ practices which were not representative for their usual pedagogical approaches. In a certain way, it may be suggested that financial constraints, amongst others, may hinder the development of sustainable, pedagogical contributions of the pilot. From a broader perspective, this could once again be symptomatic for a short-term oriented pilot, not designed for the development of realistic, sustainable practices.

1.2.2 Observed confusion of IFADEM and previously learned pedagogical methods

The external evaluators had identified confusion about the origin of practices taught during IFADEM learned and those recommended by previous education reforms. This confusion was identified as possible limiting factor for the appropriation of IFADEM methods. Implicitly, this means that the validity of the practical tests, conducted in order to assess to which extent teachers have acquired the IFADEM methods, can be questioned – even more as no base line tests were conducted with participants prior to the training.

This impression of confusion was reiterated during the field research and interviews for this study. Indeed, interviews revealed that teachers did not necessarily learn during IFADEM the practice which had been presented during the observation. Indeed, several teachers described their IFADEM practices and subsequently explained that they had acquired these pedagogical skills during the annual training days organized by the schools during their holidays.

One interviewee indicates, in a slightly disillusioned tone, that according to him, the only difference between the practices taught during these training days and those taught during the IFADEM pilot consists in using a different terminology for the same practice:

EvLC: Can you describe a typical IFADEM lessons?

Teacher: There are three steps: Discovery step, rules development, manipulation and the last step: training.

EvLC: Your methods changed since you’ve taken part in IFADEM?

Teacher: Same methods, but the terminology has changed...

As exposed earlier in Chapter 1, the Malagasy Ministry of Education has indeed launched in the past years various reforms of pedagogical approaches (so called ‘objective oriented approach’, ‘situation oriented approach’, ‘skills oriented approach’) and programs, which

continue to create confusion among teachers. Interviews showed that IFADEM teachers were not an exception: As the IFADEM workbooks propose a pedagogic approach that is a combination of the *objective oriented approach* and the *situation oriented approach*; teachers seem to continue to have difficulties to make the difference between the taught methods, besides the more frequent introduction of didactic materials. The observations didn't allow identifying in which case teachers the observed practices were a contribution of the IFADEM training or if the observed practice had been learned during the pedagogical days.

In addition to this uncertainty, both interviews and class observation revealed also a lack of comprehension of the underlying concepts of their practices, showing the lack of appropriation already identified in 2013.

In several cases, even if teachers tried to follow a lesson structure as recommended by IFADEM (or by at other occasions?) the underlying pedagogical concepts were not implemented correctly. All observed lessons were characterized by 'frontal teaching': Teachers were either writing on the blackboard and saying simple sentences or words, which had then to be repeated by the whole class or selected students. In some cases, the teacher did ask an open ended question which had then to be answered by the student, e.g. which type of hygiene activities exist (Picture 1). Even by doing so however, students answered often with single words, barely sentences. Overall, students were not stimulated to speak freely and often replied only with a single word.

A key example was the concept of 'active student participation' which seemed to be misunderstood by many teachers. An interesting example of this misunderstanding is a teacher who wanted to organize a 'role game'. The teacher showed her students a poster on which she had drawn a cartoon, showing farmers working on the field while having a conversation. She described every picture ("*the farmers work on the field*", "*the farmers go home*" etc.) and then announced that a "*role game would take place*". She selected two students who were positioned in front of the class room. However, instead of « playing » the two farmers and imitating their discussion freely, the two students solely repeated the sentences of their teacher, describing each part of the cartoon (e.g. repeating "*the farmer goes home...*"):

It was obvious that the teacher was not aware that she misunderstood the pedagogical concept of a role play: Obviously very proud she repeated several times that since the training, she “*stimulates active participation like this*” among her students.

Overall, the interviews and class-observations allowed identifying teaching practices which seemed to be a contribution of the IFADEM training. However, the appropriation of these practices appeared to be limited, both because of confusion with regards to the differences of previous learned approaches, and misunderstanding of some concepts. The contrast between observed methods, and the declarations of teachers who refer to their financial difficulty to implement these methods, raise the question to which extent observed practices are an *ad hoc* presentation driven by social desirability or actually a sustainable contribution of IFADEM.

1.2.3 Contributions for non-participants colleagues: A spill-over effect?

Finally, an unexpected sustainable contribution of the IFADEM pilot could be identified during each interview series conducted from 2015 to 2017. Former IFADEM trainees report almost systematically that they regularly share the IFADEM materials they have received (workbooks, dictionary, audio files) with those colleagues who have not had the possibility to take part in the training. The impression that IFADEM teachers felt privileged appears in these interviews, they refer to the feeling of having *benefitted*:

Until now, even though IFADEM is over, I use IFADEM, its workbooks for the pedagogical approach. And I use it to transfer competences, for those who have not benefitted from the training.

Different sharing mechanisms were reported, ranging from lending the books to organizing systematically during the school holidays training sessions in which the pedagogical practices are presented and practices. With other words, there is not only material, but also active knowledge transfer.

Interestingly, the nature of these sharing mechanisms varies depending on the work position of participants, and does not only include the content of IFADEM, but also the concept of distance, collaborative communication with a phone.¹⁶ Chef ZAPs for example, who have

¹⁶ As exposed earlier IFADEM involved the following categories: teachers, the key beneficiaries of the training, pedagogic councillor who acted as tutors, and chef ZAP, trained during as IFADEM as if they were teachers.

both supervision and managerial tasks, reported that the shared now advice how to increase the efficiency of work related administration, recommending the use of the phone:

Chef ZAP [proud]: Currently, all directors under my supervision have bought a phone, following my advice. Since 2 years, within the CISCO, we use less paper to do administration work, but more the phone for all that is related to communication.

Another Chef ZAP, who appears also very pro-active, is aware about the concept of cascade training, to which he refers when describing his way of sharing the training with others:

EvLC: Were there non-participants who solicited you because they knew that you took part in IFADEM?

Chef ZAP: It's me who took the lead, who decided to reunite non-Ifademiens of my zone, and so I trained them 'in cascade' with regards to their linguistics difficulties, and I continue do so even now.

When trying to understand what factors influence on these sharing mechanism, the interviews show that the environment of IFADEM participants, e.g. colleagues, school administration, is aware of their training; IFADEM participants have a 'reputation' of having been privileged, they are perceived and perceive themselves as a community: The repetitive use of the word 'Ifademiens' to designate their IFADEM community, is striking. Subsequently, because of their privileged experience, they occupy the role of 'knowledge focal points' for their environment. According to Weber's definition of appropriation, the 'Ifademiens' differentiate themselves from others, as they 'occupied' advantages that the others do not occupy: It is this exceptional position that seems to lead to this community feeling. To a certain degree, a process of social closure has taken place between these 'Ifademiens' and 'the others', even though these 'Ifademiens' appear to be rather open to sharing their benefits (i.e. knowledge) (Weber 1922).

Teacher: There is a colleague who approached me because of the training. It was the willingness to learn, wanted to benefit from the acquisition [of knowledge] of the training.

This community perception remains particularly strong throughout the years, as interviewees report the same experiences and reactions throughout 2015 - 2017. It reportedly has also led, in some cases, to tensions: In a few interviews, former 'Ifademiens' encounter a certain

degree of jealousy. This in turn seems even to hinder intended knowledge sharing mechanisms, as shows this common interview with two teachers in 2017:

Teacher: The others sometimes say, 'It was only for the Ifademiens... we have received nothing from IFADEM....

Teacher 2: Yes... When there is a teacher who has difficulties in French, when we are among Ifademiens we discuss it, but when there others non-Ifademiens with difficulties, we very well might be proposing what should be done, but there is reluctance regarding what should be done...they are a bit jealous.

The study could show that the lack of teacher centered training content has impacted negatively participants chance to sustainably improve their French and pedagogical practices: While higher motivation and interest could be identified, the lack of comprehension and an under exploitation of the phones, notably the highly appreciated audio-files, slowed down teachers motivation and capacity to improve and change their practices. In consequence, the gap between their current practices and the target practices and skills could not be filled – a process previously observed by Blumenfeld et al. who found that, when this gap is too large, teachers are likely to fall back on older practices or assimilate new frameworks into how they talk about teaching without making significant changes to what they do in the classroom (Blumenfeld et al. 2000). The discrepancy of declarations made during the interviews (e.g. group work) and their actual practices during the observations confirm the latter. Interestingly however, IFADEM participants have acquired a certain ‘status’ and a perceived a privileged status – they are spontaneously sharing content, materials and advice; because of their reputation, they are also approached by colleagues. A certain spillover effect can be observed, the IFADEM contributes indirectly to non-participants.

2. Non-prescribed but sustainable contributions – The phone as facilitator and motivator

As will be exposed in the following, a multitude of non-prescribed contributions could be identified, adding up on the hitherto exposed contrast of limited achievement of project goals and ‘achievement’ of non-prescribed contributions. The latter are even more interesting as they are mostly mobile-supported, and sustainable despite the absence of financial organizational framework.

2.1 The phone is sometimes appreciated for pedagogical purposes....

The interviews conducted for this dissertation allowed identifying the continuous implementation of pedagogical practices which were as such non-prescribed by the pilot (i.e. teachers had not been introduced to the concepts or shown concrete examples), and had already been noticed in the pilot evaluation and by external evaluators in 2013 (Lethuillier, Jaillet, et Jarousse 2013): Evaluators had noticed “*the teachers have considered the audio files as ‘attractive’, ‘important’, ‘interesting’ for their students. It has allowed them to correct the pronunciation mistakes [...] but also to correct themselves*” (Ratompomalalala et Rakotonanahary 2013).

The interview series from 2015-2017 indicate that this type of usage appeared to be sustainable. Indeed, when interviewees were asked to describe a typical lesson, they would often refer to practices which can be defined as student centered, by educational stakeholders as desirable presented practices. Mostly, teachers were not even aware of it. These activities included using the phone in the classroom. Almost all former participants reported spontaneously that they use the audio-files in class from time to time in order to improve the French pronunciation of their students.

When asked for a detailed description of this practice, they explained that they would write the content of the audio-files on the chalkboard, and then divide their students in small groups to let the mobile phone circulate from one group to another, allowing each group to listen to the file. Students had then to repeat what they had heard. Furthermore, when asked why they would divide students into groups, they referred to the sound, which is not loud enough to allow an entire class to listen. This exercise was repeated several times until the audio-files were understood.

With other words, the reason for group work was initially not a pedagogical goal, but a pragmatic reaction to a material issue. Teachers appeared to be spontaneously attracted to the phone and willing to exploit it for their lessons, discovering - by chance? - the positive outcomes of implementing a mobile supported group session. This in turn appeared to motivate them to sustain these practices:

EvLC: *Do you sometimes use the phone during a lesson, with the students?*

Teacher: *The audio files...the songs...excellent material! It makes a huge difference!*

Indeed, when using of the mobile phone and the audio-files in class, they reportedly observed higher participation and enthusiasm among students, as well as improved pronunciation skills:

Teacher: *...the audio files. I make them listen to the students. Listening per group.*

EvLC: *How often would you do this?*

Teacher: *Monthly.*

EvLC: *During which period?*

Teacher: *During the training. And after.*

EvLC: *How did the students react?*

Teacher: *They were enthusiastic with the listening. Their pronunciation has considerably improved with the listening.*

EvLC: *Were there things that you do differently since you have participated in IFADEM?*

Teacher: *Yes; I apply what I have seen with IFADEM, I see that it is efficient, they participate more. They talk more.*

EvLC: *What do you mean...?*

Teacher: *Before they would not raise their hands.*

Once again, it appears that through the use of the phone, teachers indirectly make the experience of participative, student centered practices, without necessarily having learned the underlying pedagogical concept. The experience itself appears to enhance the process of appropriation.

Furthermore, this experience in turn stimulates their motivation. For example, another teacher reports that she had even decided to increase the number of French lessons after having observed a significant increase of student's motivation when including the audio-files in a lesson. This declaration is reiterated by another teacher who states that she did not only use the audio files in class in order to improve the pronunciation skills, but that with regard to the high motivation and enthusiasm on the students side, she voluntarily increased the number of French lessons per week.

Teacher: It changed a lot of things. The children loved the listening. It has had an impact on their French level. They have even asked to do the listening...even during the breaks. And since IFADEM, the students are avid of French; I increased slightly the French lessons at the expense of other lessons in order to make more French lessons.

The audio-files are the most-cited, but not the only reason why teachers continue using their phone during lessons. The photo function continues also to be used in several cases, perceived as an efficient tool to attract attention and encourage shy students:

Teacher: The audio-files are very utile and very much used in class. And for me, for the shy and introverted students, I take pictures of them and I show them the photo and it helps them to come out of their shell.

Once again, it seems that the sustainability of this non-prescribed practice is to be directly related to the observed reactions and progress observed by teacher among students, encouraging in turn teachers to persevere and exploit new usages. With other words, this sustaining use of the audio-files is a consequence of a positive teaching experience, which allows teachers then to compare and reflect on the relationship between practice and outcomes, and ultimately develop further this new practice, appropriating both the tool (the phone) and pedagogical practices.

This non-prescribed, sustainable use of the audio-files for pedagogical purposes was also reported by school-directors, when they were also often occupying a teaching position. They declared that they used in turn the audio files to improve the pronunciation of the teachers in their school. Similarly, this type of practice was systematically reported among former tutors: They were highly enthusiastic about the audio-files, used during supervision and training activities for newly recruited teachers to raise their awareness and improve their pronunciation. Once again, a spill-over effect can be noted here (see 1.2.3).

Interestingly, interviews with the control group, even though they all possessed phones did not reveal phone usage for pedagogical purposes during the lesson. This type of sustainable practice seems hence not to be a simple consequence of a teacher possessing a phone, but a contribution of the IFADEM experience – a combination of training experience including phone usage. However, one interview with a control group teacher seems to indicate that there is curiosity towards phone usage in the classroom. This teacher declares that she has tried to

use the phone to entertain the smallest children. Even though the described process seems to be still frontal teaching, it may be considered as a sign of readiness for and interest in this type of usage:

Teacher: Sometimes I would record the singing, and students listen. Then, students repeat. I write it on the blackboard. And students sing.

However, in the case of IFADEM participants, interviews reveal also obstacles that put an end to the appropriation process of audio-files: A few teachers declared that they stopped the audio-files class several months to a year after the training. The two cited reasons were the already evocated insufficient sound, and the loss of the audio-files after configuration the phone. In other cases, it was the consequence of a damaged memory-card, sometimes the lack of possibility to charge the phone, and sometimes again a combination of several material issues. Once again, it seems that the lack of medium-term perspective is an issue, as no team playing the role of ‘after sale service’ was in place, which could have allowed downloading lost files or provide basic technical support. Without this type of support, these material issues ultimately represented in some cases an obstacle too high to overcome, even for motivated teachers:

Teacher: ...the issue is that there is no electricity, and I want to exploit the audio-files to their fullest, but the telephone discharges, and the solar charger [of the school] is broken...

With other words, the evocated reasons were very rarely due to vanishing interest or lack of acceptance as pedagogical tool, but to technical constraints, which possibly could have easily avoided. Indeed there was only one teacher who explained that students were “*too enthusiastic*” and “*distracted*” after listening to the audio-files, therefore deciding to cease using them.

Finally, it has to be noted that there is a contrast about the highly enthusiastic and precise descriptions of phone usages during the lesson, and the observations: None of the observed teachers used the audio-files or other phone function during the observation. It seemed that this could be due to the fact that observed teachers wanted to show and ‘typical’ IFADEM lesson – and as IFADEM did not prescribed the use of the phone in the class they didn’t include it. As exposed in chapter 1, social desirability bias and worries to be evaluated by the *vasaha*, the foreign researcher was indeed an issue. Once reassured by the translator, they

appeared then increasingly relaxed during the interviews, were ready to report their own initiatives with the phone. However, they did not seem to ‘dare’ forecasting the non-prescribed phone usages during the presented lesson, unsure if this type of innovative practice would be well-received.

2.2and always facilitates work-related tasks.

While the phone was reportedly used in a sustainable manner for pedagogical purposes, it also turned out that it occupies a sustainable role as facilitator of other work related tasks. This is particularly true in the case of pedagogic councillors (former tutors) with regards to the **video and photo function**. All but one pedagogic councillors explained using the video and photo function of their phones in order to enhance the follow-up activities of those teacher trainees they were in charge of: With the video function, they would film lessons of teachers during a supervised lesson, analysing and showing the same teachers afterwards the sequences. Reportedly, they used this type of practice to provide teachers with more precise and on-time advice, e.g. showing them at which moment of the lessons they should modify their practices and why.

EvLC: Do you happen to film your trainees?

Tutor: Yes, when we supervise the teacher, we film. And after we meet, and during the meeting I show them the sequence, how they act in front of the students.

EvLC: And this sequence, you show it to others?

Tutor: It happens that we show it to others, as an example, to advice other trainees, because....well particularly the young recruits don't know how to manage a lesson!

EvLC: And how they react, the teachers, when they see themselves?

Tutor: They are convinced that when you teach, you have to do this and not that [laughs], they understand finally!

Another former tutor reports that he would use the video function to film teacher trainees during their final examination and then transfer it on a computer. The purpose of this practice was the constitution of ‘database of practices’ which can be shared with both the teacher and other pedagogic councilors.

Furthermore, the photo function is used in similar ways by pedagogic councillors: They report taking pictures during the lessons and to transfer them on a computer at their office, with the purpose of documenting the advances of their teacher-students. Another interviewee reports that he uses the photo function in order to illustrate actively its explanations, and trains teachers to use in turn these pictures, e.g. in sciences classes:

Tutor: To explain teachers' differences of elevation and topography, I took many photos and made them use by the teachers.

Also, besides using the photo function to improve the quality and efficiency of their supervision, the majority of pedagogic councillors reported that since the IFADEM training, they would regularly use the phone to take pictures of professional events and receptions, for personal souvenirs or to use the photos later during a follow-up meeting with the administration.

Besides the use of the photo and video function, the **voice recorder** was cited as important functionality a majority of former tutors. They would use it to record meetings, which reportedly increased their concentration as they were not obliged to take notes. They also use it to record a lesson, allowing them to analyse afterwards in detail the steps of the lessons and /or to provide efficient feedback to the supervised teacher.

Also, one pedagogical councillor reported that he had deliberately learned how to use the **digital agenda**, in order to be reminded of both professional and private events.

Finally, the **radio function** is in some cases cited as work-related tool, as the local school administration uses it to let all Chef ZAP know – those who don't have a phone, but a radio – when they have to meet:

Chef ZAP: Here, the cisco is on the local radio, so we have to listen to the radio on the phone. For example when we are convened for a meeting.

Interestingly, this type of usage is reportedly new, meaning that even those who already had possessed a phone prior to IFADEM did only start to use it for supervision, pedagogical tasks since their participation in the pilot. Again, the introduction of the phone in a training scheme seems to be the 'kick of' moment for this type of practice, not the phone itself:

EvLC: And before IFADEM, did you already use a phone for supervise trainees?

Tutor: *No...it came with IFADEM ...and idea since IFADEM!*

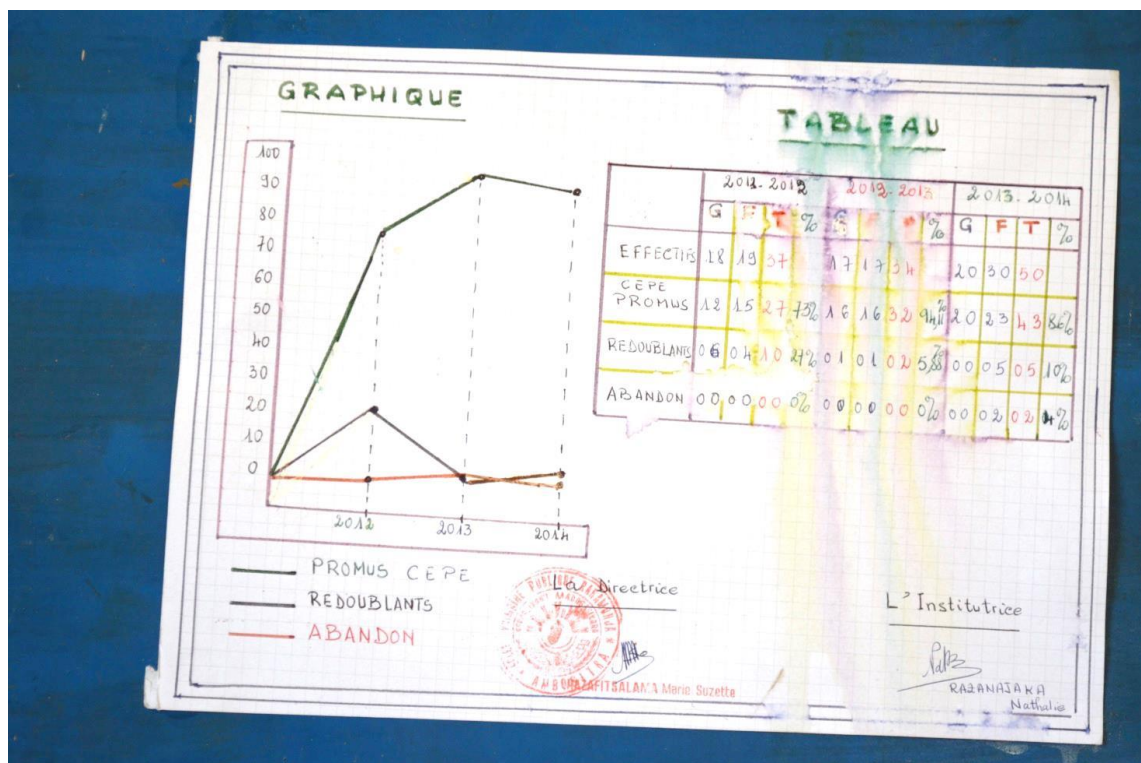
Interviews with other individuals, notably a Chef ZAP, confirm also the impression that the mobile based IFADEM training has significantly increased the perception of utility of the phone; participants report to be now more eager and aware about the usage of the phone as facilitator. This seems to be a progressive process, with an interest that increases with the more they appropriate the phone and its functions. It appears directly related to experience of usage over time, individuals becoming more and more confident to use and exploit new functions: Interviewed trainees indicated that there were various mobile functions they would like to use in the future:

Chef ZAP: Before I rarely used the phone...oh... [his phone rings, for the 3rd time during the interview] and since IFADEM I use it daily, almost abusively....I'd like to use Email but I don't know how as my children are not here to teach me.

The wide range of non-prescribed, work related usages of phone functions (communication excluded) among former tutors and Chef ZAPs contrasts with the rare use of these functions in the case of teachers: None declared to take pictures or videos for pedagogical reasons, only two school directors mentioned that they would do so during school parties, showing the pictures later parents and students. However, teachers report more often than former tutors that, since the training, they use the calculator functionality on their mobile phones for administrative duties, e.g. to gain time and accuracy when calculating the monthly ratio of absent pupils and on a yearly basis, the repetition and passing ratio (picture 2).

Overall, it appears that non-prescribed usages differ with regards to the needs of former IFADEM participants. Moreover, the appropriation process of the phone appears more advanced in the case of former tutors and Chef ZAP, a process possibly pushed by professional obligations – the phone appears fairly embedded in professional sphere of pedagogic councilors – subsequent higher phone familiarity and, not to underestimate, higher levels of income.

Picture 2: Classroom poster with average absence, repetition and passing ratio of students, calculated each month by teachers



Source: April 2015, district of Ambositra: Repetition and drop-out rates calculated and transcribed on a classroom poster. In this case, the calculations have reportedly made with the calculator of the phone the teacher had received during IFADEM.

Furthermore, when analyzing practices and usages, there can be once again observed a contrast between former IFADEM participants and the control group: Less than a third of the control group declared that occasionally, and mostly for emergencies, they would use their phone, or to arrange informal meeting.

This is also true for non-communicant functions, e.g. the calculator, which remain rarely reported. Hand-based calculations for the monthly and yearly calculation of absence, drop-out and repetitions are mostly made mentally and by hand.

Furthermore, paper based, and communication involving ‘messengers’ for work remain dominant among individuals from the control group, albeit living in the same district and villages as IFADEM trainees. A particular striking difference in organizing work related matters was for example communication with parents: Parents are alerted either by public posters in the village, or by the sound of a whistle: When they hear the whistle, they know that a parents meeting is organized at school the same day.

EvLC: *How do you interact with parents?*

Teacher: *Either with posters (in the village), or orally, or via the association with a whistle.*

EvLC: *With a whistle?*

Teacher: *Yes, there is a whistle. It is not used for everything. When there is whistle, parents are convened.*

EvLC: *And concretely, it means somebody walks with the whistle in the village?*

Teacher: *Yes.*

2.3 The power of relatedness: Mobile communications replace and enhance previously challenging face to face contact

While these ‘offline’ functionalities on their phone appear not only to be contribution of the IFADEM training, and are not observed among individuals from the control group, they also seem to illustrative an appropriation process which is particularly stimulated by a professional environment in the case of former tutors and Chef ZAPs. Mostly used for administrative purpose, the study could however also identify the use of mobile communications as important, non-prescribed contribution: As exposed in the following, the use of mobile phones for work related communications seems indeed to be the ‘key revelation for former IFADEM participants.

2.3.1 Facilitation of communications with colleagues and school administration

The phone allows former participants to reach and be reached by their school or local school administration. While some teachers had possessed a mobile phone prior to the training, they report that since the pilot was implemented with the support of the local administration, these were provided with a list of participants’ phone numbers. During and after the training, the local school district does now use these numbers in order to reach out to former participants (teachers, school directors, Chef ZAPs and pedagogical councilors). It is possible to talk here about an organizational spill-over effect. Reported underlying motivations were e.g. to inform them about administrative appointments, supervising or tasks (in the case of pedagogic councilors and Chef ZAPs) or last minute changes of meetings times or locations. In some

cases, these mobile communications complement information they received in school by the school director.

EvLC: *So, you said you call sometimes the school principal?*

Teacher: *Yes, because even if I live near the school, sometimes I need the school principal after school, and then I call him.*

In other cases, mobile communications replace face to face communication:

EvLC: *Are there things you do by phone now, and for which you had to travel before?*

Tutor: *Before, I was going myself to the CISCO [school administration], and nowadays, I call them, and same, they call me.*

Former tutors report also systematically that the IFADEM training has enhanced their awareness and willingness to use the phone for professional communications, and that the benefits of the mobile phones are considerable in this regard. As shown by the following extracts, it not only allows them to “*react quickly*”, but also to provide support to more teachers than they would be able to supervise without a phone:

Tutor: *Last week, I was in Tana and the chef [of the local administration] has told me: something is wrong in your zone, at the primary school in Farani... teachers are late.....it [the phone] is of tremendous help...*

Tutor: *[...] there are loads of teachers who need us, and we can't go and see every one, the phone is a solution to this problem... [thanks to the phone] we solicit more the trainees with regards to their difficulties, and they exchange on these; sometimes the tutor introduces a subject on which the trainee has to work and once that is done, we continue with the question-answer part [by phone].*

In addition, former tutors do also report to intensively use the phone to call other colleagues, pedagogic councilors like them. They appreciate that this allows them to convey information more quickly, and that they exchange more often as it has become easier: Geographical distances are less of an issue:

EvLC: *You said earlier you call other pedagogic councilors [with the IFADEM phone]. Why?*

Tutor: *To provide, but also ask for information. I live 22km from Fandriana, and there are pedagogic councilors who live in the center of the CISCO [Fandriana], so I have to call them to ask for information.*

Interestingly, professional communications are not limited to calls but also include SMS: Interviewed tutors indicate that the mobile allows them to reach colleagues quickly and easily via the multiple SMS function, which allows sending a single SMS in one batch to several contacts. In some cases, former tutors report even that mobile communication has replaced letter based communication.

While teachers rarely mention sending SMS for professional purposes, they report overall a similar crucial impact of the phone since the pilot, stressing that it facilitates communications and decreases the impact of distance on their work life. In 2015, during the very first interviews series with IFADEM Participants without knowing if they were still using the phone or not, the majority of former IFADEM trainees reported indeed that they continue to communicate with the phone, be it with the local school administration or other colleagues.^{17,18}

These mobile based communications reportedly replace in some cases long walks that teachers had to do in order to provide information to their superiors or administrations. Given that rain seasons, lack of infrastructures and security issues make traveling (to school and in general) sometimes hazardous, this type of contribution is crucial for teachers: Particularly striking is the declaration of one teacher, who explains that prior to IFADEM, she had first to go to the main road of her village and then wait until she would find a person traveling in the direction of the local school administration or her school in order to convey a message, e.g. notification of absence. This teacher declared that, since her participation in the training, she now uses her mobile phone to notify the school directors if she can't come to school, or the school administration if needed. This type of example is recurrent among interviewees, who frequently refer to the concept of 'facilitation' and 'efficiency':

Teacher: The phone is indispensable, as it solves many problems, as for example instead of traveling somewhere, you can call, and it's also quicker.

¹⁷ Interviewees from 2017 are not considered here given that they were chosen only among individuals who continue to use their phone: Obviously, they all declared continuous phone usage.

¹⁸ These types of described contributions, amongst others, provided a rationale for an in-depth analysis of their communications (Call Detail Records) whose study results are exposed in chapter 6.

Interestingly, both tutors and teachers underline that this type of mobile communication has started with their mobile teacher training experience:

EvLC: *And you, on average, how often do you call other colleagues?*

Teacher: *Three times per week.*

EvLC: *Did you do this already before the IFADEM training?*

Teacher: *No.*

Indeed, both teachers and former tutors estimate that since the training, they had more often the ‘reflex’ to use the phone to ask another teacher a question. One interviewee, a Chef ZAP, explains first that he uses the phone often for work, before adding that the IFADEM training was for him a ‘revelation’, even though it was his first phone ever..

Once again, a contrast between the IFADEM participant interviewees and the control group can be observed: In the case of individuals from the control group, only three out of 20 individuals use a mobile phone to collaborate. While two report that this type of usage happens only occasionally without referring to concrete examples, one interviewee distinguishes herself from all other interviews with a fairly innovative collaborative practice, via Facebook. Her attitude and explanations indicated clearly that this type of practice remained exceptional, and that she wasn’t sure that it would be well accepted:

Teacher: *...and Facebook [laughs, shyly]; we talk to Facebook when we have problems. For example if there is a student who lacks discipline, I say it in Facebook so that others teachers can see it and take action to help the student.*

From a broader perspective, this type of usage reveals, even if still a minor phenomenon in the case of the control-group, confirms the increasing presence of new technologies in the work sphere of teachers, at least in semi-urban areas (see chapter 1). Declarations like these can also be interpreted as symptom for an openness towards and interest in work mechanisms which, in the eyes of teachers, may possibly facilitate their work life.

2.3.2 “IFADEM has created linkages” - Sustainable mobile collaboration among former participants

While work related communications is a highly reported usage among IFADEM participants and appears to be stronger than among those of the control group, there are strong indicators

that more than only being phone-related, it is the common training experience that explains this difference in intensity:

Indeed, both the project and external evaluation had found that during the project, teachers had used the mobile phones to communicate with their IFADEM peers, for mostly training related purposes: Participants called each other to discuss the content of the workbooks, exchanged information and verified together their quiz SMS answers before replying to the daily quiz. Similarly, the external evaluators agreed that participants “*have harnessed the network potential of mobile connections*” and concluded that this network creation, made possible thanks to the introduction of mobile phones, was one of the most innovative and promising aspects of the training (Lethuillier, Jaillet, et Jarousse 2013, p.38).

As mentioned earlier in this chapter, the first interview series revealed that former IFADEM participants continue to call each other with the phones they had received during the training. When asked for which purposes, they declared that they exchange best practices on how to conduct a lesson, or when they learn that there is a meeting they have to attend:

EvLC: Since the end of the training, you continue to call your former tutor?

Teacher: Yes, I call and visit him [...] to talk about the difficulties of a lesson, to obtain help, particularly in French.

Again, the example of not depending anymore on an unreliable, time consuming and paper based messenger system is cited as one of the most frequent changes when contacting a former training peer. Reportedly, using the phone is “*so much quicker*”.

Furthermore, while the majority of teachers indicate that they mostly call those who live in the same area – which is not surprising given that the training was organized according to workstation of participants – there are also a few teachers who are in contact with trainees from other districts, also for work related reasons, e.g. exchange of advice or administrative information. In contrast, a majority of former tutors declared to communicate by phone with former IFADEM teachers or tutors living mostly in other districts than theirs. They explain again that the phone allows them to increase the number and efficiency of supervised teachers.

When it comes to communications made by teachers to their former tutors, this type may well be reported, but appears less intensive than tutor towards tutor, or teacher towards teacher communication: Less than 50% of interviewed teachers – including those interviews from 2017 – declare to continue to call their tutors. When they do so, they explain that the ongoing contact is also due to the fact that the former tutor continues to be their supervisor nowadays. Interestingly, the training content continues to be the main subject of discussion in many of these cases:

EvLC: Are you still in touch with your former tutor?

Teacher: Yes, she's also my pedagogic councilor – but I speak to her as my former tutor, as I continue to ask questions that concern the workbooks.

EvLC: And these exchanges, they happen face to face or by phone?

Teacher: We are geographically distant from each other so we use the phone. Up to two calls per weeks. Or SMS.

However, when teachers indicate that they would not call their tutor, interviews showed that there are not necessarily mobile, but almost systematically some type of continuous linkage: Former tutors and trainees happen to meet each other randomly when they are in the regional capital, or when the former tutor comes to their school. During these moments, they reportedly ask for support or news. It appears that ties among former tutors and teachers do exist, but that these are not necessarily based on mobile communications, particularly not if the network is insufficient.

EvLC: Are you still in touch with the teachers [you were in charge of during IFADEM]

Tutor: Yes.

EvLC: All the 19?

Tutor: No, not with those Manandriana... because of the network [...] but these, sometimes they come here too.

EvLC: What do you talk about when you meet?

Tutor: Oh, of everything...work...they share also their social life... [IFADEM] has created a real link.

The existence of these strong mobile supported ties is something that differentiates former IFADEM trainees from their colleagues. Indeed, while interviewees indicate that they use the

phone to call colleagues, they also stress the fact that, mobile supported ties (despite increasing mobile possessions) are still rare among teachers.

It appears that the common training experience, but also the introduction of the phone, have allowed creating and reinforcing existing ties: More precisely, interviewees reported that the training has “boosted” their collaborations, as they were encouraged and even obliged, in case of difficulties, to exchange with each other. The sustainability of these ties appears to be related both to their nature – interviewees qualify themselves as being “closer” to IFADEM participants than to others, as they had to exchange much – and to the introduction and availability of the mobile phone. Among the various declarations made, the following illustrate neatly how important these ties are to former participants:

EvLC: How do you explain this reinforcement [of ties], you just mentioned]?

Teacher: We got closer because of the pedagogy...collaboration was required; there were many exchanges [...]. IFADEM has enhanced the exchanges among IFADEM participants, on the contrary to the initial training; there was the possibility to exchange with a phone.

Another teacher adds that

IFADEM has boosted the exchanges among teachers. Thanks to IFADEM and the pre-paid offer, it really had some impact, I made a lot of friends and new colleagues...and even without the pre-paid offer, the network continues to exist!

A particularly interesting aspect of these peer to peer exchanges is not only that they exist, but the fact that they seem to be more or less organized - without any external support or incentive.

The sustainability of their ties appears to be related to their nature, both professional and private. There is a double motivation to maintain these connections:

EvLC: So, you are still in contact with IFADEM participants other than those in your school?

Teacher: Yes, we call each other – and organize meetings!

EvLC: Did you make friends?

Teacher: Oh yes! [Laughs]

In several cases, teachers report that they continue to meet with former IFADEM participants in a regular manner on Saturdays, while in other cases Saturday is the day they would call each other to exchange, in order “*to take stock of the week*”.

Some IFADEM participants are more ‘important’ than others

Interestingly, it appears that the reported ties are not equally strong: Some participants are solicited more often than others – because they ‘have something the others don’t’, e.g. content expertise.

Teacher: t’s always me who calls. There are things I don’t understand in the workbooks and I call this woman because she is very good in French!

Former IFADEM participants, who are also Chef ZAPs, seem to play an important role because of their role as supervisors. They are particularly often cited:

EvLC: Do you call former IFADEM colleagues for some pedagogical support?

Yes, in that case I call the Chef ZAP

EvLC: How often?

Teacher: On average three times per month, I call the Chef ZAP. [...] With the pre-paid offer it was easy to communicate, but even if there’s not anymore, teachers continue to call, even though we have to pay.

In contrast, even though individuals from the control group also possess phones – and sometimes are assigned to the same chef ZAPs - none declares calling them.

In summary, the final evaluation had identified the emergence of an IFADEM, mobile supported network during the training period. The qualitative study conducted for this research seems to confirm that this network is a sustainable and key contribution of IFADEM. The study identified motivation to enhance knowledge and relatedness as possible drivers of this network, ensuring ultimately its sustainability. These findings call for an in-depth social network analysis, carried out and exposed in chapter 7 of this dissertation.

2.3.3 A phone well embedded in the private sphere

When comparing the phone usages of IFADEM participants with those of the control group, it could be ascertained that the common training experience has clearly enhanced the use of the

phone for work and in particular, for collaborative communications among former IFADEM participants.

In addition, interviewees referred also to private usages of the phone. These appeared to be of particularly importance to them, and indicated that the phones they received are now fully integrated in their daily life's, affecting also their immediate environment, e.g. families.

Indeed, the most frequent private usage of the phone was communication with families. All IFADEM participants indicate that they use the phone to stay in touch with their families, in particular with their children who have moved to more urban areas. Members who live in the same village are not called, only those who can't be reached otherwise.

This is also the case for individuals from the control group (11/20) who compensate the geographical distance with phone communications:

EvLC: *Who do you call more often? Family, friends or for work?*

Teacher: *Family.*

EvLC: *They are far away, the family?*

Teacher: *They are over in town, they are not close, and so I need to call them.*

These findings confirm not only the expectation and findings from the research literature, indicating that mobile technology was particularly powerful when it comes to reducing social isolation of teachers. It confirms also the research findings of authors like Rivière, who had found that why telephone communications mostly serve as reinforcement of existing connections – people who live less than 10km away – communications with families are an exception: they are used as substitution of face to face contacts (Rivière 2001, p. 6). Furthermore, listening to the radio is reported to be a habit for almost all IFADEM trainees, both for reducing their 'informative isolation', as well as to entertain themselves when listening to music for example. It is also used for a social moment with their families.

EvLC: *You listen to the radio at home?*

Teacher: *With the IFADEM phone, yes.*

EvLC: *How did your family react when you brought the phone home, with the radio function?*

Teacher: *All were happy, “mom has a new phone” we listen together to the radio.*

The possibility to listen to the radio on the phone seems to be also particularly popular as it increases the teachers' independency from electricity infrastructure, which is characterized by frequent electricity cuts:

Teacher: *We have a radio at home, but in case of electricity cuts, we use to listen to the radio on the phone.*

Overall, listening to the radio via the phone represents an important activity for teachers, as it makes it easier for them to be informed on-time and feel 'collectively' connected to the rest of the region and country, complementing in this regard individual, mobile communications.

Interestingly, even though individuals from the control group also dispose radio functions on their phone, this type of usage has not been reported by any of interviewed individuals. This seems to indicate once again that in the case of IFADEM participants, the phone appropriation process was stimulated during the training; the appropriation of the phone is hence more advanced in the case of IFADEM participants.

This hypothesis seems to be even more plausible when looking at further usages of mobile functions for private purposes: Just after the radio, the **calculator** is the most frequently used mobile function; cited by a majority of interviewees from the IFADEM group. Again, its usage is motivated by the fact that it facilitates daily tasks as calculating prices at the market, increasing their independency from the sellers, as they are now able to verify if the price has been calculated correctly. Interestingly, this type of usage is again underdeveloped among the control group, only mentioned by one individual.

The impression, that phones are much more often, and more diversely embedded in the lives of former IFADEM participants increases when these report how they use the audio-file at home, for entertainment and to educate their own children. Again, this embeddedness seems to be directly related to the IFADEM training, experienced as the start of a 'virtuous cycle' in terms of phone usage:

Teacher: *I need to insist on the fact that before IFADEM, I didn't know how to use a mobile phone. It's really since IFADM that I know how to use the phone.*

EvLC: *So, did it change much in your life? Was it a big change, professionally speaking, if before, you didn't know how to use a mobile phone?*

Teacher: *My wife and my children now know how to use a phone – thanks to me.*

EvLC: *They have phones?*

Teacher: *It's me who brought it home, and now, the whole family has a phone. I am proud that thanks to me, the telephone has entered our home.*

Furthermore, the fact that the phone is frequently used for entertainment, e.g. to play games or to take pictures during family events appears to be a sign that the phone is more socially embedded in the case of IFADEM participants than in the control group:

Teacher: *Photos for example, during Christmas or New Year's Eve. Using the phone to take pictures of the family sitting at the table....than sharing [the picture].*

Finally, this embeddedness seems also to be reflected in IFADEM participants descriptions of those functions that they are not able to use, but would like to: While individuals from the control group appear more detached and refer to functions they can't use without perceiving it as an obstacle, IFADEM trainees express regrets and frustration: they have more imagination with regards to possible advantages of functions, notably E-mail and Facebook. These two features – both directly related to the perception of higher efficiency and pleasure, incarnating potentially increased relatedness and entertainment – appear to be recently most desired but less mastered functions.

Summary of chapter 5

The qualitative study presented in this chapter has shown evidence of sustaining outcomes and contributions. Mostly of non-prescribed character are not consistent with the original objectives the training, but of are still of educational and social added value. More precisely, the study showed that the IFADEM training led to sustaining contributions in the professional and private sphere of teachers and former tutors, and that these contributions involve the use of the phone trainees had received e.g. student centred practices through the use of audio-files in the classroom, feedback mechanisms and self-reflection among teachers, facilitated administrative tasks, reduced isolation, and most importantly, enhanced teacher collaboration among former participants.

Well embedded in former trainees' lives, the sustainability of these usages and contributions are a result of the collective training experience, which has led to an increased awareness and perception of usefulness of the phone and set the base of a collaborative, interdependent teacher network. When looking in detail at the nature of sustaining usages and contributions, these seem to be driven but what research defines as 'autonomous motivations': The creating conditions that allow for the fulfilment of three human needs: the need for competence, the need for autonomy, and the need for relatedness (Crehan 2017).

These findings contrast with the lack of expected project goals, i.e improvement of French skills and pedagogical practices. When analyzing the reasons why there is only limited achievement and sustainability of these goals, the qualitative study shows that the lack of suitability of the training content – too complex – and an insufficient period of training seems to have resulted in lack of comprehension and subsequently, decreased motivation to access the content.

Furthermore, the study indicates also that the environment and role of each participant influences on the motivations behind sustainable mobile usage: Former participants like school directors and Chef Zaps, whose work duties allow for higher autonomy whilst being highly involved in a supportive school community, reported particularly diverse and innovative usages. As suggested by self-determination theory these attributes come along with higher motivation to innovate, and an enhanced appropriation(Lam, Choy, et Cheng 2010). The analysis of their role for teacher collaboration shall be conducted later on, using a social network approach (chapter 7).

More generally, this study has shown, by comparing interview results of former participants with those of the control group, that the very fact of possessing a mobile phone cannot explain the motivation to sustain mobile usages. The phone is used in a much more intense and diversified manner among IFADEM participants, as they experienced a period during which the mobile phone was placed in the middle of a reflection process: overall awareness towards possible mobile usages were enhanced, and a fertile ground for the later ongoing mobile usages prepared. Contrary to individuals from the control group, the IFADEM training phase benefitted from a 'kick off' phase. Willing to continue to benefit from the experienced benefits of mobile usages, those during the training initiated phone usages were perpetuated. As described by Wertsch, training participants could appropriate mobile supported practices thanks 9 month provision of a space that stimulated the conduction of field experiences. This phase was even more determinant as individual enhanced mutual their experiences and developed a strong feeling of belonging to the 'Ifademien' community.

In order to analyse the role and extent of usage of the phone in former participants' lives, and adopt a different perspective on the appropriation process and sustainability of contributions, the subsequent chapter will analyse their Call Detail Records.

Chapter 6 – Study 2: Mobile communications and connections among sustainable training contributions – which evolutions, which sustainability factors?

In the previous chapter, the results of the qualitative study conducted through interviews and observations revealed sustainable and mostly un-prescribed contributions of the mobile supported teacher training pilot IFADEM. The study has focused on the *nature* of these contributions. It showed that former IFADEM participants continue using the phone for both professional (pedagogical, administrative) and private purposes.

These usages were mostly mobile based and, when involving voice or SMS communication, take place at their own expense and are not stimulated by external incentives as they were during the training, e.g. quiz campaign, tutored support or monthly meetings. It appeared that these existing sustaining mobile communications are, amongst others, driven by factors pertaining to intrinsic and autonomous motivation, i.e. the desire to fulfill the needs of competence, autonomy and relatedness.

After this purely qualitative approach and the focus on a selected sample of former participants, the possibility to retrieve and analyze the Call Detail Records of all former participants shall be exploited in the following. Indeed, their analysis provides not only the possibility to sharpen the research perspective on contributions by extending the sample of analyzed individuals. A quantitative lens also allows analyzing to which extent the declared usages and practices are reflected in the amount of ongoing communications.

Most importantly, by combining quantitative and qualitative datasets, the following analysis seeks more than only confirming and / or complementing the findings from the qualitative study; further contributions are sought to be identified by using the qualitative data to inform quantitative results.

Concretely, the subsequent study looks at the evolution of communications, and to which extent they have been impacted by the end of the pilot. Subsequently, the analysis of communication preferences after the end of the pilot (voice, SMS) shall allow identifying the

role that the phone continues to play in teachers' life. It also seeks to trace back observed contributions to the training period, in order to understand which factors may, from the beginning on, have a determining effect on the medium-term. By doing so, the identification of individual, training related or infrastructural factors that support autonomous and sustaining phone usages, this research aims to shed light on a hitherto unexploited field in mobile teacher training research.

In a nutshell, this chapter is organized in two phases: What can be considered as the answer to the "what and who?" – will be followed by an identification of factors explaining *why* these former trainees continue to use the phone.

➤ *Methodological implementation process*

For the purpose of this analysis, methods pertaining both to descriptive and analytical statistics are combined and when useful, qualitative findings mobilized. The methodological implementation process can be divided in 4 steps:

Willing to look at specific questions, descriptive statistics were used in order to conduct

1. an overview of communications in terms of volume and nature
2. an analysis of communications during the training period, combined with an analysis of the results from the pilot evaluation of 2013: When looking at the pilot period and the communications made during this time, is it possible to already identify some indicators of future sustainable phone usage?
3. a comparison of communications during and after the pilot period: To which extent the end of the pilot impacts on communications depending on the profile (teacher / tutor), the communication mean (voice / SMS) and the call partner category (IFADEM participant / other)?
4. Subsequently, multidimensional analytical statistics were implemented in order to identify statistically significant factors, both on the individual level and depending on the training past training experience, which can be considered as indicators / risk-factors for (non) sustainable phone usage on the medium-term.

The in this study analyzed dataset is composed of participants' Call Detail Records (CDR) and a database containing several types of attributes (Table 12, Table 13). The variables representing these characteristics can be categorized as follows: Infrastructural attributes, training related attributes and individual characteristics of training participants.

Table 12: Details of information recorded by the Call Detail Records of participants

VOICE	SMS
Analyzed training period: 7 month in 2013/4 Post-training period: 7 Month in 2014	
Number of calls per individual Date Duration of each call Direction: (outgoing / incoming) Call partner: IFADEM participant / other individual / service number	Number of SMS per individual Date Direction (outgoing / incoming) Recipient and sender (IFADEM participant / other individual / service number)
Dataset with participants attributes allows characterizing the individual (tutor or teacher, workstation...)	

Table 13: Analyzed variables – Dataset of participants attributes

Infrastructural attributes	Training related attributes	Individual characteristics
School district	Degree of phone usage ("Phone user category")	Gender
Access to electricity	Position (Teacher or Tutor)	Academic qualification
History of mobile phone possession	Phone type (Basic / Feature phone)	
Network satisfaction	Degree of quiz participation	
	Amount of outgoing calls to another participant (teacher)	
	Training wave (1 – 3)	

1. *What and who is left?* – Description of mobile supported communications in the aftermath of the pilot

The subsequent section will first describe to which extent the end of the training period (i.e. end of financial and organizational incentives) may lead to a reduced number of individuals

using the phone they have received for the training. Secondly, will be analyzed how the nature of communications (voice / SMS) evolve. Then, we will look at the post-training communications according to each 'phone user category'. This category corresponds to a variable created during the final evaluation and which classified participants according to the intensity of phone usage during the training.

1.1 Evolution of communications: Decrease but progressive appropriation

1.1.1 Almost 50 % of individuals continue to use the IFADEM phone

458 participants, composed of teachers and tutors, took part in the training. When looking at the post-training Call Detail Records of these participants, it can be ascertained that 201 of them (44%) are still 'active' after the training, meaning they still use the phone to communicate. This implies that they have decided to cover the expenses for the use of the phone and use the phone without any external stimuli.

This finding can already *per se* be considered as crucial. It confirms not only the results of the qualitative study, but also allows quantifying the declared sustainability of communications. Subsequently, this result provides once again a strong rationale to have a detailed look at the extent, and the underlying reasons behind this sustainable phone usage.

1.1.2 The particular case of SMS, a complementary mean of communication

When looking at all communications of the **training period**, a high proportion (55%) of all communications was SMS messages (Figure 29). This proportion can be easily explained by the daily quiz SMS participants received: Indeed, almost 63% of all incoming SMS have been sent by the quiz platform. Furthermore, 23% of all incoming SMS are automated SMS generated by the telecom operator Orange, i.e. a commercial offer or publicity.

Adding incoming SMS from the quiz platform and incoming SMS from the operator, this equals a total of 86% of incoming SMS which are not from a 'real' individual. While they appear in the Call Detail Records, they are here not considered as 'communication'.

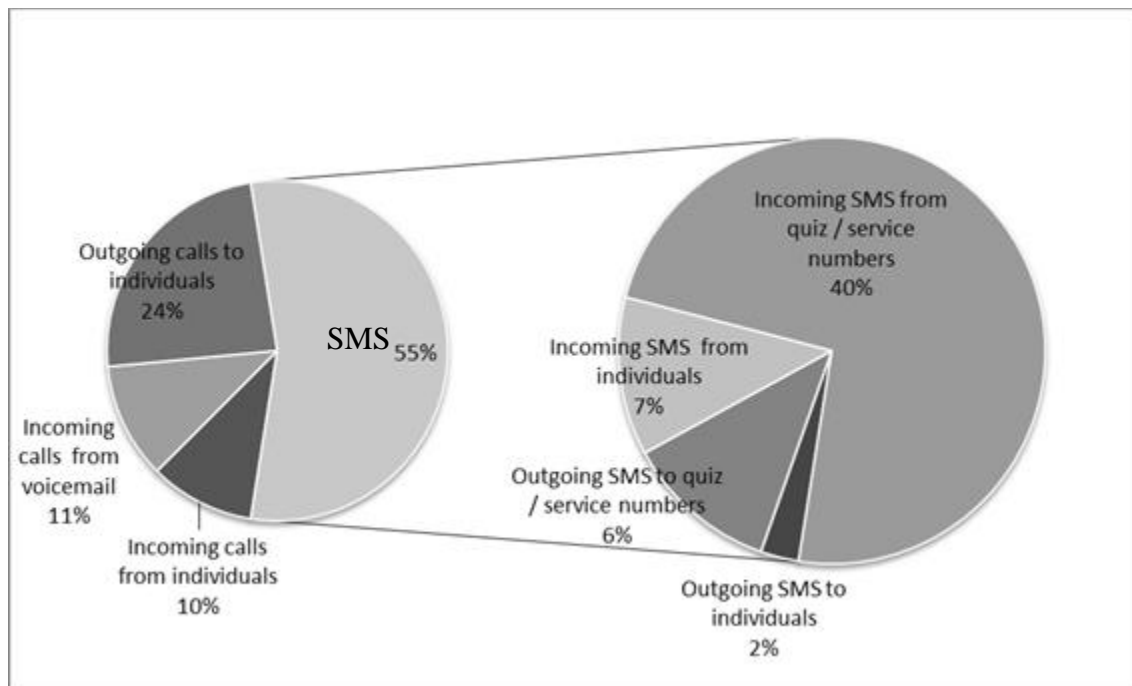
Similar, 80% of SMS sent by a participant are either an answer to the training quiz, or an answer to a service number, e.g. to validate a special offer. The explanation for this low proportion of SMS sent to actual persons is provided by the qualitative study, which had

found that SMS are rarely used for private communications. Also, the project evaluation from 2013 reports that SMS traffic peaked during the period of the large clusters – during which teachers were introduced in the use of the mobile and usages stimulated – but was very low on weekends. This suggests that SMS were mostly used for training related reasons, and not a socially embedded mean of communication.

More precisely, the pilot evaluation report and the subsequently conducted qualitative study allows confirming that it the lack of mobile literacy, and issues to read the small font size are plausible explanations for this low use of SMS during the training. With other words, even though trainees did not have to pay for SMS, there were obstacles preventing this type of communication. Overall, it appears clearly that participants prefer voice over SMS to communicate during the training period.

When looking now at the post-pilot phase, it appears that this preference for voice communications remains (Figure 30). Indeed, the proportion of SMS sent to and by ‘real’ individuals is much lower than the proportion of voice based communications: Only 14% of communications are ‘real’ SMS communication.

Figure 29: Distribution of communication types during the training (2012/2013)

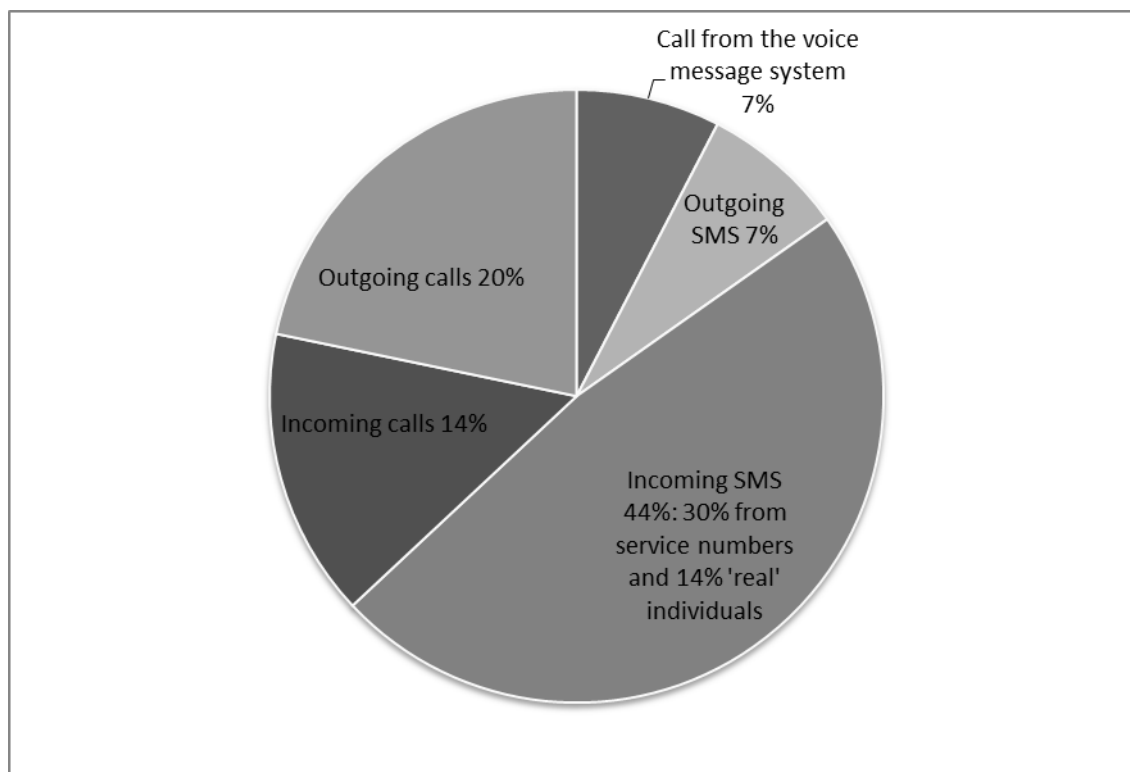


Source: Orange Madagascar; Communications of 458 individuals according to their CDR from 2012 / 2013

However, when looking at the evolution of SMS communications over time, and taking into consideration the role of the trainee (teacher or tutor) it can be ascertained that SMS communication does not only continue to figure among mobile communication, but even slightly increases in the case of teacher to teacher SMS communication.

Indeed, even if SMS remain only second choice, it appears that despite the lack of an organizational framework, former trainees' mobile literacy seems to increase, leading progressively to higher perception of usefulness and situation in which they consider SMS as appropriate. It appears plausible that the stability and increase of SMS communication can be explained by this process. Interviewees declared that they are getting "*better and better with the phone*" over time, realizing progressively realized are multiple advantages of SMS communications.

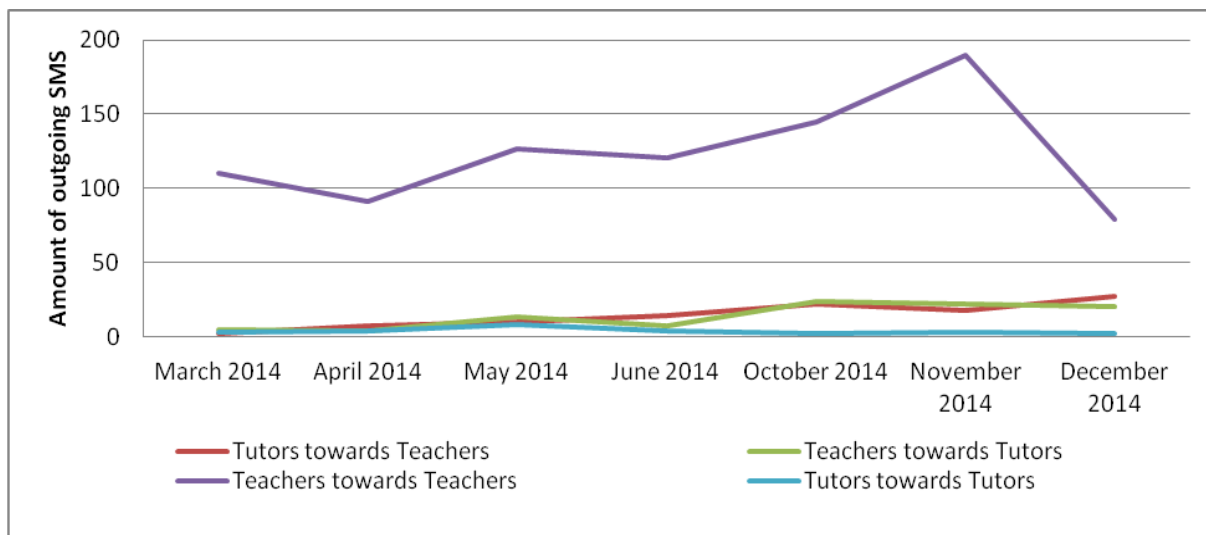
Figure 30: Distribution of communication types after the training (2014)



Source: Orange Madagascar; Communications of 201 individuals according to their CDR from 2014

These complement and even replace voice communication, influenced by both content and context, e.g. to convey information which was less urgent than those they liked to communicate per voice over the phone. SMS reduce costs of communicating benefitting from 'SMS for free' offers. They are reportedly also a convenient alternative in case of a call partner being in a location with insufficient network coverage: SMS would arrive as soon as the person would be again in a network covered area. Also, teachers reportedly used SMS to ask former tutors a "quick question" to which the tutor would then "reply by SMS, too". Longer talks or problems are discussed per voice. This dynamic is visible in the Call detail records: The number of SMS sent by a teacher to a tutor is fairly similar to the SMS sent by tutors to teachers (Figure 31).

Figure 31: Evolution of SMS communications after the training

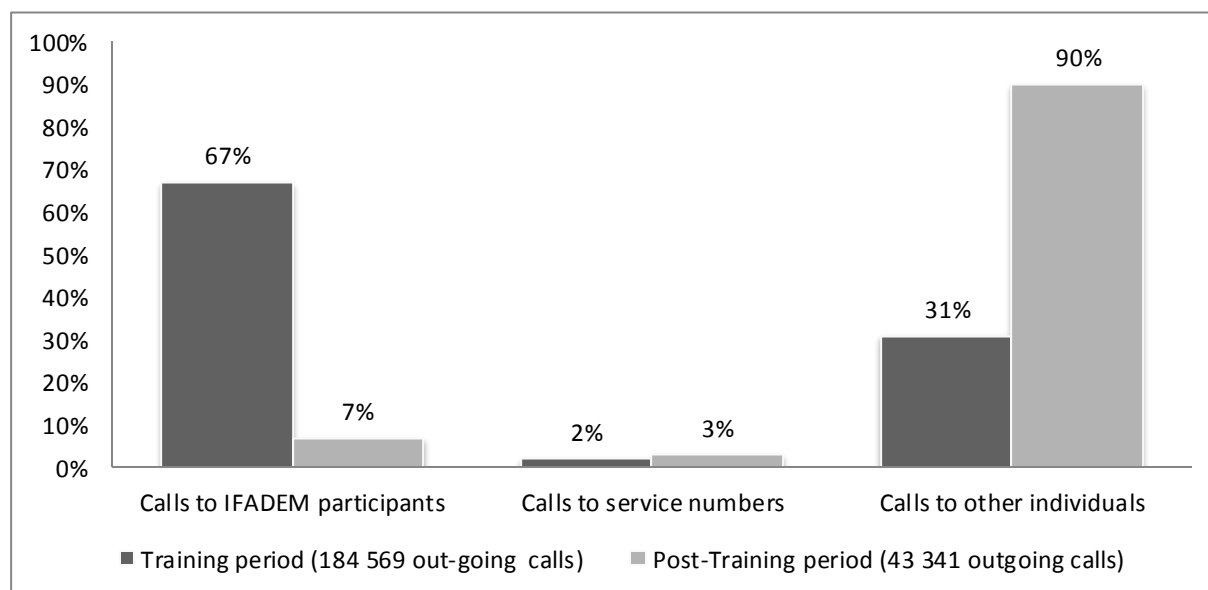


Source: Orange Madagascar; Number of outgoing SMS per call partner of 201 individuals according to their CDR in 2014; N=185

1.1.3 The shift of voice communications: A phone deeply embedded in users' lives

During the training, voice based communications were the main means of communication: Around 24% of communications were outgoing calls and 10% incoming calls from individuals. Automated calls from the voice box were excluded. This equals a total of 184 569 calls made by IFADEM participants, equaling around 58 calls per month per trainee. When looking at this type of calls in 2014, also during a 7 month period, it appears that the volume is divided by four, dropping to 43 341 (Figure 32). Knowing that there are 201 individuals who still use the phone, this equals around 30 calls per month per trainee. Again, this finding confirms that that despite the end of the pilot, the phone continues to be used for communications: Introduced as a training tool to users, it has gone beyond this role.

Figure 32: Proportion of out-going calls made by IFADEM participants during the pilot and afterwards



Source: Call Detail Records Orange 2012/3 (N=458) and 2014 (N=201)

➤ *IFADEM trainees are increasingly reached by phone*

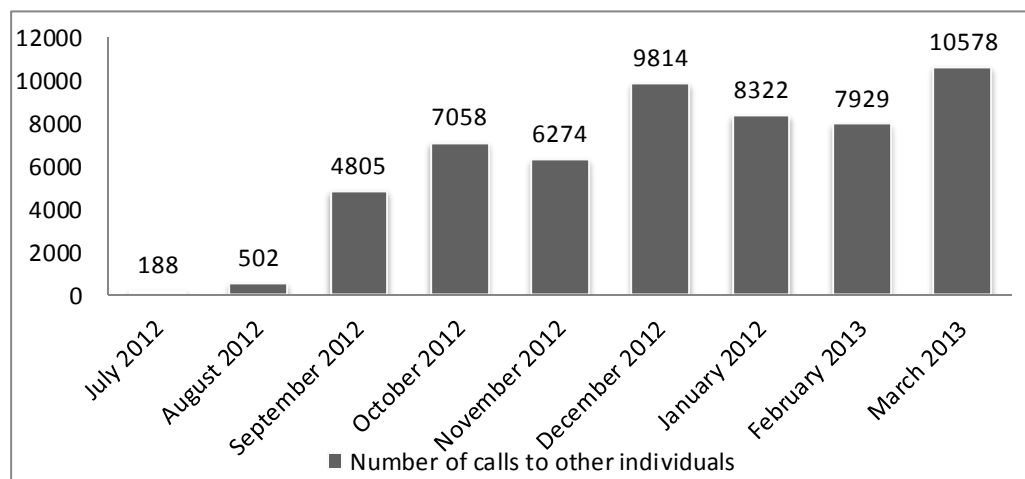
The overall number of phone users, the total number of calls made, and in parallel, the proportion of outgoing calls drops (from 24% to 20%). However, the proportion of in-coming calls increases from 10% in 2012/3 to 14% in 2014 (Figure 33). The interviews conducted in 2015 and the research literature provide here highly plausible explanations for this increase: Both the local school administration and teachers reported that all IFADEM numbers were registered by the local school authorities and directors (even if not participating in the training) and that nowadays they used these numbers to provide IFADEM teachers with school relevant information. Over time, the amount of people and administrations possessing these numbers increases, increasing hereby the amount of incoming communications. This would also be consistent with teachers declaring that they use the phone “*now more than before*”. This can be explained by research results which have shown that there is a direct link between perceived usefulness of the phone and the amount of possible contacts an individual can reach or be reached by. Here, the numbers of contacts has increased throughout the training period and afterwards, the use of this IFADEM phone becomes more and more valuable for former trainees (Pénard 2002).

In addition to this overall increase of contacts, it seems that some former trainees seem to occupy specific positions, explaining that they now “*act as focal point*” within the local community, i.e. they receive calls for neighbors who do not possess a phone. As exposed in chapter 1, phone sharing is indeed a common practice in Sub-Saharan Africa and certainly influences on the quantity of incoming calls of IFADEM participants.

➤ *The increase of calls: reflection of an appropriation process?*

The existing proportion of calls to other than training members, which has significantly increased over time, is an interesting source of information: During the training, 31% of outgoing calls concerned individuals other than training participants. These communications, which were not included in the pre-paid offer, show that the phone was already used during the training period as what could be considered as ‘traditional’ mobile phone (e.g. a tool to communicate) and not only as a training tool concerning solely IFADEM participants. The existence of calls towards other individuals, and the fact that these calls increase over time, can be interpreted as a symptom of progressive mastery and appropriation of the phone. The more teachers would get familiar with their phones, the more they would use it for communication which is not training related, i.e. with other individuals.

Figure 33: Number of calls to individuals other than training participants during the training



Source: Call Detail Records Orange 2012/3 (N=458)

Indeed, research on technology appropriation processes of pre-service teacher training indicates that appropriation is present when teachers do not only master the use of the technology for prescribed tasks, but find it personally valuable and develop derivate usages (Laffey 2004).

A look at Figure 33 shows that the number of out-going calls to other individuals increases steadily already during the training, indicating a progressive embeddedness of the phone and appropriation process. In this perspective, these communications with other individuals than IFADEM trainees complement the findings from the interviews conducted for the evaluation in 2013, as well as later in 2015 for this research. They indicate further non-prescribed and personally valuable usages, which are increasingly developed over time. The mobile phone was and further develops its hybrid role, half – professional half personal tool, both with regards to the functions used (e.g. calculator, agenda, photo) as well as for communications.

➤ *A small but existing proportion of peer to peer communication*

When comparing the evolutions of peer to peer calls and calls to other than training participants, a clear shift can be observed: While the pre-paid offer, the daily quiz and the monthly and quarterly meetings certainly stimulated individuals to make calls to other training peers explains the 67% rate of ‘IFADEM-only’ calls during the training period, this proportion drops to only 7% in 2014. In contrast, the proportion of calls to other than training participants triples: 90 % of calls made by a former IFADEM participant with the phone received during the training do not concern a training colleague.

Even if 7% of peer to peer communications appears to be very low, its very existence is a very interesting finding when researching sustainable contributions of mobile supported teacher training. The fact that former training participants continue to call each other despite the end of financial and organizational incentives indicates a development of sustainable relationships which need to be investigated further, particularly with regards to their collaborative character. The subsequent analysis will focus on peer to peer communication both in terms of quantity (number of individuals still in touch with a former training peer and number of calls) and quality (profiles of peer to peer communicants) in order to refine the nature of this peer to peer communications.

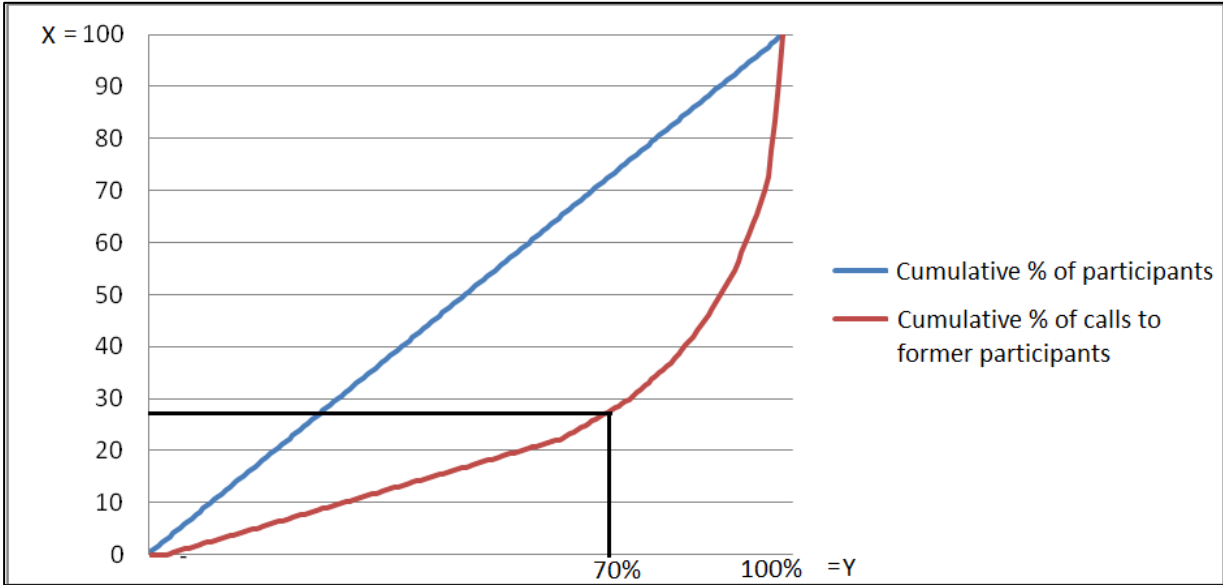
1.2 Peer to peer communication: Uneven proportions, uneven profiles

1.2.1 A small proportion of individuals is highly engaged – teacher to teacher communication is dominant

The evaluation conducted in 2013 had identified that the number of calls to other training members varies strongly, ranging from 0 to an average of 237 calls per month. Furthermore, it appears that during the training, 67% of all peer to peer calls are made by 25% of training participants. After the training, the analysis of former participants Call Detail Records shows that out of 201 still active participants, 184 teachers and 16 tutors are using the phone to call a former training participant. The amount of calls made varies significantly, ranging from 1 to 49 calls to former IFADEM trainee a month. While there is not a group which can be considered as occupying the ‘monopole’ of peer-to-peer communications, it however appears that like during the training, a dedicated proportion of individuals covers particularly many peer-to-peer calls afterwards.

Indeed, a look at the proportion after the training shows that around a quarter (27%) of those who continue to call another training member cover around 70% of these calls (Figure 34).

Figure 34: Lorenz Curve – Proportion of former IFADEM trainees (x) that cover the peer to peer communications (y)



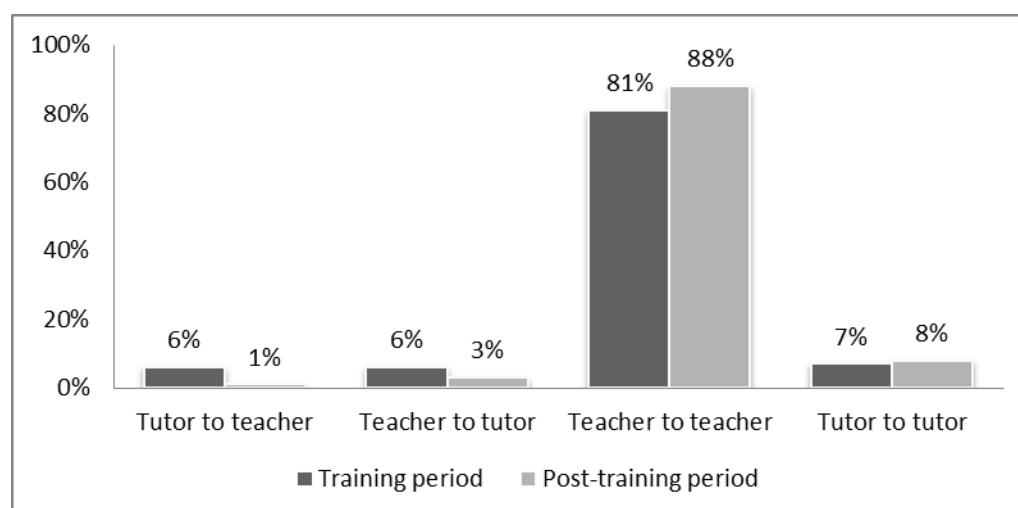
Source: Call Detail Records 2014. N=458

When comparing the amount of communications with the status of the participant during the training (teacher or tutor), it appears clearly that both during and after the training, the

proportion of teacher to teacher communication is dominant. It even increases even from 81 to 88% once the pilot is finished. Tutor to teacher communication, already very low – teachers were supposed to call tutors when they had problems, not the reverse – decreases even further.

Given that there were only 22 tutors in charge of 436 teachers, it has to be noted that 8% of all peer to peer communication after the training concerns communication among tutors. It confirms the findings of the qualitative analysis, exposed in the previous chapter, which had found that tutors were highly convinced of the utility of the phone and appreciated much to communicate with their tutor colleagues. Also, they were identified to be more familiar with the mobile phones than teachers and reported more innovative and unexpected phone usages. However, the certainly most important explanation of this sustaining communication between tutors is the fact that they were chosen among pedagogic councilors: This role obliges them to be regularly in contact with each other. Interestingly however, they declared that the IFADEM training had reinforced their relationships and influenced the amount of their mobile based communications with colleagues.

Figure 35: Proportion of communication among teachers / tutors during and after the pilot



Source: Call Detail Records 2012/3, N =458; 2014. N=189

Finally, despite the fact that communications have overall decreased, peer to peer communication continues to that extent is an interesting finding: It indicates again that a certain proportion of teachers has developed sustainable relationships which involve the use of mobile phones to communicate with each other. It is very likely that the monthly tutored

meetings have favored the creation of these contacts for which teachers are, once the pre-paid plan was over, willing to cover for communication costs.

1.2.2 The ‘phone user category’ during the training, a predictor for post-pilot phone usage?

An interesting way to comprehend the profile of those who continue to be in touch with training peers is to look at the *phone user category* to which a participant belongs. The 2013 project evaluation had created a typology of phone users that classified IFADEM trainees into three categories: *Rare user*, *intermediate user* and *frequent users*. These categories took into consideration the amount of:

- outgoing calls *to* other training participants;
- incoming calls *from* training participants;
- outgoing SMS other than those to a service number or Quiz answer
- outgoing calls to individuals other than training peers
- and the degree of quiz participation.

When looking at the user category of individuals making calls to former training peers, it can be ascertained that the majority has been categorized as either frequent (41%) or intermediate user (48%) during the training. Only 10% of peer to peer communicants after the end of training are rare users, and none of these rare users has, unsurprisingly, a high average calls towards other former participants (34-48 calls per month, or 26-29 calls per month).¹⁹

How do peer to peer communications evolve according to these user categories? After having excluded tutors from the analysis for the sake of comparability – their profile and role is too distinctive – three analyses were made for each category:

¹⁹ The user groups were defined in the evaluation report at the end of the training. Individuals were categorized after having ranked them according to factors like the amount of communications and the participation in the quiz campaign. (Le Quentrec et Gire 2013)

- the proportion of individuals, who still use the phone
- the average amount of calls that individuals from each user category would make towards another training peer and
- the regularity of peer to peer communications (7 out of 7 analyzed months being the highest regularity score achievable).

Two results are here striking: Firstly, the higher the phone user category intensity, the higher the proportion of later active individuals (Table 14): While among strong users, around 68% are later still using the IFADEM phone, moderate users have an almost equal proportion of later active and inactive (52% / 48%) individuals. In contrast, a large majority of rare users happen to not use their IFADEM phone anymore (86%).

Secondly, when comparing the amount outgoing calls made towards peers after the training with the amount of outgoing calls towards peers during the training, it can be found that

- active *rare users*, provided they are part of the few rare users who continue to use the phone, will continue to call as often as during the training (1 to 2 a month) another training member. However, they are not regular in this regard: On average they use only 2 to 3 months out of 7 the phone to contact former IFADEM participants.
- active *intermediate users*, who had called on average 4 times per month another training member, their average decreases to an average of 2 calls per month. They are slightly more regular than rare users, using the phone IFADEM participant communication 3 to 4 times out of 7.
- active *frequent users*, who had called on average 13 times per month another training member during the training period, have with 5 calls per month the highest amount of average calls to other training members per month. Frequent users will use at least 5 out of 7 months the IFADEM phone to contact their former training colleagues.

Table 14: Activity level and average of amount of calls to other training members per user category

		Use the phone after the training	Calls to former training peers per month	Don't use the phone	Regularity of calls	
Frequent User	Count	69	5	33	5	102
	% within User Category	67,6%		32,4%		100,0%
Intermediate User	Count	94	2	86	3-4 / 7	180
	% within User Category	52,2%		47,8%		100,0%
Rare User	Count	21	1-2	132	2 – 3 / 7	153
	% within User Category	13,7%		86,3%		100,0%
Total (teachers only)	Count	184		251		435
	% within User Category	42,3%		57,7%		100,0%

Source: Orange Call Detail Records of 435 trainees (tutors excluded) and identified as using their phone or not after the end of the training period. Analyzed period covers 6 month in 2012/3 and 7 months in 2014.

Here, a look at the profile of ‘peer to peer champions’ is useful: They all have been *frequent users during the training* and have been interviewed during the interview series in 2015 and 2016. An analysis of their profiles shows that a positive training experience and particularly high enthusiasm for a phone that they describe, reported as useful both outside and inside the classroom (cf. Box 5). In some cases, a particular professional function (school director, Chef ZAP) seems to favor this perception of usefulness and influence on the use of the phone later on.

Finally, the most striking finding when looking at the evolution of peer to peer communications according to the phone user group is the difference in terms of geographical location and technological experience.

Indeed, *rare users* are of a large majority composed of individuals from the remote and isolated areas Ambatofinandrahana and Manandriana, as well as individuals who do not have possessed a phone prior to training start nor access to electricity. In the aftermath of the

training, they are rarely active and still in touch with former training peers later. In contrast, frequent users are mostly composed of the semi-urban area Ambositra; individuals in this category have possessed a mobile phone and access to electricity. Intermediate users are almost a mixture of both profiles, besides the fact that there are almost no individuals from Ambatofinandrahana.

Box 5: Profiles of individuals with high volume of IFADEM communications - Findings from the interviews

Jean Francois R., average of 26 calls per month other training peers: Jean Francois is Chef ZAP, a function that obliges him to be in contact with a lot of teachers. Very enthusiastic about the phone, used solely for work, he stresses that he uses it almost “*abusively*” and on almost “*daily*” the phone – and that prior to the training, he rarely used a phone: “*It has really facilitated work as with the phone, everything becomes quick, you call right away. All problems are solved with the phone*”. When asked why he is still in contact with former training peers, he explains that it is mostly for administrative reasons, but also to discuss questions related to the IFADEM workbooks. At the time the interview was conducted he waited for his children to come to visit in order to ask him how to use the E-mail function on his phone.

Charline R. is the trainee with the highest average calls to other former IFADEM members, and her profile is as exceptional as her average monthly amount of calls to former training peers (39) – even though she is ‘just’ a normal teacher and not in a professional position that stimulates particularly mobile supported communications. Despite the lack of a electricity at home, and no previous phone experience - The IFADEM phone was her first phone – she found it very easy to use and integrate it in her private and professional life. Overall identified as **frequent phone user**, she did only moderately take part in the quiz campaign. Now, for work, she appreciates, like Jean Francois, the fact that it helps to «*quickly solve problems*». More important than the practical aspect though she appreciates the phone as it has a positive impact on her lessons when she decides to use it in the classroom. Most importantly however, she praises the phone as it has “*developed the exchanges between us Ifademiens, contrary to the pre-service training, there was this possibility to exchange*”. Her exchanges with her former colleagues from the training are highly organized; they call each

other every week to “do a debriefing”. When her phone broke, she decided to keep the sim card so that she could continue to use it.

André R., with an average amount of 32 calls per month, is also a regular teacher who particularly appreciates the phone as it allows him to stay in touch with former training peers and to prepare the lessons, particularly at the end of a training year. According to him the training and the phone has launched a “*pedagogical ties*” amongst training members; he has “*more contacts now than then*”. Interestingly, he uses the mobile to contact people who live and work within his school district, all people he can meet in person too.

R. – has an average of 26 calls per month to former IFADEM peers and has been a frequent participant during the training, and also participated frequently in the quiz campaign. His function – he is a school principal – favors the frequent interaction with other colleagues, something he actively encourages. For him the mobile is “*indispensable, as it not only allows exchanging and staying in touch, but also because of the audio files you can use during a lesson*”. When asked why he continues to exchange with former IFADEM participants, he explains that he either asks advice from colleagues who “*speak better French*” or to provide advice to others. R. presses that before the training, “*there was no collaboration between the teachers. And those who have not been trained have been kind of trained by those who had received the training*”.

2. Why? – Identification of factors for sustainable phone use

Based on the use of descriptive statistical methods, and mobilizing the findings from the qualitative study, the comparison of Call Detail Records during and after the training period has allowed to show that there is a certain number of individuals (43% out of 458) who continue to use to communicate with the phone in a sustainable manner after the end of the training. Furthermore, when looking only at the proportion of communication among training participants during the training and how this proportion evolves after its end, it can be ascertained that this type of communication is also sustainable. This continuity is particularly noteworthy in light of the end of external organizational stimulations or financial incentives. The overall increase of communications towards non-training individuals since the start of the pilot confirms also the by interviewees declared appropriation process, enhanced by progressive mastery of the phone and its functions.

The analysis has shown that neither the type nor the quantity of communications is homogeneous: While SMS communications are present and revealed to be a complementary mean of communication, chosen in specific cases, there is an overall preference for voice based communications, confirming hereby the findings from the qualitative studies conducted in 2012 and for this research, in 2015.

With regards to the quantity of communications made by former training peers, the descriptive analysis revealed that peer to peer communications are not equally distributed. Individuals who have been highly engaged during the training (both in terms of communicating with the phone and taking part in the quiz) are overrepresented among those who later still use the phone and continue to communicate with training peers. A closer look at their profiles reveals that they are mostly from the less isolated areas Ambositra and Fandriana, more experienced with mobiles phones and have more often access to electricity. In contrast, individuals from the rural and remote areas Ambatofinandrahana and Fandriana were not only less engaged during the training but are also less present among active and peer-to-peer communicants.

These findings show the need to mobilize inferential statistical methods in view of analyzing if and to which extent these individual and contextual inequalities of participants and school districts are *de facto* associated with sustainable use of the phone. Besides the identification of the most discriminant factors among these variables, the objective of the subsequent section analyze the dynamics of infrastructural inequalities resulting in an unequal training experience, and determine how and to which extent these dynamics are at the origin for the cease or sustainability of mobile communications.

2.1 Individual factors: Gender and diploma do not impact on sustainable phone use

The evaluation of 2013 could identify some differences in terms of training engagement related to individual aspects like gender. Even if these were ultimately not identified as being highly discriminant, it appears important to control their impact on later use of the phone for communications.

When extracting the numbers of individuals using the phone after the training period, it appears that 201 out of 458 participants still use their phone (43,3 %), including 185 out of 436 teachers and 16 out of 22 tutors. A cross-reference of those individuals who were marked as still being active in 2014 with their same socio-economic indicators shows that among those who still use the phone, 59,7% are women (Table 15). The average age remains in-between 50 – 55 (63,7%). While the majority has obtained the *BEPC* (79%), only 15, 4% of those who still use the phone hold a *baccalaureate*. The majority has a civil servant status (77,6%), which is not surprising as a large majority of participants were civil servants. Fandriana remains the region where the majority of still active former participants work (49%), followed by Ambositra (44,5%). Only very few former training participants from Manandriana (1,5%) and Ambatofinandrahana (4,5%) are still using their phones.

Table 15: Socio-economic profiles of participants during and after the training

	During the training	After the training	
Active participants (N)	458	201	
Civil Servants	75 %	78 %	
Men	44%		
Women	56 %	60 %	
Average age	50 – 55	50 – 55	
BEPC holders	84%	89 %	
Baccalaureate holders	10%	15 %	
From Ambositra	77%	45%	
From Fandriana		50 %	
From Ambatofinandrahana		23 %	4,5 %
From Manandriana			1,5 %
Phone user category	33,4 % Rare User 25,5 % Intermediate User 41 % Frequent User	10,4% Rare User 40,8% Intermediate User 48,8 Frequent User	

Source: Orange Call Detail Records (6 months in 2012/3 and 7 months in 2014. N = 485 (2012/3) and 201 (2014))

2.1.1 Women and men have almost equal chances to develop sustainable phone usage

The evaluation of 2013 did not identify an impact of gender on the grade obtained during the theoretical evaluation (which could have been interpreted as a possible positive or negative training experience). Neither could be identified gender related differences when it comes to difficulties manipulating the phone. In contrast, it was found that women had 2,5 times more chances to be a strong SMS campaign participant, were slightly calling more often individuals not concerned by the training (Le Quentrec et Gire 2013). Among socio-economic characteristics, gender appeared hence a factor possibly influencing on the sustainable use of the mobile phone among former trainees.

When cross-referencing the variables gender and activity level (Table 16) it can be ascertained that among the 201 still all active training members, only a slight majority are women (130 = 50,6%).

Table 16: Contingency chart including of the variables phone usage and gender

	Women	Men	
Don't use the phone	130	127	257
Use the phone	120	81	201
Total	250	208	458

Source: Analysis based on the CDR retrieved for a dedicated period in 2012/3 and 2014. N = 458

The performance of a Chi-square test indicates a moderate association of the variables gender and phone usage (p -value <0.05 ; Cramer's $V = 0,10$). The identified risk ratio is unsurprisingly low: Women have only 1,2 more chances than male participants to use the phone in the aftermath of the pilot.

This lack of strong impact of gender on sustainable phone use is consistent with recent research findings: While men in Africa are still more likely than women to possess a phone, several studies on mobile pedagogy readiness and studies on teachers ICT acceptance identified that there is no statistically significant impact of gender on the actual phone usage, when both sexes possess it (Street et al. 2015; Ismail et al. 2013; Mumtaz 2000).

2.1.2 Higher academic qualifications do not impact on phone usage

The academic level of participants was another socio-economic characteristic which appeared to possibly influence on sustainable communications with the IFADEM phone. Given that the 2013 evaluation report had found that “*teachers with a higher degree (baccalaureate and higher) have less difficulties to learn how to use the phone*” (Le Quentrec et Gire 2013, p.34), it appeared possible that this ease of use would positively influence the training experience of tutors and, subsequently, their willingness and capacity to use the phone after the end of the training. However, when cross-referencing the variables *diploma* and phone usage it was found that there is only a slightly higher proportion of trainees who are still using the phone and have a BEPC. Also, the distribution of individuals with the baccalaureate (BAC) is almost even (21 and 22) among those who continue to use the phone and those who don’t (Table 17).

Table 17: Contingency chart including of the variables phone usage and diploma

	BAC (and +)	BEPC	
Don’t use the phone	22	207	229
Use the phone	21	158	179
Total	43	365	408

Source: Analysis based on the CDR retrieved for a dedicated period in 2012/3 and 2014. N = 408.

The performance of a Chi-Square test does not allow identifying an association of the variables (p. value > 0.05). This absence of significant association shows that the training participants’ level of academic diploma does not impact on sustainable phone usage. In this regard, higher qualified teachers have not more chances than lower qualified colleagues to develop sustainable phone usages, and *vice versa*. This confirms recent research results of Ismael which had ascertained an absence of correlation between teacher qualification and mobile readiness (Ismail et al. 2013).

2.2 Infrastructure factors: Challenging school districts impact on phone usage

Found by the project evaluation 2013, confirmed by qualitative study and shown earlier in this chapter, infrastructural challenges are significantly higher in the districts Ambatofinandrahana and Manandriana. These differences are visible both in terms of infrastructure and

engagement of trainees. More precisely, the report indicates that “*the availability of modern infrastructure, i.e. access to electricity, and the possession of a mobile phone prior to the training start, is much higher in Ambositra, the county seat of the region. In contrast, there are large blank zones of network coverage in Ambatofinandrahana*”(Le Quentrec and Gire 2013, p.8). Most importantly, the evaluation concluded that the above cited challenges had a negative impact on the overall involvement of trainees located in Ambatofinandrahana and Manandriana in the training activities. It appeared hence possible that these infrastructural challenges affect the decision – ability? – of former training participants to use the phone in the aftermath of the pilot. In the following will be analyzed to which extent the geographical location seems to indicate that infrastructural factors like electricity, familiarity with phones and network satisfaction is associated with a later phone usage.

2.2.1 Overrepresentation of sustainable phone users from Ambositra and Fandriana: Indications of local, favorable factors

As exposed earlier in this chapter, the proportion of individuals who still use the phone is mainly composed of individuals from Fandriana and Ambositra. More precisely, out of 40 participants from Manandriana, only one individual is still active (3%), and from the 59 participants from Ambatofinandrahana, only 7 (12%). These proportions contrast with those from Ambositra and Fandriana: From respectively 162 and 175 individuals, 83 and 53 (51% and 53%) still use the phone after the training. It was hence expected that the geographical location (i.e. the school district) would be statistically associated with phone usage (Table 18).

Table 18: Contingency chart of the variables phone usage and school district

	Ambatofinandrahana	Ambositra	Fandriana	Manandriana	Total
Use the phone	7	83	93	1	184
Don't use the phone	52	79	82	38	251
Total	59	162	175	39	435

Source: Analysis based on the CDR for a dedicated period in 2012/3 and 2014, focusing on 435 individuals (tutors are excluded). N = 435.

The performance of a Chi-square test confirmed this intuition and revealed a moderate to strong relationship of both variables (p-value <0.05; Cramer's V=0,38). The subsequent performed binomial regression, performed to ascertain the dedicated effect of appurtenance to

a school district on later phone usage, revealed that former training participants from Ambositra or Fandriana have around 22 to 23 more chances than an individual from Manandriana to use phone after the end of the training.

This is most likely due to the above cited challenges individuals face in Ambatofinandrahana and Manandriana. Indeed, the proportion of still active individuals is not only much higher in Ambositra and Fandriana, it seems also to go along with a higher proportion of individuals who indicated that they already used a phone at the moment the training started, that they had access to electricity and were satisfied with the network. Manandriana and Ambatofinandrahana are clearly composed of individuals who were less satisfied with the network and had less often access to electricity as well as less phone experience (due to the network?) than their peers in the other districts (Table 19).

Table 19: Contingency chart of the variables school district and proportion of still active individuals, individuals with a mobile phone at training start, access to electricity and who were satisfied with the network

	Ambositra	Fandriana	Ambatofinandrahana	Manandriana
Proportion of still active individuals	51%	53%	11%	3%
Possession of a phone at training start (among active)	42%	34%	16%	8%
Access to Electricity (per district)	71%	16%	11%	2%
Proportion of network satisfaction	76%	66%	33%	45%

Source: Questionnaires distributed at the end of the training period; Call Detail Records 2012-2014

In light of these findings it appears indispensable to analyze to which extent the reported key challenges in these districts (network satisfaction, the access to electricity and the anterior possession of a phone) is associated to the fact of still being active after the end of the training.

2.2.2 The lack of electricity influences on a trainees chance to be active after the end of the training

The project evaluation had identified that the lack of electricity had a negative impact on the involvement intensity of trainees during the training period: Individuals were reliant on solar chargers and hence depend on the daily climate or had to find another source of electricity. The rain season for example had led to reduced communications and quiz participation, as individuals were unable to recharge their batteries.

It appeared plausible that an ongoing lack of electricity would affect negatively a sustainable phone usage after the training, discouraging former participants, even more as they now have to pay for communications.

When looking at the contingency chart, it appears that among those respondents who did stop using the phone active, a large majority had reported to have no access to electricity (192). However, it also seems that even among individuals with continuous phone usage, the proportion of those without access to electricity is also higher than the proportion of those with access to electricity (Table 20).

Table 20: Contingency chart of the variables phone usage and electricity access

	No Electricity	Electricity	Total
Use the phone	111	51	162
Don't use the phone	192	32	224
Total	303	83	386

Source: Analysis based on CDR retrieved for a dedicated period in 2012/3 and 2014. N = 386

Firstly, the performance of a Chi-square test allowed firstly to confirm this intuition and reveals a strong strength of association between the two variables (p-value <0.05; Cramer's V=0,20). Then, the subsequently performed binomial regression shows a negative impact of a lack of electricity on a participant's likelihood to still use the phone after the end of the training period. More precisely, it reveals that the risk to not use the phone is nearly 3 times higher for individuals without electricity.

The field research phase and the interviews conducted with former IFADEM participants, as well as the high amount of active individuals who had no electricity access (111) makes it here important to underline the context of this pilot project: Access to electricity is, particularly in rural areas of Madagascar like in many rural African regions, fairly rare. Many interviewees even reacted surprised or even amused when they were asked if they had access to electricity. Populations are used to this lack of this infrastructure and the overall presence of mobile solar chargers and panels proves that they adapt to it quite well. With other words, while access to electricity is for sure a privilege and positive factor for sustainable phone use, it is not expected to be among the most discriminatory factors.

2.2.3 The amount of phone familiar individual is significantly higher among active individuals

Being particularly familiar with a technology infrastructure, notably mobile phones, appears clearly a factor potentially affecting sustainable usages. The impact of the latter could be identified right at the end of the pilot: At the beginning of the training, participants had been asked via questionnaires if they were using a phone at the training start, if they were not but already had possessed a phone in the past or if they had never possessed a phone prior to the one provided by IFADEM (3). The evaluation at the end of the pilot had found that among *rare phone users* – who are less likely to use the phone later on – a high amount had not possessed a phone in the past.

Table 21: Contingency chart of the variables phone usage and previous phone possession at / before training start

	Possessed a phone at training start	No phone possession at training start but in the past	IFADEM phone is their first phone	Total
Use the phone	123	13	20	156
Don't use the phone	135	16	59	210

Source: Analysis based on the CDR retrieved for a dedicated period in 2012/3 and 2014. N = 366

When looking at the cross table (

Table 21) of those who had possessed a phone in the past and could be identified among those later using the phone, it appears that this proportion is fairly similar to the one containing individuals who later don't. In contrast, when it comes to individuals who have never

possessed a phone, the difference becomes much more visible: Among the 79 teachers who had received a phone for the first time in their life at the training start, a majority (59) is 'inactive'. The performance of a Chi-square test allowed identifying a moderate association (p -value= 0.05; Cramer's $V = 0,18$) of phone familiarity and sustainable communications. The performance of the binomial regression revealed that those who have never possessed a phone increase by three their 'risk' to be among the later inactive individuals.

Even though these odds may not appear particularly high, they are in line with the results of the qualitative study: The fact that a lack of previous experience with a phone increases the chance of later *not* using the IFADEM phone can be interpreted as the confirmation that, as declared by interviewees, a 10 month training period is certainly a 'kick-off' moment for all trainees, but may be insufficient for those who have never used a phone. For those, the end of organizational support and stimulations may be an issue, as their own appropriation process is not at a point where they develop autonomous sustainable usage. With other words, it appears possible that these trainees may have learned how to use the phone for the training purpose, but could not build on previous experiences with the phone: It was introduced to them as a training tool only, and was not yet known as socially embedded tool.

This hypothesis appears to be even more plausible when looking at the statistical association of previous phone possession and reported use of the phone in the classroom. In the case of novice mobile phone users, and in contrast to those who already had possessed a phone, the phone was not used during the lesson. The association of phone familiarity and pedagogical innovation could be confirmed with a Chi-Square test (p -value < 0.05). Among the 240 individuals who had answered that they use during a lesson the audio files, preloaded on the phone, 200 were already familiar with the phone (74%).

A multinomial logistic regression reveals that those participants who have been familiar with the phone are indeed 3, 4 times more likely to use the phone in the classroom. With other words, teachers who have fewer phone experience – or are less aware? – will be less likely considering the phone as a tool to be used during the lesson. These findings correspond to those exposed in the previous chapter, linking the use of the phone to a higher degree of appropriation.

However, the fact that there are 20 teachers who never possessed a phone but are later among active individuals leads to the impression that phone familiarity may certainly play an important role, but that other factors need to be considered in order to understand the origin of the sustainability of communications.

The question of the importance of access to satisfying network coverage appears here clearly: Indeed, users who live and work in areas without satisfying network coverage appear less likely to use their phones and in consequence, to appropriate it fully in their lives. Ultimately, may it be the lack of network coverage at the origin of this slowed down appropriation process and ceased sustainability in the case of almost 50% of participants?

2.2.4 Significant network satisfaction differences among the school districts

Knowing that intermediate and frequent users are mostly from Ambositra and Fandriana leads to the question of network coverage in these regions. The final evaluation had revealed an uneven network quality in network quality among participating regions, particularly in Manandriana and Ambatofinandrahana. Most importantly, it had found that this insufficient network quality was had impacted negatively on training engagement (e.g. communication, quiz participation). During the interviews conducted 2 years later for this research, the negative impacts of lacking network coverage could be confirmed. For example, a tutor explained that poor network coverage was the reason why she was not anymore in touch, at least per phone, with trainees of her group living in Manandriana:

In contrast, a satisfying Orange network was one of the reported reasons to keep the phone, as shows the following declaration of a tutor, already exposed in chapter 5:

EvLC: *Are you still in touch with all teachers (whom you supervised)?*

Tutor: *Yes*

EvLC: *All the 19 (trainees)?*

Tutor: *Oh, well no not those from Manandriana..*

EvLC: *Why?*

Tutor: *They don't have network coverage. But sometimes they come here, too.*

EvLC: *Why did you keep the phone?*

Tutor: *Because there is a lot of Orange network here, in Fandriana.*

Clearly, network coverage appeared intuitively important for sustainable phone usage. When looking at the frequency distribution in the contingency chart, this intuition is reinforced (Table 22).

Table 22: Contingency chart of the variables phone usage and degree of agreement with the statement “My network coverage was satisfying”

	“My Network coverage was satisfying“				Total
	Strongly Disagree	Moderately Disagree	Slightly Agree	Strongly Agree	
Use the phone	17	17	21	120	175
Don’t use the phone	83	28	41	73	225
Count	100	45	62	193	400

Source: Analysis based on the CDR retrieved for a dedicated period in 2012/3 and 2014. N = 400

The Chi-square test indicates a very strong association of the variables ($p\text{-value} < 0,05$; Cramer’s $V = 0,38$), confirming the intuition and declarations of interviewees. A binomial logistic regression was performed to ascertain the effects of network coverage satisfaction on the likelihood to still use the phone after the end of the training period. The regression allowed concluding that participants who strongly disagree with the statement ‘my network coverage was satisfying’ are 8 times more likely to stop using the phone for good after the training.

Per se, this finding is not surprising: It is obvious that a lack of network coverage makes the phone useless for communications - and subsequently excludes concerned individuals the possibility to communicate. The impact on phone usage is however more complex, and directly relate to the perceived utility: As previously exposed, the added value of a mobile phone increases in parallel to the number of individuals that one can reach by phone. A look at the Call Detail Records of individuals from Manandriana and Ambatofinandrahana shows that not only they call less than their peers from Ambositra and Fandriana, but they have also less mobile contacts in their zone. This lowers even more the utility of the phone, leading in turn to a slow down or in existing process of increased mastery and appropriation. Most importantly, the lack of network means that trainees from Ambatofinandrahana and

Manandriana are also less enabled to contact their IFADEM peers (cf. interview extract on the next page), excluding them from the 'Ifademiens' community described by their peers. In contrast, in those zones with better network coverage, trainees were able to develop new and strengthen existing mobile supported relationship as well as develop new usages.

Overall, the strong association and risk analysis confirms both the previous evaluation findings and results from the qualitative analysis conducted for this research: A satisfying network is crucial for a rich training experience and to develop continuous and various phone usage in a sustainable manner.

Also, it seems that the lack of network coverage is not only an infrastructural issue, but a crucial factor impacting on the motivation of trainees, an element already investigated in the evaluation report. Indeed, teachers who, because of network insufficiency, are unable to take part in the quiz, unable to contact peers and their tutors appear to be more vulnerable to resign and drop out. Later, interviews with former trainees from Ambatofinandrahana revealed that they had to climb a small hill in order to receive and answer the quiz, which subsequently discouraged some peers:

EvLC: Did you encounter difficulties during the training, because of the network coverage?

Teacher: Sometimes we have to go higher. Climb on a small hill to participate in the quiz.

EvLC: Did this impact on your motivation to participate?

Teacher: No, not in my case...but I know yes, for some it was discouraging.

This explanation and the fact that the interviewee deliberately distinguishes himself from the others ("*not in my case*") confirm what could be found from the contingency table: There are also individuals (34) who have managed to be active *despite* a lack of satisfying network coverage. With other words, there are factors of influence which are difficult to measure (e.g. outstanding motivation, pro-activity, ambition) but which certainly play a compensating role, to a certain extent. The attitude of climbing a hill can indeed be considered as a sign of technological appropriation. A recall of Hahn's description and research results, exposed in chapter 1 is here useful:

Technological appropriation and economic appropriation are directly related to difficult technical, infrastructural and economic situations of users. Hahn observes that villagers exhibit an inventive attitude in extending the scope of the mobile network signals when they climb hills in order to make a call, or look for alternative ways to charge their phone or repair batteries. Hahn observes that villagers exhibit an inventive attitude in extending the scope of the mobile network signals when they climb hills in order to make a call, or look for alternative ways to charge their phone or repair batteries. Hahn observes that villagers exhibit an inventive attitude in extending the scope of the mobile network signals when they climb hills in order to make a call, or look for alternative ways to charge their phone or repair batteries (Chapter 1; Section 2.1.4).

2.3 Training related factors: Do training behavior and imposed training modalities impact on sustainable phone communications?

In order to comprehend the impact of infrastructural factors on sustainable phone usage, it is indispensable to understand to which extent these factors have influenced in turn the way participants could take part in the training. This participation, reflected in practices and engagement during the training, has been found to be of relevance for sustainable phone usage: Both the final and external evaluations, as well as the later on conducted qualitative study (see chapter 5) indicate that the training experience may influence the capability and motivation to communicate with the phone later on. Besides assessing the importance of network coverage 'behind' these training related variables; the following section shall identify those practices (calling tutors or peers, being particularly engaged during the training) but also imposed training modalities (being assigned to one of the three training waves, having received a basic phone or a feature phone) may increase the chance of a trainee to continue to use the phone for mobile communications.

2.3.1 Phone usage and training engagement

➤ *Intensive phone users during the training are sustaining phone users*

Previously it could be ascertained that among those individuals who later use the phone, there is over-representation of IFADEM trainees which had been identified to be ‘intermediate’ and ‘strong’ phone users, the two categories of individuals who happen to be later mostly active.

Knowing that

- they are mostly composed of members who are mainly from Ambositra and Fandriana
- have possessed a mobile phone prior or at training start
- had access to electricity
- had indicated to be satisfied with their network coverage
- had higher proportion of non-participant communications

and knowing that these variables are all significantly associated with the fact of using later the phone, it appeared important to analyze the regrouped effect of this variable on the fact of using later the phone.

A look at the contingency chart confirms: Among the 184 teachers using the phone after the end of the training, 94 and 69 individuals are respectively strong users and intermediate users. In contrast, out of 251 teachers who do not use their phone after the end of the training, 132 had been labeled as rare users (Table 23).

Table 23: Contingency chart of the variables phone usage and phone user category

	Rare user	Frequent user	Intermediate user	Total
Use the phone	21	69	94	184
Don't use the phone	132	33	86	251

Source: Analysis based on the CDR retrieved for a dedicated period in 2012/3 and 2014 N= 435

As expected, the performance of a Chi-square test found a very strong association (p-value=0,05; Cramer's V=0,43). A binomial regression was performed in order to measure the effects of the user type on the likelihood to be active after the end of the training. The regression reveals that those who have been among the intermediate users during the training

subsequently have 13 times more chances to develop continuous phone usage after the end of the training.

This finding confirms the crucial impact of a poor infrastructure on the sustainable use of the phone for communication and is line with the findings from the qualitative study: The subsequent study results will show further effects on training participation, phone usages and the extent to which these in turn hinder or favor sustainable mobile communications.

➤ *Degree of quiz participation, an indicator of a sufficient network coverage and collaborative stimulus*

Among all variables that were considered when creating the variable *user type*, the variable *quiz participation level* appears to be of particular interest when it comes to analyzing which type of user is still active after the end of the training period, as it is very informative of the importance of network coverage for a positive training experience: According to the evaluation conducted in 2013, trainees who had indicated that they were *not* satisfied with their network coverage had six times more chances to never or anecdotal participate in the daily quiz campaign. In contrast, satisfying network coverage would multiply the chance to actively participate in the campaign by seven (Le Quentrec et Gire 2013, p.32).

The performance of a Chi-square test confirms the very strong association of the variables network satisfaction and quiz participation (p-value <0.05; Cramer's V = 0, 38). A more detailed look at the contingency chart (Table 24) shows: Among individuals having anecdotally participated in the quiz, there are significantly more individuals who had replied that they were not satisfied with the network.

Table 24: Contingency chart of the variables quiz participation level and network satisfaction of former IFADEM trainees

Quiz participation	Anecdotal	Weak	Frequent	Moderate	Never	Total
Unsatisfying network coverage	73	30	7	9	26	145
Standardized residuals	5,1	,3	-5,6	-2,2	3,3	
Satisfying network coverage	39	48	114	42	12	255
Standardized residuals	-3,8	-,2	4,2	1,7	-2,5	

Source: Analysis based on the CDR retrieved for a dedicated period in 2012/3 and 2014, N = 400

Subsequently, the distribution of responses according to the phone usage shows that the majority of individuals who have never (89%) or only anecdotally (76%) taken part in the quiz campaign ceased communicating with the phone after the end of training (Table 25). In contrast, a majority of those who were identified as frequent participants is still active (64%).

An association of the variables quiz participation with phone usage was expected as a high participation quiz participation rate was one of the characteristics individuals with a higher network satisfaction than their peers and who, in turn, were identified to be more likely to be active afterwards. The performance of a Chi-square test confirmed this intuition and revealed a very strong association in-between the two variables (p. value <0.05; Cramer's V = 0,38).

Table 25: Contingency chart of the variables quiz participation level and activity status

Quiz participation	anecdotal	frequent	moderate	never	weak	Total
Use the phone	30	83	30	5	36	184
% in Quiz Participation	23,8%	64,3%	56,6%	11,4%	43,4%	42,3%
Standardized Residuals	-3,2	3,8	1,6	-3,2	,2	
Don't use the phone	96	46	23	39	47	251
% in Quiz Participation	76,2%	35,7%	43,4%	88,6%	56,6%	57,7%
Standardized Residuals	2,7	-3,3	-1,4	2,7	-,1	

Source: Analysis based on the CDR retrieved for a dedicated period in 2012/3 and 2014, N = 435

A binomial regression was performed, indicating that the odds of not using the phone are 5, 6 times higher for rare quiz participants than for those who had frequently taken part in the quiz.

While the quiz participation can be considered as an indicator of later sustainability because of its strong dependency on network coverage, the interviews conducted with former participants indicate that the quiz participation did also influence on the later activity of trainees because it allowed them to live a collaborative training experience.

Indeed, both the evaluation of 2013 and the interviews conducted two years after the end of the training indicated that individuals did exchange with peers before sending the answer; in some cases tutors wrote down every quiz question to discuss the questions during the tutored training session.

With other words, those who participated in the quiz campaign were also part of collaborative exchanges. These mobile supported ties and exchanges explain why, even after the end of the training and hence the quiz, they continue to use their phones. In the case of individuals who were less engaged in the training and the quiz because of the network, and subsequently less able to exchange with peers, the mobile phone – at least the one provide with an Orange network supported SIM card – became unusable.

The importance of the collaborative exchanges initiated by the quiz campaign appears even more in the interviews conducted with individuals from Ambatofinandrahana and Manandriana who managed to take part in the quiz moderately or frequently, but whose phone use ceased after the end of the training. Interviews with these trainees indicated that, because of the insufficient Orange coverage in their district, they used actually another phone with a SIM card from a concurrent provider to exchange with peers during the training, and related to the quiz, and continue to do so after the training. This is also the case for some who have lost their phone, but make the effort to communicate their new number in order to stay in touch with former training peers, as shows the declarations of a former IFADEM participant, a director with teaching functions:

Director: I still have my number. I am still in contact with other Ifademiens who don't have their numbers anymore. Regularly, at the end of the month...it's really to exchange. It's really among Ifademiens.

This shows that, even if some participants are according to their IFADEM (Orange) Call Detail Records, categorized among those who are inactive, they are actually ‘sustainable’, individuals who continue to exchange with colleagues and peers met during the IFADEM training. This means not only that the proportion of still active Ifademiens is likely to be higher than expected, but also that the collaborative dynamics established during the training are sustainable even if somebody loses the IFADEM number: it appears clearly that ongoing exchanges with their training peers is important for former IFADEM participants.

➤ *Peer to peer communication: Crucial for sustainability?*

Knowing that the variable user type which had categorized every trainee into one of the 3 user types categories (strong, intermediate and rare users) was created taking into consideration the amount of outgoing calls to other training members, it appeared important to identify to which extent the amount of this peer to peer (teacher to teacher) communication would actually impact on the fact that trainees use or not their phone after the end of the training period. After having identified 2h45 of outgoing communication as a threshold, a binary logistic regression was performed to ascertain the effects of communication level with a trainee during the training (>2h45) on the likelihood that a former participant will still be active after the end of training. The logistic regression model allows to ascertain that a teacher calling more 2h45 another trainee during the training period has hence 4,6 times more chances to use the phone after the end of the training.

This finding confirms the overall impression of continuity for individuals who have been using the phone intensely during the training period (cf. section on user category): Again, while this continuity is only possible with a satisfying network coverage, it can also be interpreted as symptom that these users have created mobile supported relationships with other trainees, and that these are important enough to be maintained after the end of the financial support they had benefitted from during the training.

2.3.2 Teacher or tutors: Factors of influence on sustainable phone usage

Both teachers and their tutors received a phone at the beginning of the training period. Tutors of the IFADEM project were chosen among the pedagogic councilors of the participating school districts. Disposing of higher qualifications and trained at the INFP (*Institut National de la formation Pédagogique – National Institute of Pedagogic Training*) for their role as

ongoing support and supervisor for teachers, IFADEM had provided them with specific training how to teach the IFADEM content and provide support when it comes to the use of the mobile phone.

➤ *The particular role and activities of tutors increases their chances to be active*

It appeared plausible to expect that tutors are much more likely to develop sustainable phone usages over time: All interviewed tutors declared using their phone²⁰ and teachers reported to be in touch with their tutors. In addition, they acted as focal points for teachers, which they managed in the monthly sessions and for whom they were available by phone. Both their managerial role as pedagogic councilors – supervising schools and teachers –, and this particular IFADEM experience seems to be a favorable factor for ongoing phone usage.

Table 26: Contingency chart of the variables phone usage and training role

	Teacher	Tutor	Total
Use the phone	184	16	200
Don't use the phone	251	6	257

Source: Analysis based on the CDR retrieved for a dedicated period in 2012/3 and 2014. N=457

As can be seen in the contingency, 16 out of 22 recruited tutors are still using their phone after the training. Out of 235 teachers, 185 could be identified as still active (Table 26).

The Chi-square confirmed a moderate strength of this association (p -value < 0,005; Cramer's $V=0,13$). The calculated relative risk ratio showed that the probability to be active is 3,4 times higher for tutors compared to teachers.

However, these findings need to be considered with caution. Indeed, tutors have a profile so different from teachers that they are barely comparable: Tutors are more educated – they have all completed secondary education with at least a *baccalaureate* degree, and have all possessed a phone prior to the training start. Most importantly, it is important to remember

²⁰ One teacher had indicated that the phone got stolen but that she is still in contact with former participants. This kind of profile is not included in the quantitative analysis as we do not dispose of the Call Detail records of those who have changed their phones since the end of the training.

that tutors were chosen among pedagogic councilors who continue to work in this position after the training: As evocated, their daily activities include management and regular contact with colleagues and the administration. In their case, a mobile phone is particular useful which may increase both their familiarity and motivation to use it.

Another, and not to underestimate difference possibly affecting their phone usage is the salary: It is higher than those of a teacher, a factor that also impacts on the capacity and willingness to use the phone once the financial incentives have disappeared. While financial constraints were never mentioned during interviews with tutors, it was mentioned several times by teachers.

➤ *Amount of outgoing calls to tutors only*

Several interviews with former trainees who distinguished themselves by a particular high motivation and enthusiasm with regards to the phone usage and the training experience referred to the importance of being able to call a tutor during the training. The declarations of these individuals created the overall impression that these individuals did benefit more than others from the training due to this contact with and support of the tutor. During the interviews it appeared also that a closer (= more communications) relationship with the tutor was accompanied by tighter relationships among training peers, more likely to be maintained/survive after the end of the training. It seems hence important to verify the hypothesis that, beyond a certain threshold of communications towards a tutor, trainees have higher chances to be still active after the end of the training.

On average, all trainees called a tutor during 12,7 minutes throughout the 6 analyzed months during the training period. Several outliers with particularly high amount of communication levels towards tutors could be detected and were removed.

Table 27: Contingency chart of the variables average minutes of communication towards a tutor for all / later active and inactive individuals

	All trainees (N =424)	Later active (N = 191)	Later inactive (N= 233)
Average minutes of communication towards a tutor	12,7 minutes	13,3 min	5,8 min

Source: Analysis based on the CDR retrieved for a dedicated period in 2012/3 and 2014. Trimmed N: 424, outliers removed

When comparing sustainable and unsustainable participants, a considerable difference of communications towards a tutor can be identified:

Individuals who continue to use the phone after the training happen to have called a tutor on average 13,3 minutes (during 6 months analyzed), which indicates rather short exchanges and not complex problem discussions. However, the average communication towards tutor is however even lower for those who stopped using the phone after the training.

In order to verify if and to which extent this observed difference is statistically associated in a significant way to activity after the training, the distribution of communications were analyzed on a histogram. This allowed to identify a threshold and a threshold of 500 secs (around 8,3 minutes) of outgoing mobile communications during the 6 month period with a tutor identified; a dichotomous variable (below / beneath the threshold) created.

A binary logistic regression was performed revealed that the risk to not use the phone is 3, 8 higher for trainees who had called less than 5,8 minutes in total a tutor.

Table 28: Contingency chart: Network satisfaction and communication level category towards a tutor (above / beyond threshold of 8,3 minutes)

	Below threshold	Above threshold	Total
Unsatisfying network	120	23	143
% within Communication towards tutor	42,4%	20,9%	36,4%
Satisfying network	163	87	250
% within Communication towards tutor	57,6%	79,1%	63,6%

Source: Analysis based on the CDR retrieved for a dedicated period in 2012/3 and 2014, focusing on 435 individuals (tutors are excluded). N = 393

This result indicates that an increased amount of outgoing communications with tutors has some impact on the fact of being later active or not. This is in line with declarations of trainees. According to them, the added value of tutors consists not only in being a focal point in case of difficulties, but as supervisor of the monthly training session during which teachers found themselves in small learning communities; they played a pivotal role, connecting teachers to each other.

The performance of a social network analysis shall allow understanding the role former tutors play within this network of former IFADEM communications. Finally, this result confirms once again the crucial importance of network coverage, impacting on a trainee's capacity to reach out to a tutor. Indeed, a large majority (79%) of those who are beyond the threshold are also individuals who had indicated to be satisfied with their network, and are mostly (68, 6%) composed of later active individuals (Table 29).

Table 29: Contingency chart: Phone usage and satisfaction and communication level category towards a tutor (above / beyond threshold of 8,3 minutes)

	Below threshold	Above threshold	Total
Use the phone	113	81	194
% within communication towards tutor	36,6%	68,6%	45,4%
Don't use the phone	196	37	233
% within Communication towards tutor	63,4%	31,4%	54,6%

Source: Analysis based on the CDR retrieved for a dedicated period in 2012/3 and 2014, focusing on 435 individuals (tutors are excluded). N = 427

2.3.3 Consequences of organizational factors - The influence of training wave and phone type

While phones usages and engagement may always be influenced by personal motivation and characteristics, individuals were also facing imposed training modalities: They were all divided among three training waves and could not choose the phone type (basic or feature phone). As a result, it is indispensable to verify if these project choices were determinant for sustainable phone usage.

- *The lack of individuals from training wave 3 confirms the negative impact of local challenges*

All training participants were divided in respectively one of the three training waves. During these 3 days, participants were introduced to the workbooks and training materials. Throughout the 3 days, which were organized away from their homes and workstations, all teachers met, exchanged and familiarized together with the training content. The training waves were organized according to geographic criteria: Individuals belonging to the school administration Ambositra were trained in training wave 1, those from Fandriana in training wave 2 and individuals from Manandriana and Ambatofinandrahana in training wave 3. The particularity of the third and last training wave was that those who couldn't attend 'their' training wave were sent to this wave. Also, all Chef ZAPs, independently from their location of workstation, were assigned to the training wave 3.

Table 30: Contingency chart of the variables training wave and phone usage

	Training wave 1	Training wave 2	Training wave 3	Total
Use the phone	72	69	43	184
Don't use the phone	66	77	108	251
Total	138	146	151	435

Source: Analysis based on the CDR retrieved for a dedicated period in 2012/3 and 2014. N=435

Visually, the high proportion of individuals who both stopped communicating with the phone and who are from training wave 3 is striking (Table 30). A look at the contingency chart reveals that 108 out of 251 inactive teachers have been trained in training wave 3, which is almost $\frac{3}{4}$ of all individuals who have stopped to communicate with the phone. The performance of a Chi-square test confirms that both variables are associated (p - value < 0.05); the strength of association is strong (Cramer's V: 0,20). The performance of a binomial regression shows that a trainee from training wave 1 (individuals from Ambositra) has 5, and a trainee from training wave 2 (individuals from Fandriana) around 2, 5 times more chances to be active.

Knowing that training content and trainers of the training waves were exactly the same for each training wave, and that these were organized according to geographical locations, it

appears that the explanation for this existing association is not the training wave *per se*, but confirms again the impact of geographical challenges: *De facto*, teachers from and trained in waves composed of individuals from Ambatofinandrahana and Manandriana (training wave 3) did face more constraints (isolation, network issues) than their peers from Ambositra and Fandriana (Le Quentrec et Gire 2013).

While the high proportion of non-communicating trainees from training wave 3 is a source of information, the detection of active individuals from the same training wave is even more interesting: Which characteristics of the 43 individuals can explain that they overcame these location related challenges and continue to use their phone?

When looking closely at their characteristics, it appears that this number is mainly composed of ‘fake’ wave 3 members: Indeed, among the 43 individuals, 35 are either from another training wave – and hence from Ambositra or Fandriana - or are *Chef ZAP*. Similar to the case of tutors, the fact that they are still active is very likely due to their professional characteristics: Their professional obligations – providing support to teachers located in various schools and reporting back to pedagogic councilors and the local school administration – puts them in a pivotal, mobile position: They are used to mobile supported communications, the phone provided by the IFADEM project is easy to use for them and given their work assignments that make a phone indispensable, they do already perceive a phone as useful. This confirms the findings of Adedoja who had found a positive correlation between Perception of Ease to Use (PEU), Perception of Usefulness (PU) and ultimately the acceptance of a technology in a distant training context (Adedoja et al. 2013). In the case of the IFADEM training, this acceptance is directly linked to the willingness and ability to still use the phone after the training or not.

➤ *Basic or Advanced phone: The type of phone doesn't matter*

Another imposed training modality was the phone model. The project provided every participant with a mobile phone, containing the same resources. 75 participants who had higher qualifications than their peers had received a feature phone (model OT908F) with more advanced functions than their colleagues who had received a basic model (ZTE R222). The 2013 evaluation had shown that accessing the audio files on the basic phone was more difficult than on the feature phone, impacting on the ability of trainees to take part in the

training and fulfill some lessons in the workbook and ultimately, leading possibility to frustration and disengagement. On the other hand, the evaluation had also revealed that, all things being equal, those who had been equipped with a feature phone had 4 times less chances to be label as frequent users: the need to charge more frequently the phone – in a context where electricity is rare and/or unstable - appeared to be a problem (Le Quentrec et Gire 2013). However, neither a significant impact of the model of the phone on the amount of communications, nor on the participation in the daily quiz campaign, could be detected. When looking at the proportion of mobile types among individuals who still communicate and those who don't, these appear to be fairly similar: Among still active trainees, 145 possess a basic phone compared to 39 with a feature phone. Inactive members are in turn composed of 182 individuals who had been provided with a basic phone and 69 with a feature phone.

The Chi-square test confirmed that there is no significant association between the two variables of possessing a specific type of phone and being still active or not. This lack of significance is interesting: It shows that even though the participants had described difficulties in both cases, these are not significant enough to impact on the fact to continue to communicate after the end of the training. Most generally, it confirms recent research in mobile learning arguing that the 'phone type doesn't matter' (Hashemi et al. 2011).

2.4 Network coverage, prerequisite for a training experience which determines sustainable contributions

Hitherto, the look at both infrastructural and training related factors could reveal that a poor infrastructure impacts on phone usage and training engagement, which ultimately seem to impact on trainees chance to maintain sustainable mobile communications.

2.4.1 *All things being equal* - Results of the regression models

In order to identify the principal effects of each as significant identified factors on the phone usage of users after the training, a binomial regression was performed (step wise method²¹). In

²¹ Stepwise regression is an automated tool used in the exploratory stages of model building to identify a useful subset of predictors. The process systematically adds the most significant variable or removes the least significant variable during each step.

the first model were first included only training characteristic related variables (user type, school district, communication with tutors). Variables identified as significantly associated with activity but which could not be included in the model because of their collinearity with the variable school district were *quiz participation* and *amount of communication to peers*.²²

Table 31: Binomial regression explaining activity with the variables Communication with tutor, user type and school district – Model 1

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Step 1 ^a <8,3 min com. to tutor	,813	,332	6,015	1	,014	2,255	1,177	4,319
User Category ²			45,936	2	,000			
Frequent User	-2,096	,353	35,316	1	,000	,123	,062	,246
Intermediate user	-1,777	,289	37,800	1	,000	,169	,096	,298
School district ³			33,283	3	,000			
Manandriana	2,551	,767	11,068	1	,001	12,825	2,853	57,657
Ambatofinandrahana	1,401	,448	9,805	1	,002	4,060	1,689	9,760
Fandriana	-,561	,254	4,875	1	,027	,571	,347	,939
Constant	,765	,416	3,379	1	,066	2,149		

a. Variable(s) entered on step 1: <8min com to tutor, User Category, School district

Source: Analysis based on the CDR retrieved for a dedicated period in 2012/3 and 2014, focusing on 435 individuals (tutors are excluded). N = 435; 1 compared to beyond 8 min to tutor; 2 compared to rare user; 3 compared to Ambositra.

All things being equal:

- having the same amount of communications with a tutor,
- and having been categorized as the same phone user type,

²² Multicollinearity, as defined by Goldberger, is defined as the existence of one or more near-exact linear relations among the columns of the regressor matrix X. As a consequence, the sampling distributions of the coefficient estimators may have such large variances that the coefficient estimators are unstable from sample to sample and hence too unreliable to be useful (Goldberger 1991).

- and working and living in the school district Ambositra,

doubles the chance ($=1 / 0,571$) to develop sustainable phone usages after the of the training. In contrast, the chance is divided by 13 for trainees from Manandriana and by 4 for former trainees from Ambatofinandrahana (Table 31).

Table 32: Binomial logistic regression explaining Activity with the variables School District, Network satisfaction, phone user level and previous phone possession (Phone Before) – Model 2

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1 ^a	School District ¹			23,399	3	,000			
	Manandriana	2,852	1,078	7,002	1	,008	17,323	2,095	143,255
	Ambatofinandrahana	1,095	,528	4,311	1	,038	2,990	1,063	8,410
	Fandriana	-,855	,358	5,709	1	,017	,425	,211	,858
	Phone user level ²			22,301	2	,000			
	Frequent User	-2,142	,506	17,891	1	,000	,117	,044	,317
	Intermediate user	-1,902	,425	20,036	1	,000	,149	,065	,343
	<8,3 min with tutor	,649	,412	2,479	1	,115	1,913	,853	4,291
	'Network is Satisfying' ³			11,992	3	,007			
	Strongly Disagree	1,340	,444	9,104	1	,003	3,818	1,599	9,117
	Moderately Disagree	,148	,469	,099	1	,753	1,159	,462	2,906
	Slightly Agree	1,005	,440	5,221	1	,022	2,731	1,154	6,466
	Familiar with a phone ⁴	,175	,431	,166	1	,684	1,191	,512	2,771
	No electricity ⁵	,199	,367	,296	1	,586	1,221	,595	2,504
	Constant	,385	,681	,320	1	,572	1,470		

Source: Analysis based on the CDR retrieved for a dedicated period in 2012/3 and 2014; N = 435. 1 compared to Ambositra; 2 compared to *Strongly Disagree*; 3 compared to *Rare user*; 4 compared to *strongly agree*, 5 compared to *access to electricity*

The different types of phone use engagement during the training has also a significant effect on the later phone usage of users: Individuals who had been identified in the 2013 evaluation

to be frequent users see their risk to be later inactive divided by 8, and intermediate users – which we know are the largest part of later active trainees – by 6. Finally, being below the threshold of 8,3 of communications towards a tutor during the training period multiplied by 2, 2 the risk to cease phone communications the training period.

When adding in a second model the variables representing the technical experience and infrastructural environment of trainees (phone possession, network satisfaction, and electricity) to this model, the model classifies correctly over 80% of all cases and the explained variance rises from 40 to 49% of variance in phone usage.

When these variables are considered, the hitherto significant variable communication level with a tutor is not significant anymore. The variables which had in a univariate model tested to be significant (electricity, degree of phone familiarity at training start) are neither significantly associated with activity. However, the school district, degree of phone usage during the training and network coverage continue to be significant. The model allows concluding that, all things being equal, the likelihood to develop continuous phone usages are divided 17 for a trainee from Manandriana. This risk is still existing, but much lower for individuals from Ambatofinandrahana (divided by 3). In contrast, individuals from Fandriana see their risk to be later inactive divided by 2,3 (=1/0,425) after the end of the training. Moreover, individuals who had been identified to be frequent phone users during the training see their risk of inactivity divided by almost 9, and by almost 7 in the case of intermediate users. Most importantly, the likelihood to develop continuous phone usages is divided by 4 for those individuals who indicated that they *strongly disagree* with the statement ‘*my network coverage was satisfying*’ (

Table 32).

Knowing how closely related the variables user type, network satisfaction and school district are, the results of this model confirms that those trainees who did benefit from a satisfying network – which was much better in the districts of Ambositra and Fandriana – will also be more able, and likely, to be active after the end of the training period.

The fact that electricity is not a discriminatory factor is a noteworthy result: In the case of this project, this absence of need of electricity can be explained by the presence of mobile solar chargers. Not only they were distributed by the project, but they appear to be widely in use

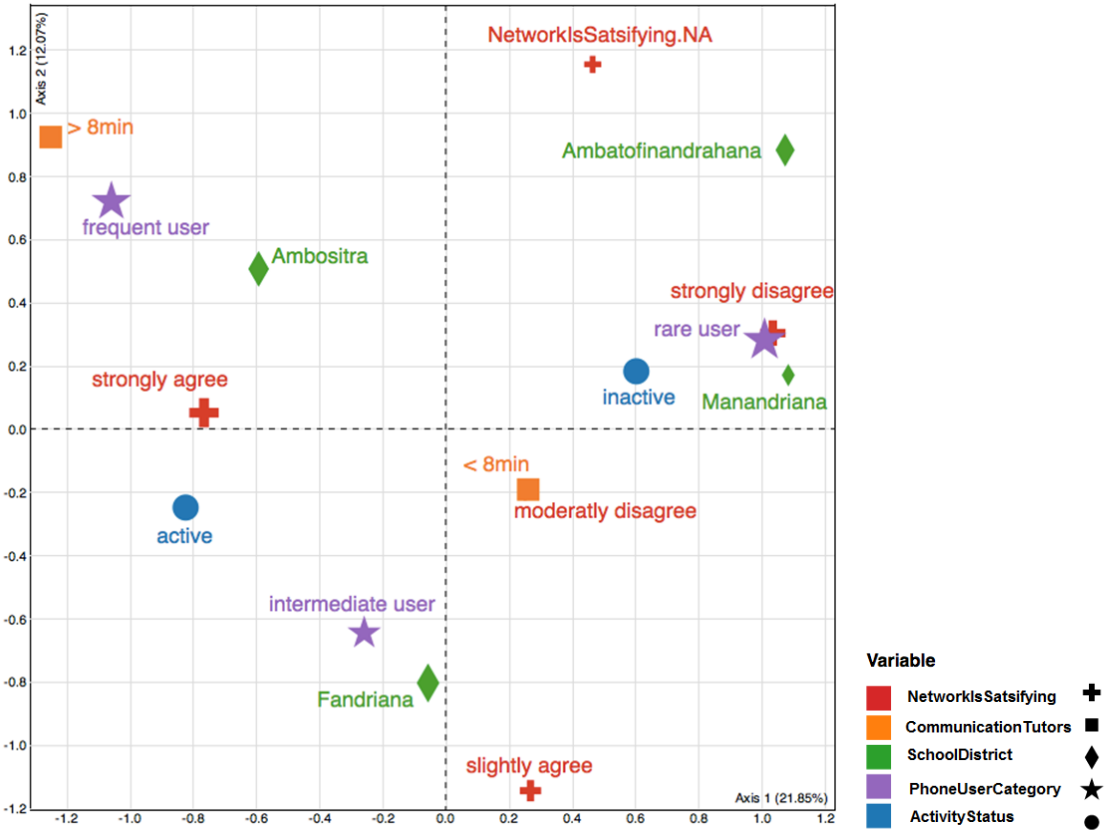
among the population, as observed during the four field research phases in both rural and semi-rural area. Indeed, their presence was striking and could be observed on a daily basis: In schools, public places, taxis, and were massively sold on market.

2.4.2 Visual representation of variable: Multiple Correspondence Analysis (MCA) and inferential statistics decision tree.

The performance of a MCA allows for a visual confirmation of the previous findings:

The axes represent 33% of the total inertia. The first axe opposes later active and inactive users as well as individuals who have either strongly agreed or disagreed with the statement that the network coverage was satisfying. Also, the MCA puts in opposition those who have called more than 8 minutes a tutor and 2h45 other teachers during the analyzing training period with those who have had lower communication levels to a tutor.

Figure 36: Multiple Correspondence Analysis with the variables activity status, communication to tutors, network satisfaction, phone user level and school district

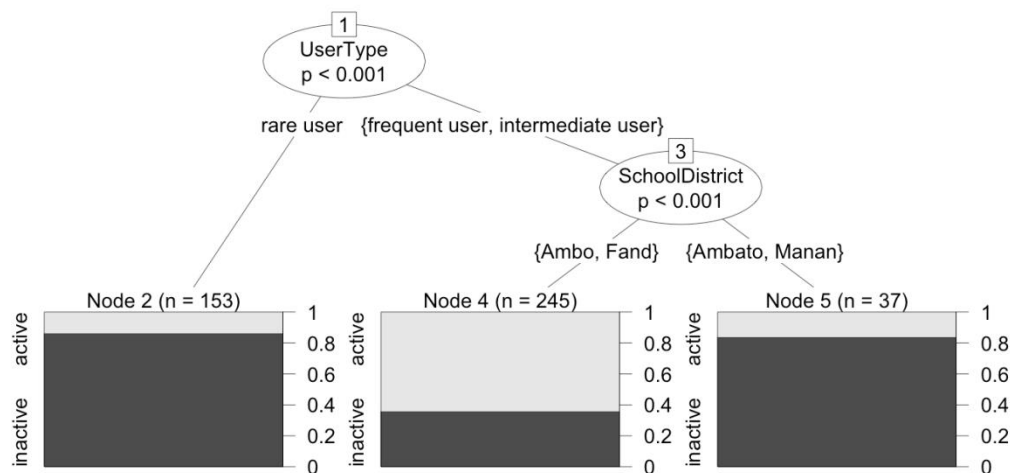


Source: Analysis based on the CDR retrieved for a dedicated period in 2012/3 and 2014, focusing on 435 individuals (tutors are excluded). N = 435; Interpretation aid: The axes present 33% of the total inertia and

oppose later active and inactive users, individuals who have either strongly agreed or disagreed with the statement that the network coverage was satisfying.

The second dimension opposes the both extremes of phone usages (frequent and rare) to intermediate phone users. In light of the construction of this this variable, it equals saying that individuals with rare and high quiz participation, low and high levels of peer to peer communications and communications towards other individuals are opposed to individuals with intermediate quiz participation and peer to peer as well as individuals other than training peers. Moreover, the isolated school districts oppose the more accessible and urban districts. The factorial design indicates a *Guttman* effect, observable when variables are strongly related. The visual representation obtained via a Multiple Correspondence Analysis allows affirming that the more individuals have indicated to be satisfied with the network, the more likely it is that they live and work in Ambositra, are frequent phone users, have more often communicated with a tutor – and develop sustaining phone usages.

Figure 37: Inferential statistics classification tree



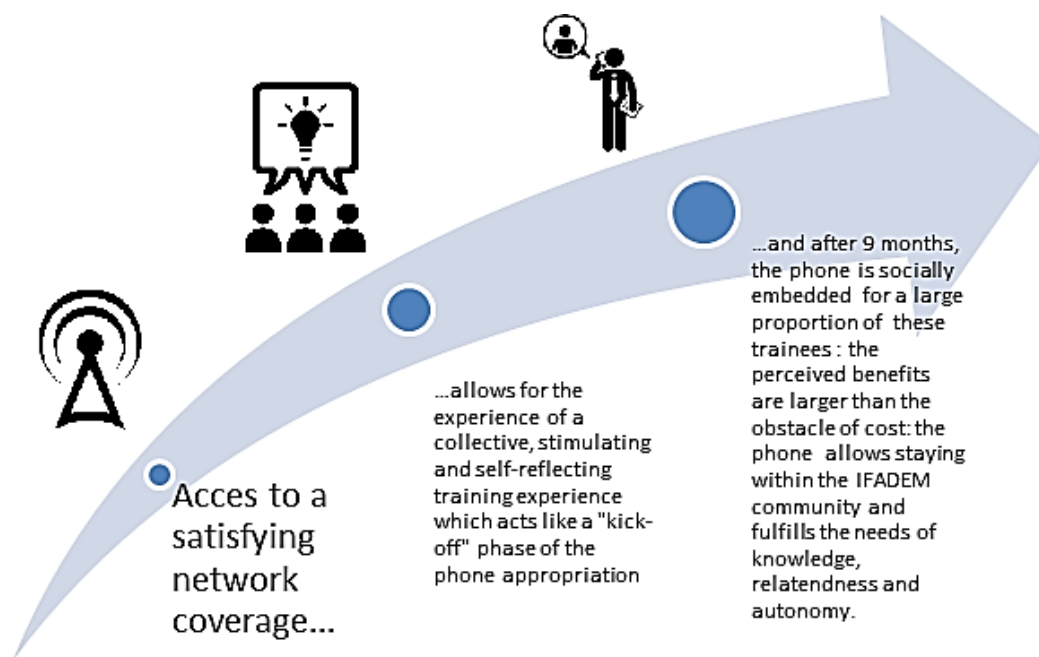
Source: Analysis based on CDR 2012 to 2014 combined with datasets containing participants' characteristics and attributes. Each classification is based on a chi-square test; significance level of <0.05; N=201

Subsequently, the performance of a inferential statistics classification tree allowed once again to represent the dataset and to visualize the association between the training, the infrastructure and the subsequent likelihood of developing sustainable phone usage: The fact that here, the school district has been identified as the discriminant element of classes can, unsurprisingly, explained by the influence of network coverage, which is reflected in this variable.

Summary of chapter 6

The here presented study, based on the analysis of former participants Call Detail Records, has allowed to confirm and complement the results of the qualitative study: Almost half of former users continue to use the phone to communicate 2 years after the end of the training. It can also be ascertained that, despite the end of organizational incentives and the pre-paid offer which had stimulated communication among training participants throughout the pilot phase, almost half continue to call a another training participant. It could be confirmed that SMS remain a minor mean of communication: SMS are chosen in emergencies, to complement information already provided by voice or when the network situation makes voice communication hazardous. The descriptive analysis of the amount of communications had revealed that communications, including peer to peer communication, are not equally distributed. Among sustainable phone users, there is an overrepresentation of individuals who had been highly engaged during the training, live in Ambositra and Fandriana, have already possessed mobile phones and benefit from better infrastructures, e.g. access to electricity. Building on the results of this descriptive approach, an inferential analysis was conducted first in order to have a close look at each possible factor of influence.

Figure 38: Network coverage, condition sine qua non for an appropriation process



While past research had difference in usage of the *internet* among female and male teachers (Ladage et Ravestein 2013) the study confirmed recent research results in the area of mobile practices that showed that mobile usages were used in the same manner independently of their gender (Street et al. 2015; Mumtaz 2000). More precisely, it revealed that neither gender nor academic qualifications impact on a trainees' chance of developing sustainable phone usage in the medium-term. However, there were significant 'sustainability gaps' according to trainees' workstation. These gaps can be explained by infrastructural differences (access to electricity, quality of network coverage, previous phone experience) among which network coverage progressively appears as key variable when predicting impact on trainees chance to use their phone on the medium-term. The importance of the network for phone usage exceeds the simple fact that obviously, without network coverage, continuous phone usage is impossible. The relationship between network coverage and medium-term contributions in form of sustainable communication towards former peers and other individuals is more complex: Indeed, the impact analysis of training modalities on later sustainability has allowed ascertaining that satisfying network coverage influences strongly the training experience and its outcomes: All training related variables which were found to be significantly associated with sustainable phone usages reflect this influence of satisfying network coverage. The phone user category (rare to frequent communicant), degree of quiz participation, amount of communications to peers and tutors, and the training wave, organized according to the geographical location of users: All variables translate the importance of network coverage, but it is this interaction of access to network coverage and training experience which allows comprehending the source of sustainable phone usage.

Apart from reducing the utility of the phone for communications, those participants concerned by a lack of satisfying network coverage were excluded from a process of apprenticeship and relatedness other training peers could be part of. During this process, the mobile phone made increasingly sense to those able to use it, notably as it allowed building relationships. Individuals with satisfying network coverage could exploit the phone to create ties not only with training peers but also with other individuals. The importance of these relationships, the overall perception of usefulness is reflected in a willingness to cover the costs of communications, already during the training for non-training call partners, and for all costs once the training had come to an end. In contrast, individuals living in districts with poor network coverage could not experience the training in the same manner. Confronted with

limited usability of the phone, the lack network put also an end to the creation of the 'mobile reflex' individuals in favorable districts could develop; the overall appropriation process of the phone for communications and other tasks was limited. This is in line with research findings which had found that poor infrastructure diminishes inextricably the perceived usefulness and appropriation of the phone in general (Laffey 2004; Adedoja et al. 2013).

In this regard, it is useful to recall here the results of qualitative study: The control group, living in also in areas with satisfying network coverage, did not report the same range and intensity of phone usages, showing clearly the importance of the training experience for sustainability. With other words, while existing network coverage is a prerequisite for a positive training experience, it is the training which determines the sustainability of communications and medium-term contributions.

These findings confirm not only the results of the qualitative study, but are also in line with research results of Laffey and Adedoja, who found that a poor infrastructure did diminishes inextricably the perceived usefulness and appropriation of the phone in general (Laffey 2004; Adedoja et al. 2013). Even more, it appears even plausible to say that the common training experience among '*Ifademiens*' is a key factor of the appropriation, and may even exceed the importance of perceived usefulness.

The from the previous studies arising impression that former IFADEM participants continue to perceive themselves as part of a community, could be reinforced through a quantitative lens: The existing and continuous proportion of IFADEM to IFADEM communication is an important finding. These contributions needs to be further investigated, particularly with regards to the question to which extent these communications reflect the reported on-going collaboration among former trainees.

Chapter 7 – Study 3: From connection to community, a social network analysis of former training participants

The previous findings from qualitative and quantitative analysis have shown that former IFADEM participants continue to use the phone they received, both in their private and professional sphere. Among the key contributions identified figure the continuity of peer to peer exchanges among former participants. There are strong indications that since the training, a collaborative network composed of former IFADEM participants is in place and sustains autonomously, more than 2 years after the end of the pilot.

In order to analyze the structure of these collaborative exchanges, a social network analysis was conducted. Among the multiple available definitions, Haythornthwaite's presentation provides a clear definition of social network analysis (SNA): Social network analysis is an approach and set of techniques used to study the exchange of resources among actors, who are considered to be part of a network if patterns of resource exchange are regular (Haythornthwaite 1996). Here, this approach was chosen in order to "*understand how actors constitute the ties that cluster into groups and the consequences of that flow not just from network position and roles, but also from changes to such positions and roles*" (Kilduff et Tsai 2003, p.128).

Concretely, the here presented social network study allows analyzing the patterns of mobile supported ties among former participants, the identification of key roles and their contributions, as well as underlying group dynamics, affinities and activities that characterize this network. Also, the analysis shall allow identifying those factors which have favored to the creation of the network in the first place.

➤ *Methodological implementation of this chapter*

The studied sample was composed of those individuals who are still using their phone to contact a former training peer (Table 9).

Firstly, in order to generate a visual representation of the relationships in-between former IFADEM participants, the open source software for social network visualization 'Gephi' was chosen. Through the use of software functions that mobilize several social network algorithm

(cf. annex) it was possible to generate graphs whose visual aspect allows for the analysis of both patterns and actors within the network.

Table 33: Sample characteristics of individuals studied in the network analysis

N	185	
Civil Servants	100%	
Men / Women	38%	61%
Average age	50 – 55	
BEPC / Baccalaureate holders	86%	11%
% of individuals from Ambositra and Fandriana	96%	
% of participants from Ambatofinandrahana and Manandriana	4%	

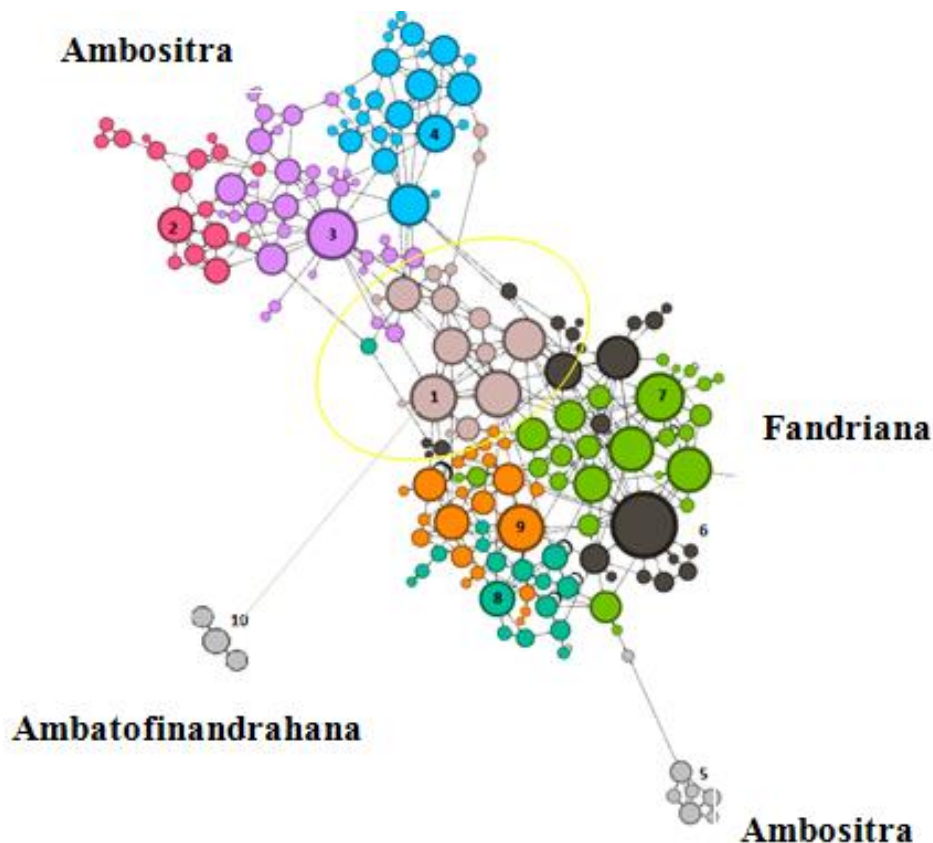
This analysis was combined with a qualitative approach, a so called ego-network analysis based on interviews with network members. The purpose of the latter was to provide in depth explanations for the patterns and dynamics highlighted in the graphs. Each participant received a list with names of their group within the network which allowed qualifying the ties through the use of three instruments inherent to ego-network analysis: Name generators, name interpreter and density questions. This analysis allowed qualifying the type of relationship within groups and the network (cf. chapter 4).

1. Structure of the former IFADEM trainees network

Firstly, in order to observe the overall structure of the network and visualize existing ties, the Force Atlas 2 function was applied. Secondly, the visual appearance of node sizes was computed in accordance to their degree, meaning that sizes took into consideration the average degree, the in-degree and out degree. Thirdly, the modularity class function calculated participants' belonging with a dedicated group and visualized these memberships in different colors.

Out of the 201 still active individuals, 171 find themselves in a group of 3 or more people. 13 individuals were identified as having a mobile connection to one trainee only, who in turn was not connected to the rest of the network: This explains why in the following presented graphs, the analysis focuses on 171 individuals. As will be exposed in the following the network is actually larger because of the loss of IFADEM phones or SIM cards, which had then been replaced by new mobile phones in order to maintain the IFADEM connections.

Graph 1: Mobile supported network of former IFADEM participants: Overall network incl. sub-groups and degree centrality



Source: Social network based on the Call Detail Records of each still active participant during a 6 months period in 2013-4. Colors indicate a sub-group within the network – group 1 to 10 – and size of nodes indicate the total amount of connections (degree centrality). The visual position of nodes do not correspond to GPS points. N=171

When looking at the generated graph generated with Gephi, it appears clearly that it is composed of two clearly identifiable main components, connected by a thinner area that occupies a ‘bridge position’ in-between the two components (Graph 1). The graph is composed of 10 groups; participants’ belonging to a group is visualized through a common

colors code. All groups are inter-connected; none is entirely separated from the rest of the network. The group sizes within the network vary, ranging from 3 to 32.

1.1 A network organized according to training locations

A first look at the characteristics of nodes in the two components shows that the areas correspond to geographical locations of network members, each represented by a node. While individuals in the upper level of the network belong to the Ambositra district, the lower level is mostly composed of individuals from the Fandriana district. In contrast, there are small groups (Nr. 5 and 10), which are composed of individuals from Ambositra and Ambatofinandrahana. The absence of groups situated in Manandriana, one of the more isolated regions of the IFADEM project, is noteworthy.

This homogeneity of district membership contrasts with the nodes in the middle of the graph: Here, individuals come from various locations and have large connections, easily to recognize by their node size, larger than the network average. A look at the database containing the functions of each node during the training period reveals that a large majority of these individuals are former tutors of the project (pedagogic councilors).

The fact that the network is strongly influenced by geographical location of members, and the fact that former tutors are both those with the larger amount of connections and situated in the middle of the network, indicates that the sustaining structure of the network remains constructed in accordance with the training structure.

Figure 39: Target region: Amoron’I Mania and the districts of training participants



Source: SRAT, 2011

1.2 Centrality of the network: Heterogeneous actors but no centralized power

When looking at the structure of a network, network centralization is a useful characteristic to retrieve information about the relative centrality of a single actor in contrast to the other actors in the network (Moolenaar, Slegers, et Daly 2012). For this research purposes, it is interesting to know if, besides the identified tutors, there are actors who differentiate themselves from others because of a significant higher amount of connections (average degree) or if there are one or a few teachers who occupy the central position in the IFADEM network, acting as a focal point to which surrounding colleagues reach out for advice.

Obviously, the identification of these profiles can only be conducted after an analysis of the average amount participants’ connections: This average degree of direct connections of each former IFADEM trainee, without differentiating between in and out-going relationships is 6. The mode of network connections is 2, which is fairly low and indicates that former trainees tend to be rather in contact with a restricted amount of other former training participants with whom they form a group.

Looking now at the number of these mobile connections allows retrieving further information: the number of connections is highly uneven – an often observed phenomenon in network

graphs (Cherven 2015). Among the 202 identified individuals, some use the mobile phone to connect to only one former participant, while others are connected to up to 31 former training peers. Around a third (61 individuals) of the 201 network members has more connections than the average (6) and 9 % have more than 15 connections. Explanations for this uneven number of connections can be found in the interviewees: These indicate that a different training experiences, previous familiarity with the phone, and particularly an uneven quality of the network influence on the number of individuals a former training participant continues to call.

It is important to keep in mind that the here presented scores and figures are not the perfect representation of the actual network, but rather a support to understand the global structure of interactions in-between former training peers. Indeed, the interview series revealed that in addition to the here presented mobile connections – based on the IFADEM phone– there is often additional *face to face* contact with former training members or via a new number when a former training member has lost their phone:

EvLC: *Are there people from your group with whom you are particular often in touch?*

Teacher: *Yes but we have both lost our [IFADEM] phone recently [so we use another phone].*

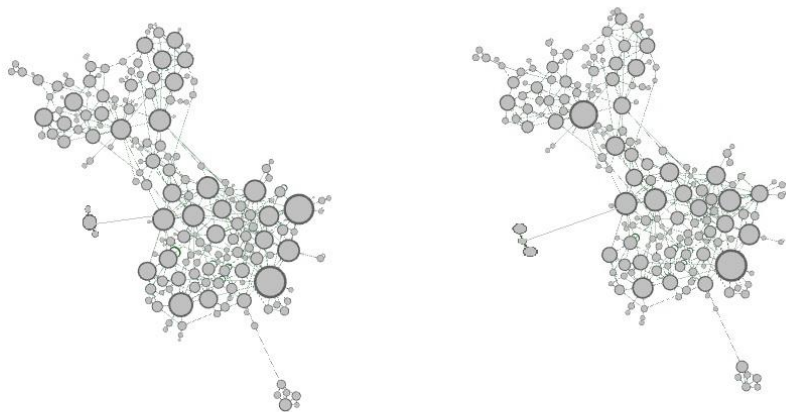
EvLC: *And besides her, are there others you still call [with your new number]?*

Teacher: *Yes, around 10 or so... in the district I worked before, there are many who have participated in IFADEM. They all asked for my new number before I left [for my new job in the new district].*

This example is not an exception and allows assuming that the average amount of direct connections per actor is very likely to be higher than six when considering those mobile ties which rely on new, not identifiable numbers.

While graph 1 illustrates the average connections of individuals, the centrality function allows now to create two graphs: The first graph represents each participant according to their out-degree, i.e.: they use the phone reach out to n-number of individuals. The second graph is computed in a way that it takes into consideration the in-degree (i.e.: they are solicited by n-number of individuals). When comparing the two (Graph 2), slight differences can be ascertained, notably in the upper area of the network.

Graph 2 : Mobile supported network of former IFADEM participants : Actors with high in-degree (left) vs high out-degree (right)



Source and interpretation: Social network based on the CDR of each still active participant during a 6 months period in 2013-4. Visualization of the relationship among former IFADEM trainees with a focus on their in and out-going relationships. The higher the node size, the bigger the in-degree / out-degree value. N = 171

This means that there are some, but not many participants who are more solicited than others, having hence a higher degree of power of influence, and potentially more access to resources and support (Moolenaar, Daly, et Slegers 2010); yet there is no extreme difference among network members. Most importantly, those who have higher in-degrees are the same with higher out-degrees. While there are difference among network members, the absence of extreme size gaps as could be observed in Graph 1 show that the network of former IFADEM trainees is composed of a relatively heterogeneous population with regards to the structural position of network members (Cherven 2015). The network is fairly decentralized; it does not depend on only a few former participants who ‘control’ interactions within the network. This is crucial for sustainable collaboration, as the contrary would mean that the loss of these ‘control actors’ would potentially weaken the whole network structure (Moolenaar, Slegers, et Daly 2012). Hence, it is not only possible to affirm that there is a sustainable network of former IFADEM members, but also that this network is ‘healthy’ and stable. With regards to the collaborative potential of the network, this means that the majority of former IFADEM members is theoretically able “to sustain productive collaborative relationships over time” (de Laat et al. 2007, p.99).

1.3 Diameter and eccentricity: A clustered but efficient network

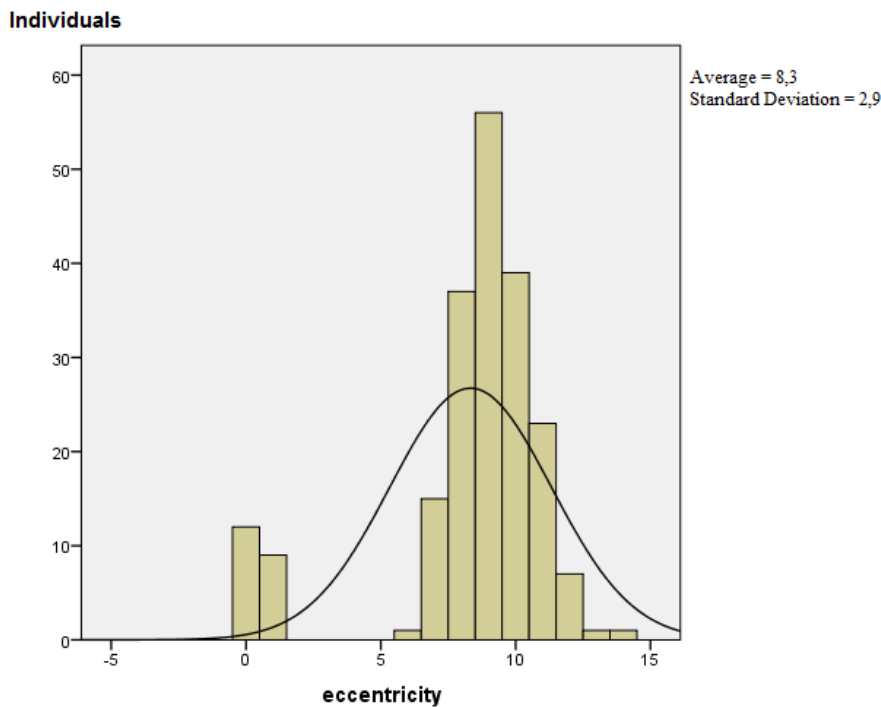
While the diameter function allows calculating the maximum steps required for the two most distant nodes in the network to reach one another, the eccentricity score indicates for each node the number of steps required to cross the network. It allows assessing the relative position – and influence – of each actor within a network.

The calculated diameter of the former IFADEM trainees' network is 14. This value allows retrieving two conclusions: Firstly, the fact that a single diameter value was calculated confirms the visual impression that the network is connected means that theoretically, all individuals can reach other individuals. In case the software would have calculated several diameter values, this would have indicated the presence of several small and disconnected groups. With other words, the IFADEM experience has, in the case of those who are still using the phone, not only led to a sustainable network but also to a complete network; there are not fully separated individuals and groups of former trainees. On the other hand, a diameter score of 14 means that it would take 14 steps to traverse the graph between its two most distant points. Given that the network is composed of 202 former individuals, this value indicates not an extreme, but yet a fairly clustered, group oriented network. The latter confirms the overall impression that the sustainable network is built in accordance to the past training structure – organized in groups, be there monthly and small or large and trimestral.

Furthermore, the calculated average path length of the network is 5. This means that information needs a maximum of 5 steps to cross the network. The fact that this score is much lower than the diameter score of the network indicates that the information transmission within the network of former trainees is fairly efficient (Jansen 2006). This is particularly interesting given that the previous graphs have shown that the network is composed of two main components and multiple groups.

With other words, it is possible to affirm that even though the network is clustered, there is no apparent friction or isolation that could, for example, lead to information withhold or isolation (Adler, Grümayer, et Schmidt 2010).

Figure 40: Distribution of eccentricity values within the network



Source and interpretation: Eccentricity distribution chart generated with Gephi and based on the CRD of a 6 month period from 2013 to 2014. Amount of nodes – eccentricity value. The eccentricity value corresponds to the length of a longest shortest path starting at a node. N=185

When calculating now the distribution of eccentricity values – the length of the longest shortest path of a node in a network – an average score of 8 with a standard deviation of 3 can be ascertained. As visualized in the histogram (Figure 40) it seems that besides a few outliers, the majority of network members is of a fairly similar distance from each other.

More precisely, there are 23 individuals with an eccentricity score of 11 (23%) and 15 (8%) who have a score of 7. The remaining, almost 70% of the network has eccentricity values in-between 8 and 11. This presence of this large majority allows concluding that network of former IFADEM trainees is relatively evenly distributed and easily traversed by all actors.

Interestingly, the calculations reveal also that there are two individual with eccentricity scores of 13 and 14, the latter being the highest possible eccentricity score, given that the diameter of the network is 14. It can be expected that these individuals are more vulnerable than others; a closer look at their position and characteristics will be conducted in the subsequent section of this chapter (2.4).

1.4 Density: Low overall cohesion contrasts with inner-group cohesion - strengths of relationships are directly related to different types and purposes of communications

In social network research, density is defined as the proportion of direct ties in a *network* relative to the total number possible. The calculation and representation of graph density make it possible to analyze the extent to which the network is dominated by a few groups (Hawe et Ghali 2007; Balkundi et Kilduff 2005). It allows further to retrieve information with regards to the network cohesion and strengths of relationships; this can be expressed through common attitudes and characteristics.

In the case of the here analyzed sustainable IFADEM network, different degrees of density are visually identifiable: The ties in between nodes within the upper area, composed of members from Ambositra, appear clearly sparser than to those ties within the bottom area, composed mostly of members from Fandriana. There, the higher density is accompanied by an overall higher number of nodes present in that area. There are also fewer sub-groups in the upper area of the network (3 groups) than in the lower area (5 groups).

In addition to this visual analysis, three complementary functions in Gephi allow to calculate and analyze the density and, most importantly, the cohesion of network members: The density function, the clustering coefficient function and the modularity class function.

While the density function allows to assess the density within the network *as a whole*, the clustering coefficient measures the extent to which nodes are grouped together, as opposed to being equally or randomly connected across the network (Cherven 2015). Thirdly, the modularity class function is used to identify specific sub groups based according to their most dense connections. This function was applied in combination with the two previous functions.

At first sight, the calculated density score closer seems to indicate a rather sparse network and a lack of cohesion: Indeed, the calculated score is closer to 0 than to 1, meaning that the average number of ties is much lower than the theoretically number of 201 ties (ibid).

However, the density measure has to be put in context with the purpose of the network. As explained by Cherven, a collaboration network is very likely to have lower density scores than a network that is based on simple interaction (e.g. Facebook). Collaboration requires that

individuals actively work together, e.g. in the IFADEM case, use the phone to ask and answer a question or discuss a problem. As described by Cherven, this is a more challenging criteria compared to the simple acknowledgement that individual X is a Facebook friend with individual Y. In light of a more demanding connection criteria (making the effort to call, pay the communications, maybe even look for a place with ideal network coverage etc.) and the unrealistic fact that a former IFADEM member needs to be in contact with all 201 former training members every day, the low density value is hence not to that surprising.

Moreover, the low density score is also an often observed phenomenon in clustered networks as the one here analyzed (Cherven 2015). Interviews with former training members confirm the latter: When asked, a large majority declared that they were mostly in touch with individuals from their group, and more rarely with individuals from other districts and groups. The interviews revealed also that the smaller the groups, the closer participants seemed to be to each other. This impression could again be confirmed by the observation of an inversed correlation of degree centrality and cluster coefficients: Firstly, The use of the clustering coefficient function indicates an average value of 0,208: This means that over 20% of all possible connections within the graph are established, confirming the presence of clusters.

Then, a look at individuals with the highest degree scores – respectively 23 and 31 connections – shows that they are also among those with the lowest clustering coefficients: 0,04 and 0,08. In contrast, those individuals with a high clustering coefficient happen to have not more than the average degree of 6 connections. This inverse correlation has been identified in school network research as a phenomena reflecting cohesion within small groups, and can be explained by the fact that

“...in a school network, the most highly connected members have rather low clustering coefficients, while those nodes that tend to stay closer to home with their links sport much higher values. The idea of having your own friends connect to one another (thus forming closed triplets) is more likely to happen in smaller, more cohesive groups”

(Cherven 2015, p.13).

Finally, the juxtaposition of the low density value with the relative high modularity class value (0,6) confirms further the impression that cohesion dynamics take place at a group level.

Indeed, “networks with high modularity level [closer to 1 than to 0] have dense connections between the nodes within modules but sparse connections between nodes in different modules” (Chu, Wipfli, et Valente 2013, p.4) With other words, the presence of 10 subgroups in a rather sparsely connected network of 202 former trainees can be considered as an indicator for cohesion at a micro-level.

The fact that density and cohesion is uneven within the network provides interesting information on the collaborative nature of the network : Knowing that density is an indicator of engagement in collaborative and technology supported networks (de Laat et al. 2007), this finding allows confirming that former participants in Fandriana are more engaged than their peers in Ambositra; the difference is even more striking when looking at the tie density of individuals in Manandriana and Fandriana. While these findings confirm the results of the qualitative and quantitative analyses, showing the ongoing impact of geographical discrepancies, the clustering indicates also that the cohesion and feeling of belonging, created during the training, sustains over time. Most importantly, the group cohesion increases the efficiency of collaboration within each group.

1.3.1 Network coverage as an organizational factor for density

In light of the previous findings from the qualitative study (chapter 5) and the analysis of the call detail records (chapter 6), it appeared indispensable to verify the resulting hypothesis that the difference in density and cohesion is related to the difference of network coverage quality.

It appeared indeed imaginable that satisfying network coverage is directly linked to higher density and cohesion of the network, meaning that respondents of the upper area of the network report lower network satisfaction. This intuition could *per se* not be confirmed, as the upper area is composed of people who had, according to the questionnaire fulfilled at the end of the training period in 2013, a satisfaction average of 3,8 out (4 equaling 100% satisfaction). This is higher than the satisfaction average of bottom and denser area of the graph: Here, network satisfaction is on average 3,2 out of 4. At least, this result confirms again how important high networks coverage satisfaction is in the first place for the sustainability of the network.

In this regard, group 10, is both a highly informative example and exception: Unlike the majority of participants from this district, they were rather satisfied with the network coverage. However, these group members reported all that unlike them, there were many participants from Ambatofinandrahana who progressively disengaged and were unable to join the mobile supported collaborative group. However, they reported also that they would still collaborate with the teachers, but face to face.

1.3.2 The strengths and quantity of relationships: Cohesion leads to collaborative and innovative practices

Differences in density do not only indicate different degrees of cohesion within the network, but also provide information on the different strengths of relationships (Avenarius 2010). In the case of the IFADEM network, the relationships of individuals in the bottom area are theoretically stronger than in the top area. This can be explained by a higher social proximity as defined by Freeman (1992), indicating that the more members of a network or sub network are directly connected to other members the stronger the relationships. Subsequently, it is possible to affirm that the relationships within the different subgroups of the bottom area are stronger than within the sub groups of the upper area. Also, the relationships in-between the groups of the bottom area are slightly stronger than those in-between the group of the upper area.

When comparing this network result with declarations made during interviews, the following can be ascertained:

Individuals indicate a high degree of community feeling and cohesion, both within each group and as a global 'IFADEM' community as a whole. As shown previously by the qualitative study (chapter 5), interviewees utilized constantly the term 'Ifademiens' to designate themselves. Taking into consideration these declarations and ascertaining the particular strong relationship within groups in the network allows concluding that

- meeting on a monthly basis with training peers with an attributed tutor, available only for them
- being equipped with pre-paid communication offers for IFADEM communications

- taking part 3 times in 3 days lasting training sessions that included free transportation, accommodation and the provision of new learning materials

was perceived as a strong collective experience resulting in a feeling of cohesion. The fact that their immediate environment sees them also as different and articulates this difference actively reinforces this cohesion even more. The following declaration of a teacher referring to the impression that non-participating colleagues were sometimes envious:

Teacher: The others sometimes say, 'It was only for the Ifademiens...we have received nothing from IFADEM...'

However, the fact that IFADEM participants spent time together is not the only factor of cohesion. Some groups appear to have established particularly strong relationships. When they are asked about their perception of cohesion, they refer often to the private sphere:

Teacher: Mrs. [group member] is in the same school as me, so we can see also each other every day; there is a permanent face to face contact. The other person [in the group] is a bit more far off, so we call each other more often, [we rather meet on Saturday because otherwise] it's impossible to meet.

Similar to these teachers, a look at the network position of former tutors (graph 1) also shows that these have particularly strong relationships. When asked, former tutors do explain that they do not only need to call each other regularly, but that they also work in the same building and see each other during meetings. This result is consistent with Granovetter work, who ascertains that a relationship between two individuals becomes stronger the more time these individuals spend together. Also, Granovetter indicates that the more intimate, intense and aid-rich exchanges are – e.g. if teachers start exchanging advices on personal matters – the stronger and sustainable these relationship will be (Granovetter 1973).

1.3.3 Professional and private ties, new and old contacts – An instrumental and expressive network

Finally, the ego – network analysis allows to adopt a second perspective on the nature of group relationships, confirming that the different natures of inner group relationship impact on cohesion and sustainability of the network: When analyzing the average proportion of individuals who have qualified their group members as either former colleagues or new connections they made during created connections, it can be ascertained that in each group,

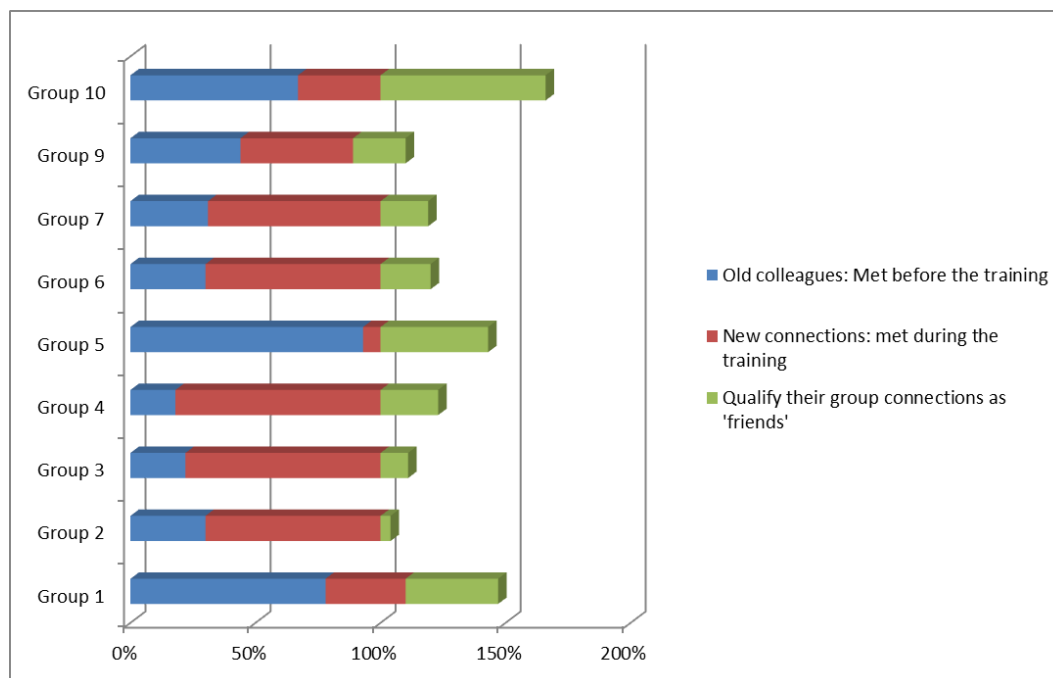
both types of connections are identifiable (Figure 41). Interestingly, the proportion of new contacts is larger in the case of 5 groups (Nr. 2, 3, 4, 6, and 7). This finding is consistent with interviewees declaring that the strong common training experience, willingness to continue to exchange with individuals met during the training and impression that they are part of a 'special community'.

Indeed, the fact that only a minority of individuals in every group declare that they are friends indicates that a mayor number of mobile connections are of professional nature. Density is not 'simply' due to old colleagues or friends who 'just catch up'. For example, the majority of former trainees in group 6 (70%) and 7 (69%) have not known their connections prior to the training and qualify only 20% of their group members as friends. Still, these groups are in the highly dense areas, also characterized by high cohesion.

Hereby, results confirm once again the interview findings and vice versa: the training has led to the creation of new colleagues, i.e. new resources for teachers, and that this is one of the key motivations of teachers to continue to use their phones.

However, the importance of ties which have been created prior to the training and are now connected with the mobile phone, as well as ties which are qualified as friendship are still a source of information, contributing also to the sustainability of the network: In light of the above presented research findings on the positive impact of face to face and personal ties on professional collaboration, both the familiarity with training members as well as exchanges of personal matters – reported in several interviews – certify a healthy network: The decision to continue to use the phone to connect with former training peers is enhanced by complementary motivations; the most important added value is of professional nature but personal benefits exist.

Figure 41: Groups and nature of ties ('old colleagues', 'new connections', 'friends')



Source: Interviews conducted with group members in January 2016 in Ambositra, Madagascar. Ego-network analysis could be exploited in the case of the 2 interviewees from group 8, N=30

This coexistence of 'purpose' reflects the existence of a both instrumental and expressive network as defined in social network research: While instrumental networks are "*conduits for the circulation of information and resources that pertain to organizational goals*", expressive networks reflect "*patterns of more emotionally charged relationships [...] that transport and diffuse resources as social support, trust, and values*" (Moolenaar, Daly, et Slegers 2010, p.635) .

Most importantly, the identification of these network types indicates that former IFADEM members come also together in groups who are linked by social ties, share common perspective and goals. This finding is in with their proper declarations, and allows to consider them as a community as defined in social network research (MacQueen et al. 2001) These instrumental and expressive mobile ties reflect, as already found by the qualitative study, the hybrid role of the phone: It connects former trainees for mostly professional, but also private reasons, increasing hence their motivation to use it regularly. As previously discussed, it is this combination of both professional and private connections, mobile and face to face

contact, which ultimately favors one of the key activities within the network: teacher collaboration.

1.3.4 A contribution of density: Professional collaboration and innovative practices

Strong ties, shared experience and expectations with regards to the purpose of connections appear to directly influence on former trainees' degree of collaboration and willingness to explore innovative practices. As exposed by the qualitative study (chapter 5), a large majority of interviewed network members indicated that the training had increased the degree of professional collaboration among those who had participated in the training part. The interviews revealed also that this collaboration mostly happens within their groups. Again, while the common training experience was also cited as mayor source of cohesion, the fact that members lived and worked in the same school and administrative district during the training appeared also as factor enhancing this collaboration. Interestingly, when they were later appointed to another district, this collaboration did not cease, as showed the declaration of the teacher reporting that she continues to call former IFADEM participants from her old workstation. The feeling of belonging to each other, sharing similar point of views are sustainable and allow teachers to build a distance, mobile supported support network of which they take care of, even if they have to change phone or telephone number:

Teacher: I have broken my phone late 2014, but I figured something out...it did not decrease the volume of exchanges.

Here, when comparing the statements and school practice descriptions made by interviewees from the upper graph level (lower density/cohesion) and the lower graph level (higher density/cohesion), it is interesting to note that interviewees reported more often and in more detailed manner innovative practices they developed and applied within the group and school. The following interview extract illustrates this well. The interviewed teacher has kept the IFADEM SIM card but bought a new, fairly sophisticated smartphone, has both professional and private contact with former peers and reports non- prescribed, innovative phone usage in class:

Teacher: With those from the same school [we are in contact] on a daily basis, and face to face. And the others, when they come to Ambositra to receive their monthly salary, they call me first and we meet up...asking for advice and exchange... [But they also call] in general, not only when they come to Ambositra. We've become

friends...we also discuss personal things. With regards to the phone, I mostly use SMS and calls, the agenda and calculator for work, the camera for personal matters, or to take pictures during a lesson, as a souvenir...but I also use the voice recorder. I record my students and then I make them listen so they can improve.

These practices are consistent with recent research findings that established a link between high density, cohesion and the willingness to innovate and take risks (Moolenaar 2012): Indeed, it appears that the more densely connected the school social networks around work-related and personal advice, the more teachers perceived their school to have an innovative climate in which teachers were willing to collectively create new knowledge and practices.

Furthermore, it confirms once again the importance of social ties for the cohesion of former 'Ifademiens', source of innovative practices. This link has previously been researched by Moolenaar who had found that densely connected social network structures with many reciprocal ties may foster an innovative climate both directly and indirectly by increasing opportunities for shared decision-making (Moolenaar 2012).

While close relationships have positive impact on innovative and collaborative teaching practices, density is also crucial with regards to the number of ties: Indeed, there is abundant research suggesting that a high number of close social and professional relationships may influence teachers' practice by creating a safe environment in which teachers can engage in innovative practices and experiment with new instructional strategies without the fear of being punished or ridiculed (Moolenaar, Daly, et Slegers 2010). More in-depth analysis on innovative practices within the groups shall be provided in the second section of this study, focusing essentially on group composition, activities and contributions.

1.3.5 In contrast: Lose ties are used for non-complex exchanges

A look at the social graph of participants (graph 1, graph 2) shows a contrast between close ties, forming groups and clusters, and rather lose ties in-between these clusters. Interviews with network members allowed affirming that these ties reflect mostly exchange of routine information. Indeed, when interviewees were asked to describe the purpose of these ties, they reported mostly the exchange of administrative information, e.g. up-coming meetings or purposes that did not require complex problem solving. Relationships were qualified as only

professional, and interviewees appeared clearly to be less close to these contacts than to group members.

This finding indicates a link between the strength of relationship and the lower intensity is directly related to a different nature of communication and motivation to maintain the tie over time. While most group ties are motivated by strong relationships and the wish to collaborate and exchange, these loose ties correspond to Hansen's (1999) findings who had found that links between members of different groups in a sparse network are motivated by the exchange of non-complex routine information.

1.3.6 Cohesion within the more isolated groups

The previous findings seem to indicate clearly that those who have a high number of ties, are densely connected and well positioned within the network are those who benefit the most from the mobile network and its professional and private contributions. Notwithstanding, as discussed at the beginning of this chapter, the particular case of the highly isolated groups 5 and 10 (Graph 1) has allowed identifying another type of cohesion: Cohesion as a result of 'shared isolation' and cohesion as a result of prior – training familiarity due to a shared workstation.

In the case of group 10, the source of this isolation is on hand: They are the rare 'training survivors' from Ambatofinandrahana, the district where poor infrastructure has hindered the sustainability of practices and phone usage. At first sight, they appear highly vulnerable: Barely connected to the rest of the network, they could easily be cut of the whole network if the person connecting them with it would disappear. However as suggested by previous (Le Quentrec et Gire 2013), the fact that some individuals have more ties within their group and then other members of the network indicates the presence of a strong community feeling, enhancing in turn collaborative dynamics. Both the interviews and the ego-network analysis indicate a similar result: it is this isolation that contributes to their group cohesion. Aware of their minority status, and aware that they had not the same opportunities as other training peers, a feeling of group solidarity explains the higher friendship ratio. When three individuals from group 5 were asked to indicate which of the seven group members they knew before, they all indicated that they knew each other prior to the training (21 out of 21 seniority points). Their group achieved a high density; all group members are well connected. This was

also the case of group 10, where a very strong group feeling and cohesion was the key finding of the ego-network analysis. Interviewed teachers from this group explained not only that they were a minority within their own district, as the majority was concerned by the lacking network coverage, but also that they did not connect much to individuals from other districts. They rarely met other training participants from Ambositra, and did not exchange much with those who were part of their training wave because they were unable to attend the training wave they had been initially assigned to. Reportedly, the lack of interactive training during the waves did prevent the creation of new relationships; in the end they gathered with those teachers working and living in the same district.

2. Key actors and vulnerable individuals within the former IFADEM trainees network

The analysis of network centrality, diameter, eccentricity and density has allowed identifying the patterns of the sustainable network of former training participants. It did also ascertain different degrees of cohesion and contributions, varying according to the strengths and nature of these mobile supported ties. In the following, an analysis of key actors and leaders was performed, guided by the question to which extent their role contributes to the sustainability of the network.

4 approaches for the identification and qualification of leaders within the network of former IFADEM trainees have been mobilized:

- A look at leaders defined as such because of the number of their connections (centrality degree) and their characteristics
- A look at leaders defined as such because of their potential to ensure rapid information transmission (betweenness centrality) and their characteristics
- A look at leaders defined as such because of their favorable position, close to 'influencers'.
- An ego –network analysis: Interviewees were asked to indicate who they qualify as leader within their respective group and describe both their characteristics and activities.

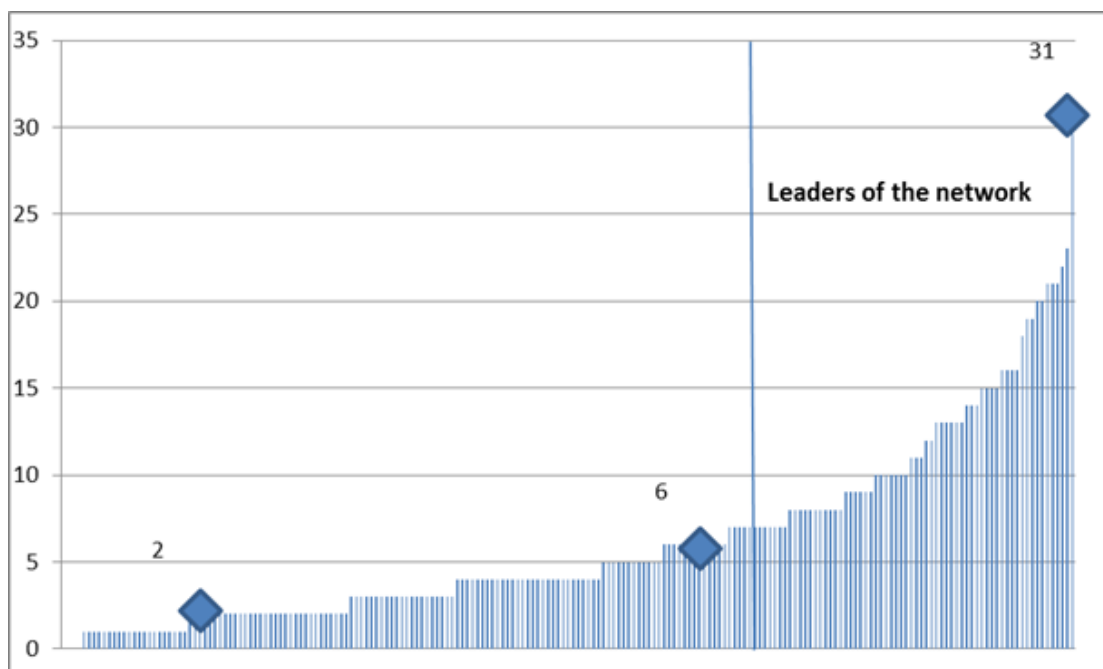
2.1 Leader analysis I – Popularity and influence – degree centrality

In social network research, one approach to leadership is of quantitative nature, meaning that a high number of connections is considered as sign of popularity, a characteristic of individuals who are potentially capable to influence other individuals. More precisely, their importance is assessed according to the amount of relationships they maintain in relationship to the total number of relationships within the network (Balkundi et Kilduff 2005).

For this analysis, the centrality degree function allowed to compute and identify the presence of these leaders. It is known from the previous studies that individuals as former tutors (pedagogic councilors) and Chef ZAP are, because of their work related tasks, likely to be among the leaders.

In the following, leadership will first be approached independently from professional roles in order to focus first, before looking in detail on the characteristics, role and pertaining effects of this type of leaders.

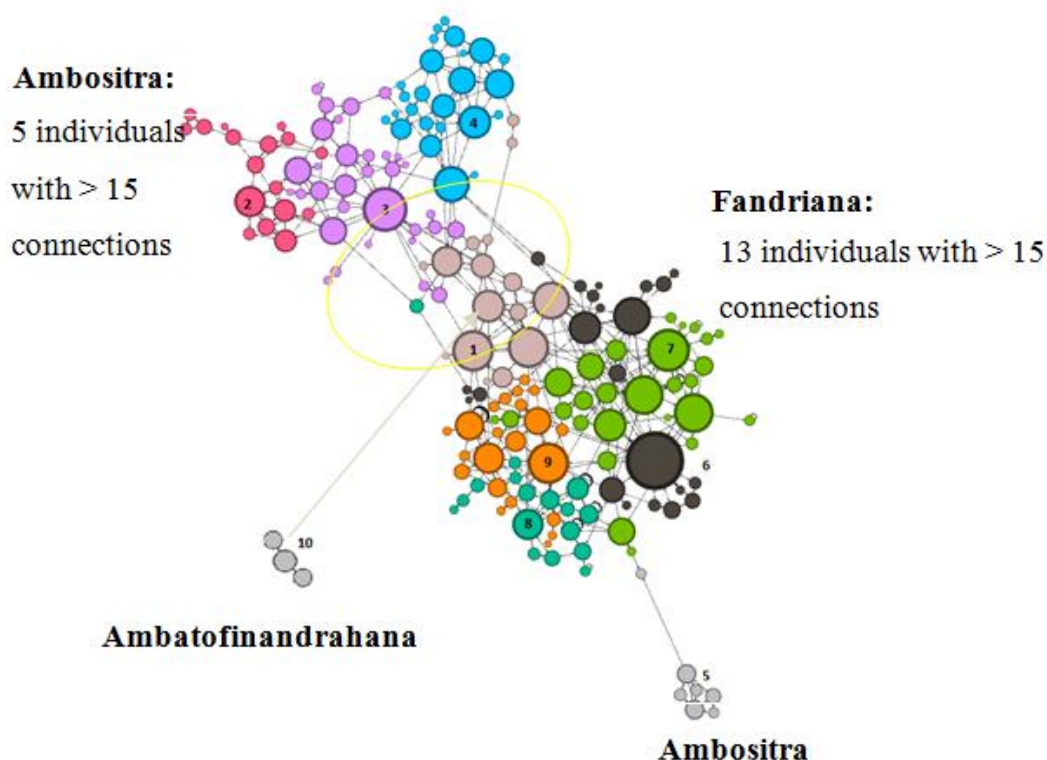
Figure 42: Identification of leaders within the distribution of mobile supported connections per network member



Interpretation: Amount of connections of former IFADEM trainee. Identification of the average and maximum value. Individuals on the right side of the line have more than 10 connections and are hence considered as leaders. Mode value 2, average 6, maximum value 31. N=171

When looking at the workplaces (school districts) of members with a degree average equal or above 10, it appears clearly that individuals from Ambositra and Fandriana are overrepresented. 36 and 44 former participants from Ambositra and Fandriana have more than 10 connections. Knowing that the majority of former participants are from these districts, this result is *per se* not surprising. Indeed, as revealed in by the study results exposed in chapter 6, this underrepresentation of individuals from Ambatofinandrahana and Manandriana among the network of later active trainees can be explained by the bad network coverage and isolation that has led to difficulties to take part in the training to exchange and tie relationships with peers (see chapter 6).

Graph 3: Mobile supported network of former IFADEM participants. Leaders with high centrality scores and their workstation



Source and interpretation: Social network based on the Call Detail Records of each still active participant during a 6 months period in 2013-4. Visualization of the relationship among former IFADEM trainees with a focus on their connections. Colours refer to a common group. The largest node of each group is labelled with the group number. N=171

However, when looking at those participants with 15 and more connections, a gap between Ambositra and Fandriana becomes more visible: Only 5 participants from Ambositra have 15

and more connections, compared to 13 from Fandriana region (Graph 3). Unsurprisingly, these connection levels are still much higher than the connections in Ambatofinandrahana and Manandriana: There is only one participant who has more than the average of 6 connections and works in Ambatofinandrahana. A closer look at his profile provides the explanation for this exception: This individual is a pedagogic councilor, hence an individual who acted a tutor during the training. His superiority in terms of connections can hence be explained by his role during the training but also be due to his other professional obligations as pedagogic councilors: These involve the supervision of teacher trainees and frequent interaction with the local administration.

2.1.1 Individuals with large connections were particularly active trainees

Knowing from the analysis of the Call Detail Records that intermediate and frequent users had higher chances to continue to use their phone, it is *de facto* certain that they would be overrepresented in the network of former participants. Indeed, the latter is composed of a majority of trainees who had been labeled as *strong users* (67) and *intermediate users* (87). Only 17 network members had been categorized as *rare users*.

Among the 63 participants who have more than the average of 6 connections to other training members, only two have been identified as *rare users* in the past. In contrast, 41 out of these 63 individuals have been categorized as *intermediate users* and 21 as *strong users*. When looking now at those who have at least 10 connections, no rare user can be found.

While the highest amount of connections (31) is detained by a participant who had been categorized as frequent users, it is the intermediate user category that is dominant when looking at the range of 11 to 31 connections.

In light of the fact that those who had been identified as *rare users* are mostly individuals living in areas with poor network coverage, their minority situation is not surprising. The domination of intermediate and frequent users among those with high connections allows to affirm now not only that high user engagement during the training will increase the chance of sustainable phone usage, but also increase the chance of connecting and collaborating by phone with a higher number of training peers.

2.1.2 Network leaders with large connections are mostly men

While the overrepresentation of intermediate and frequent users are not surprising, the analysis of gender distribution among network members led to an unexpected and interesting result: The network (201 individuals) is composed of a majority of women, with 121 women in contrast to only 80 men (121 to 80). However, the gender difference decreases when looking at those participants who have more connections than the average of 6 connections per node: 31 women and 38 men have on average 6 direct mobile supported connections. When looking at those individuals with the highest amount of connections within the network, the majority is inversed: No women is present among the top three nodes with 21, 22 and 31 connections, and among those in between 10 and 31 connections there is a 14 women: 19 men ratio. When looking at those with 15 to 31 connections, the proportion drops further to only 5 women but 14 men.

This result contrasts with both the absence of significant dominance of men in the network, and the absence of gender as significant factor for sustainable phone usage (cf. chapter 6).

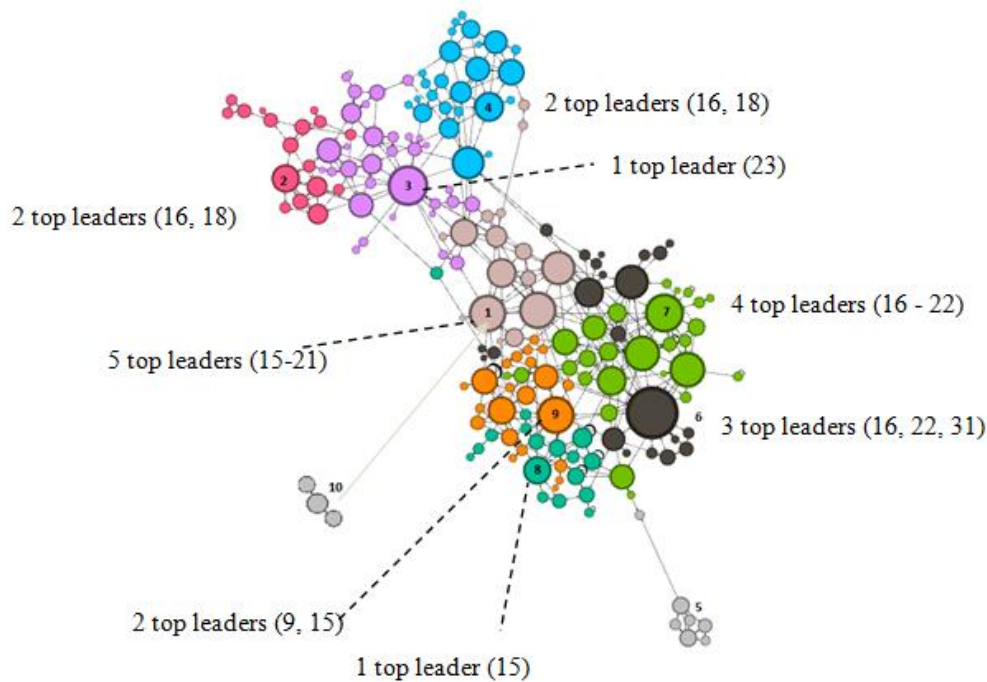
Explanations for this underrepresentation can be found in the interviews with network members: Female participants reported several times that information exchange took also place during the school breaks and when they met out of the school, e.g. on the market. It is plausible that the existence of larger number of face to face contacts diminishes their need to multiply mobile supported contacts. Considering the number of connections as symptomatic for leaders, further explanation can in this case be provided by role congruity theory: Research on male domination in leadership has revealed that female leadership is held back by either the negative perception of women in leadership positions, and slowed down by less favorable evaluation of leadership activities when fulfilled by women. The persistence of gender stereotypes is accompanied by the social acceptance of women occupying lower status positions (Eagly et Karau s. d.). Also, it has been found – and observed throughout the research for this dissertation – that traditional gender expectations are still strongly present in the patriarchal society of Madagascar and do not encourage proactivity among Malagasy women (Skjortnes et Zachariassen 2009).

2.1.3 The network is led by leaders, present in (almost) every part of the network

So far, it could be ascertained that the network of former IFADEM trainees hosts individuals who are leaders in terms of the number of network connections, meaning that they have more connections than others. These individuals are mostly from dense areas and mostly men.

Looking now at those individuals with larger connections – easily identifiable because of their size, larger than their peers – it appears clearly that they are located fairly evenly in every part of the network. Furthermore, it appears that almost every group hosts at least one leader with a particularly high number of connections. These individuals can be considered as ‘top leaders’ with regards to their outstanding number of connections.

Graph 4: Mobile supported network of former IFADEM participants - Distribution of top leaders (< 15 connections) per group



Source: Social network based on the Call Detail Records of each still active participant during a 6 months period in 2013-4. Visualization of the relationship among former IFADEM trainees with a focus on their connections. Colors refer to a common group. Identification of top leaders within the group. N=171

This is an important finding, allowing retrieving useful information on the role of these leaders for the sustainability of the network: In almost every part of the network of former IFADEM trainees there are individuals who are potentially able to provide support to a large amount of surrounding peers and who are, in consequence, capable of influencing their

neighborhood. Overall, this fairly even distribution of leaders – from a quantitative perspective – within the network can be interpreted as a sign of a healthy and stable network: In contrary to a network with a single actor with a high centrality, the network of former teacher network can count on more than one person to provide support, and if one leader would disappear, the network would not collapse.

While there are two groups (group 10 and group 5) which don't host any of these 'top leaders', an analysis of their characteristics provides explanations and confirms the previous findings:

All member of group 10 are from Ambatofinandrahana, a region where a large number of participants dropped out because of network coverage issues. As found earlier, this is a key reason explaining why these individuals have less (mobile) contacts than their peers in other regions (Le Quentrec et Gire 2013). As mentioned earlier, the only exception from this region is a pedagogic councilor who, who has more connections than average but still much less connections his peers from other regions because of this network issue.

The case of group 5 neither hosts a 'top leader', but for different reasons: The whole group is characterized by a relative homogeneity when it comes to their ranges of connections, varying from 3 to 8. Interviews with three members of this group provided interesting information on the apparent absence of these leaders. Indeed, there is a real feeling of 'equity' within the group and, more importantly, a large proportion of all exchanges are reported to take place not via the mobile phone but face to face, as all group members work in the same school.

2.1.4 Profiles of top leaders: Males, Chef ZAP and tutors

While the presence of leaders certifies relative healthiness of the network, an analysis of the profile of this network allows understanding their actual role for the network sustainability as well as the reasons that made these former training participants network leaders once the pilot has ended. When looking only at the top leaders of the network – the 20 individuals with more than 15 connections – the following conclusions could be retrieved:

The first striking result is the confirmation that every group but group 5 and group 10 has its own top leader. In group 1 and 7, there are even respectively 5 and 4 leaders with more than

15 connections. Given that there are more group in the bottom area of the network, it is not surprising to ascertain that the majority of top leaders are also from Fandriana (14) and only a minority from Ambositra (5).

Another crucial finding is the professional status of these top leaders: Besides three individuals, all are either tutors or chef ZAP. In the case of the tutors, the leadership role can be explained by the fact that tutors were supposed and obliged to be in touch with a large amount of individuals, in particular with the members of the group they tutored. Hence, these large connections seem to be a consequence from the training period and a sign of sustainability of the established training schemes.

Interestingly however, tutors are not the leaders of each group. This role is occupied by a Chef ZAP (*Zones d'Administration Pédagogiques*), which in turn can be explained by their role, favoring a position as leader:

Indeed, Chef ZAP function, hierarchically positioned in-between the teacher and the pedagogic councilor is a respected but not feared position. Chef ZAPs naturally have more contacts to other individuals as they are in charge of looking at the school activities in a dedicated zone and provide support to school directors: They are in charge of supervising teachers both from a technical and pedagogical point of view, which implies managerial tasks like monitoring the absence, scheduling meetings with school directors and teachers, providing feedback without conducting an evaluation that impacts on the teachers careers. Interviews conducted with teachers and chef ZAP lead to the impression that their support is well – accepted. This impression is in line with Ratompomalalala description of the Chef ZAP participants within the IFADEM project: *“The Chef ZAP tries to have good relationships with them [the teachers], to win their trust, and he tries to avoid putting a distance between them, to avoid problems”* (Ratompomalalala et Rakotonanahary 2013).

The fact that top leaders are Chef ZAPs explains also why, again, why these are mostly male. Indeed, there is again clear domination of male individuals: There are only five women among those with more than 15 mobile connections, among which 3 are tutors and two teachers. In addition to the already exposed factors favoring male leadership, the reason for their absence among top leaders within the network of former IFADEM teachers seems to be specifically due the professional status of these leaders: Males are simply more likely than women to

occupy a Chef ZAP positions: Indeed, teachers can become Chef ZAP provided they pass exams and increase their level of education – career decisions which are reportedly more difficult to undertake for ‘average’ female teachers because of their family obligations. Those top leaders with a lot of connections who are women are de facto either tutors, and all from a better educated milieu; the average teachers will have difficulties to make the same career paths than their male colleagues. Finally, it appears also plausible to assume that the higher phone familiarity and network coverage has favored these individuals to be later top leaders: Indeed, all have been categorized as frequent users during the training, have intensively taken part in the quiz campaign, reported to be satisfied with their network coverage and had possessed a phone prior to the training.

To summarize, the leader analysis based on a quantitative approach of connections shows that there are leaders in every part of the network, particularly in the bottom area representing Fandriana and that top leaders are mostly male; have longer phone appropriation history and work in hierarchical positions that oblige and favor the creation of mobile supported ties. While their presence indicates a stable and healthy network – meaning no dependency on a single leader – they also indicate that there are some individuals who have higher chances to be network leaders and connect to multiply former training participants because of a more favorable environment and professional assignment. The network of former IFADEM participants sustains, amongst others, thanks to the presence of Chef ZAPs who have not only taken part in the training, but continue to play a pivotal role among former training participants. However, the presence of leaders with many connections does not tell us to which extent these individuals actually contribute to the information flow within the network, a crucial aspect for a collaborative teacher network. In the following the question of leadership will be approached in terms of an actors’ capacity to transfer rapidly information to the rest of the network.

2.2 Leader analysis II – Rapid information transmission – betweenness centrality

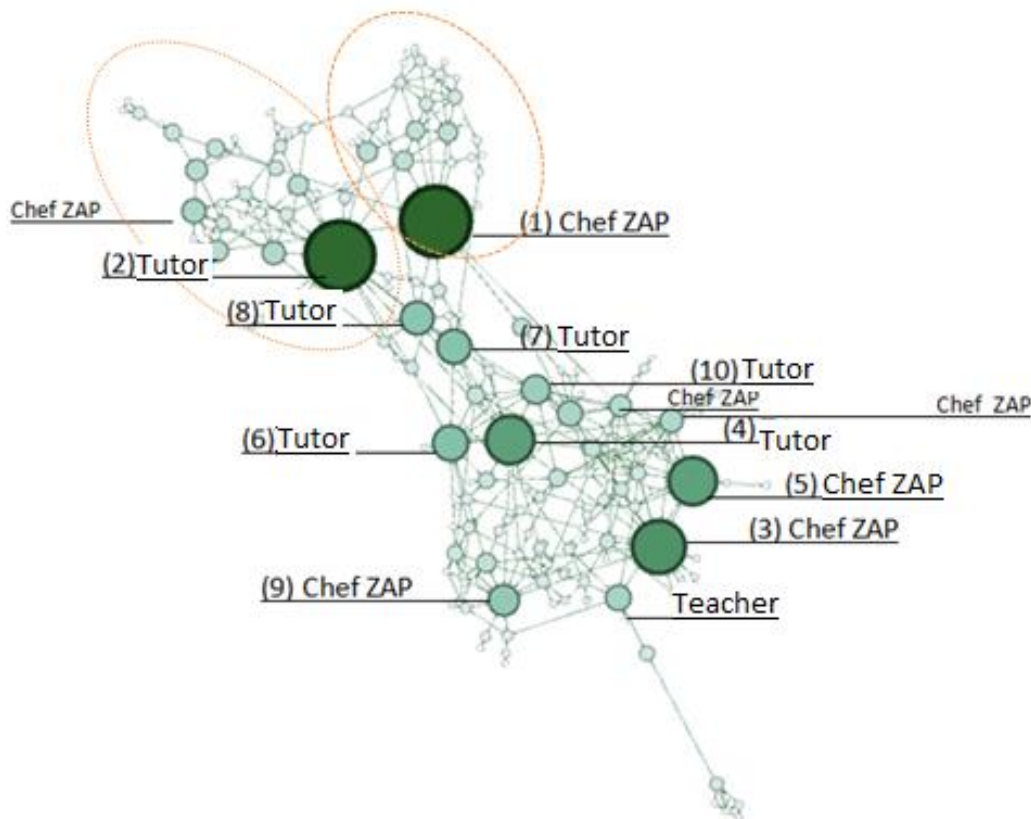
Betweenness centrality measures the frequency of the appearance of a node on the way between other nodes of the network. The more often nodes has to be crossed, the higher is

their capacity to take influence on information transmission, e.g. convey information to otherwise difficult to reach parts of the network. In contrast, these nodes have also the possibility to control and hold back the information flow (Mutschke 2010). Crucial for collaboration, actors with the power of rapid information transmission are also known to be more innovative (Leenders, Kratzer, and Van Engelen 2007).

2.2.1 Degree vs. betweenness centrality: Quantity vs efficiency

After having computed in Gephi the network so that node sizes would change according to their respective betweenness centrality score, the visual changes of the network compared to the previous networks are striking (Graph 5).

Graph 5: Mobile supported network of former IFADEM trainees: Detection and ranking of individuals high betweenness-centrality scores



Source and interpretation: Social network based on the Call Detail Records of each still active participant during a 6 months period in 2013-4. Visualization of the relationship among former IFADEM trainees with a focus on betweenness centrality scores: Bigger and dark nodes are possible leaders for the network. Ranking of nodes with regards to their power to convey information quickly (1 – 10). N=171

Firstly, only a few of those leaders who had been identified because of their high amount of ties to other training peers remain clearly identifiable in the network. This shows that a former

training participant can indeed be popular in his or her immediate neighborhood, have a lot of connections and influence them, but be of less important when it comes to the network as a whole as they can't convey rapidly information to all network members.

Also, the leader analysis based on the quantity of connections had led to the identification of many leaders in the bottom and denser part of the network, mostly composed of individuals from Fandriana. A focus on individuals with high betweenness centrality scores reveals again the presence of leaders with significantly higher betweenness centrality scores than their peers (light and dark green nodes) in this area. However, the two top leaders in terms of information transmission happen to be located in Ambositra (top area of the graph).

There are two explanations for this shift: Firstly, the density of the former IFADEM teacher network in Ambositra is lower, which increases the importance of a few individuals and makes it easier for them to convey information rapidly. Indeed, a look at the network shows that the upper network is composed of two strong sub-components which count respectively on the presence of these leaders to receive and transmit information. Knowing how challenging the work conditions of former IFADEM teachers can be (e.g. bad transportation possibilities particularly during the raining season) these two individuals have considerable authority and control over mobile supported information exchange. From another perspective this means however also that former IFADEM trainees located in Ambositra have less choices, information transmission is here more centralized than it is in Fandriana: This makes the network members located in Ambositra more vulnerable. Indeed, former IFADEM teachers in Fandriana dispose of more 'bridges' and have hence more choices and chances to receive and transmit quickly. In this regard, leadership is more shared in Fandriana than it is in Ambositra. The loss of connections (e.g. loss of mobile phone / sim card, retirement) could potentially have a negative impact on the collaboration of teachers in that area.

2.2.2 Importance of the work position: Chef ZAP and tutors confirm their role as network leaders

A look at the top 10 of these 'leaders of information transmission' confirms the importance of both pedagogic councilors (former tutors) and Chef ZAPs for the sustainability of the network. For both Chef ZAPs and tutors, it seems that their professional obligations are the most plausible explanations for their role as information hub within the network:

While Chef ZAPs are not only well accepted and respected among teachers, their power to convey rapidly information among former training partners is directly related to their daily tasks: As exposed, Chef Zaps are in charge of providing support to schools within a dedicated area and required to visit these schools regularly. In order to facilitate their duties and shorten the transportation time in-between the schools and the local school administration, they all receive motorbike from the local school administration. This can be considered as a significant privilege which does not only underline their hierarchical superiority (above the school director but below the tutor) but is also the 'secret' behind their rapid information transmission power: They are very present in a high number of schools and in constant contact with local school administrations, school directors and teachers. It is this mobility that, as already observed, allows them not only to increase the amount of connections, but also to transmit information easily to a large amount of individuals.

In the case of pedagogic councilors / tutors, their power to transfer information can also be explained by their professional obligations to be in contact with other tutors, but differs with regards to the reach of contacts: While Chef ZAPs are mainly active within one small area, and travel physically to many places, tutors have to exchange with administrative peers and tutors within whole administrative region. However, they do not have a motorbike and interviews show that they use more often the phone for these types of contacts, as well as traditional mail. These duties oblige them to be in contact with peers and administrations; they are less often in direct contact with teachers and less accessible because of their role as evaluators.

Recent research appears to confirm the validity of this explanation: Indeed, the characteristics of both Chef ZAP and pedagogic councilors correspond to the conceptual model of teacher leadership developed by York-Barr and Duke (2004): They are in a by peers respected position, act in a continuous learning environment, their work is valued by their hierarchy as well as visible and shared (York-Barr et Duke 2004). Their mobility is also a typical characteristic of teacher leadership, particularly when it comes to leadership based on the use of technology (Riel et Becker 2008). Furthermore, York and Bell also refer to a personal capacity to influence that appears to be also striking when interviewing these leaders. This aspect will be subsequently discussed in section 2.5 on the expectations and perspectives on leaders' characteristics.

Furthermore, both Chef ZAP and tutors have certain degree of responsibility towards teachers, school directors and administrative staff. It is this responsibility and the fact that their own success depends on the success of others which is very likely to influence on their engagement and collaborative attitude. Indeed, as found also by Riel and Becker, when it comes to teachers considered as leaders in the use of technology and innovation, these teachers often individuals who *“not only work in collaboration with other teachers at their school to improve teaching and learning, they also see their responsibility in terms of the larger community of educational practitioners”* (Riel et Becker 2008, p.399).

The fact that individuals with instructor positions are later leaders in terms of information transmission is also in line with recent research findings on online and distant learning environments. Mazur for example found that the individuals perceived as instructors and experts were those with the highest betweenness centrality scores and happened to be also the most active when it came to initiating collaboration between network members (Mazur, Doran, et Doran 2010).

Here, it is interesting to recall that the IFADEM project had deliberately chosen pedagogic councilors to act as tutors in order to *“build the project on existing hierarchies in view of enhancing the overall efficiency”* (IFADEM website: www.ifadem.org) In the end, it appears that the existing hierarchy is indeed one of the core strengths of the mobile network of former IFADEM trainees, but not entirely the way it had been expected: Chef ZAPS – who had not been attributed any different role than a teacher during the training period, they were treated as normal beneficiaries – are as least as important for the information exchange within the network as tutors.

2.2.3 Leadership and possible impacts on innovative practices

Finally, an interesting finding of the leadership power in terms of information transmission is the link between this power and the development of innovative practices. Similar to what has been observed by Leenders, whose research ascertained a positive correlation between innovative actors and their betweenness centrality, Chef ZAPs and former tutors are those who happen to have developed the widest range of non-prescribed, innovative phone usage at work (Leenders, Kratzer, and Van Engelen 2007). Similar to the findings exposed in chapter 5, it

appears again that the perception of added value of phone usage is enhanced by a position in which the phone can be widely exploited, is well accepted by the environment and that provides them quickly with the experience and activities of other network members, stimulating in turn their capacity to innovate.

While the presence of this type of leaders certifies that the network is composed of individuals particularly efficient in terms of information transmission and potentially favoring innovation in the network, it is also important to keep in mind that individuals with high betweenness centrality are also in a position of social control: De facto, they are also able to withhold the information flow. In consequence, their leadership position can potentially influence negatively on innovative practices among teachers as they may interrupt or inhibit the development of new ideas and risk-taking behavior by controlling the dissemination of work-related advice (Moolenaar, Daly, et Slegers 2010).

To summarize, both Chef ZAPs and (former) tutors could be identified as key leaders with regards to the power of convey rapidly information. Their presence is crucial for the sustainability and efficiency of the network, increasing its collaborative potential, as well as the development and transmission of innovative practices.

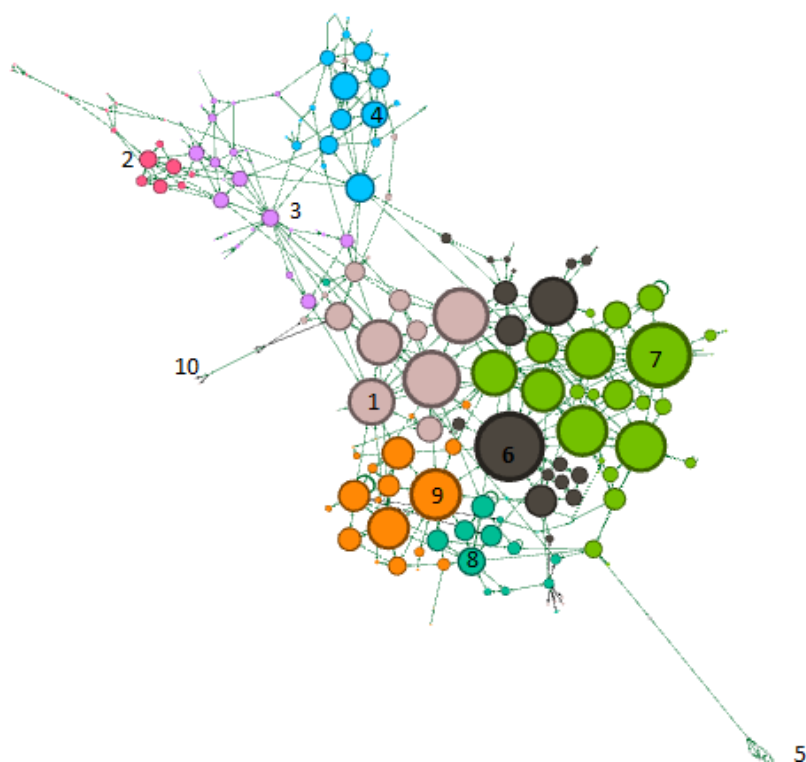
It shows also that in this regard, the network relies on members whose work position is, from a hierarchical and managerial perspective, both pivotal and superior in hierarchical, increasing the number and nature of contact partners. The particular dominance of Chef ZAPs among information transmission leaders can be explained: They are well accepted, not feared by their connections (the teachers), familiar with phones and open to innovative practices.

2.3 Leader analysis III – Connected to influencers – Eigenvector Centrality

Degree centrality and betweenness centrality allow respectively identifying leaders with regards to their power to influence surrounding actors, and leaders capable to convey rapidly information to the entire network. In addition to these two approaches to leadership, focusing on the Eigenvector centrality of network members provides a third perspective on leadership and, ultimately, their contributions to the sustainability and stability of the network of former IFADEM members. As exposed in the chapter on methodological approaches, Eigenvector centrality is often considered as natural extension of degree centrality (Bonacich 2007).

Focusing on the eigenvector centrality of a network member means looking for those former IFADEM trainees who will be considered as leaders because they are the most central actors with regards to the overall structure of the IFADEM network (Kaye et al. 2014). A former trainee who is connected to other former training peers who themselves have a multitude of central relationships will be considered as more central, more leader than an actor tied to a multitude of actors tied to many, but non-central actors. In contrast to degree centrality, analyzing the eigenvector centrality of actors allows identifying their ‘global’ (as opposed to ‘local’) prominence of a vertex in a graph (Doran, Doran, et Mazur 2011).

Graph 6: Mobile supported network of former IFADEM trainees - Eigenvector centrality analysis (Well-connected individuals)



Source and interpretation: Social network based on the Call Detail Records of each still active participant during a 6 months period in 2013-4 with a focus on eigenvector centrality of nodes. The bigger the node, the more it is connected to well-connected nodes. Colors refer to a common group, number to group numbers ranging from 1 to 10. N=171

2.3.1 Eigenvector scores at network and group level: Detection of influence

Once node sizes have been computed according to their Eigenvector centrality (Graph 6), the following visual changes can be ascertained: The bottom area of the IFADEM network, mostly composed of trainees from Fandriana, hosts now all leaders. Indeed, the two leaders who had been previously identified (in graph 6) to be leaders in terms of information flow and were located in Ambositra ‘disappear’. They are visually not different from to their surrounding peers. This shows that while they are important when it comes to conveying information among IFADEM trainees in the Ambositra district, they are yet not well connected to what could be considered as ‘hot spots’ of the teacher network, and which are located in Fandriana.

In contrast to this change, there are also various individuals with very high eigenvector centralities who already had been leaders in terms of betweenness centrality (leaders of group 6, 7 and 9) and remain leaders from an Eigenvector perspective. Once again, higher density and centrality degree (higher number of connections) are here underlying factors for their domination. They are leaders as they are not only connected to many connected, but many *well connected* members. Again, the professional obligations of these actors explain this domination of Eigenvector centrality leaders: The fact that they are mostly Chef ZAPs and pedagogic councilors mutually increases their scores. Chef ZAPs and pedagogic councilors are not only more important within the school hierarchy, but also more connected to important actors and so on.

The overall presence of Eigenvector leaders certifies that former trainees, particularly in the Fandriana districts, benefit from a particularly stable, dynamic and hence sustainable network. Subsequently, analyzing the distribution of at Eigenvector scores from a group level allows ascertain that there is a direct link between eigenvector centrality and group building.

Indeed, when looking at average eigenvector scores per group, these confirm the visual impression of groups differentiating themselves from one another because of these scores: Group 7 is composed of individuals with the highest eigenvector centrality average (average of 0,3), followed by group 6 (0,2) – whose high average is mainly due to one individual with very high eigenvector centrality – and group 9 (0,19). In this area, group 8 contrasts with the other groups as it has only an eigenvector centrality average of 0,12.

In the component representing mainly Ambositra, present groups are characterized by an average eigenvector centrality which is much lower (0,07 for group 2; 0,06 for group 3;) or equal to the least central group in Fandriana (group 4 has the same average than group 8: 0,12). Without surprise, the most isolated groups remain group 5 (0,02) and group 10 (0).

A comparison of these scores confirms the visual analysis: the majority of group members have similar eigenvector centrality scores. This corresponds to recent research findings, ascertaining that individuals with low influence tend to be connected with their peers. In contrast, network members with high influence often find themselves close to members with similar high influence (Cherven 2015).

While section 2 will analyze in detail the affinities and homophily dynamics explaining the creation of group, this result allows to affirm that a 'similar standing' explains why for example in the case of former tutors(group 1), these find themselves in the same group. This appears particularly true as they are now also closer positioned to the influent actors in the bottom areas: These are mostly Chef ZAP, a professional category to which they are closer than to the simple teacher category. Their 'bridge function' in-between Ambositra and Fandriana, remains existent but their particular attraction towards network members located in Ambositra could be ascertained.

2.3.2 Eigenvector consequence: access to resources and innovation

The presence of leaders with high Eigenvector scores within the network and their overrepresentation within one part of the network is of high importance, in light of recent research results attesting a positive correlation among Eigenvector and knowledge acquisition (Salman and Saives 2005). Concretely, this means that network members located in Fandriana have more often and more numerous possibilities to accumulate knowledge of gaining access to important information. This in turn can be interpreted as a higher capacity to transform accumulated knowledge into innovation. In this perspective, individuals from less denser areas and farer away from these leaders are still part of a network that allows them to access knowledge, but their peers from Fandriana benefit from particularly favorable conditions for innovation (Powell, Koput, et Smith-Doerr 1996).

The domination of leaders with high Eigenvector scores in the Fandriana area is also important as it may be one explanation for the domination of declared innovative practices in that area. A couple of studies found that members of a collaborative network can be all equal and similarly efficient in terms of collaboration, but those who were in addition strongly connected to other well connected individuals and had hence different sources and types of knowledge were more innovative (Leenders, Kratzer, et Van Engelen 2007; Ferriani, Cattani, et Baden-Fuller 2009).

2.4 Well-connected versus isolated members: closeness centrality

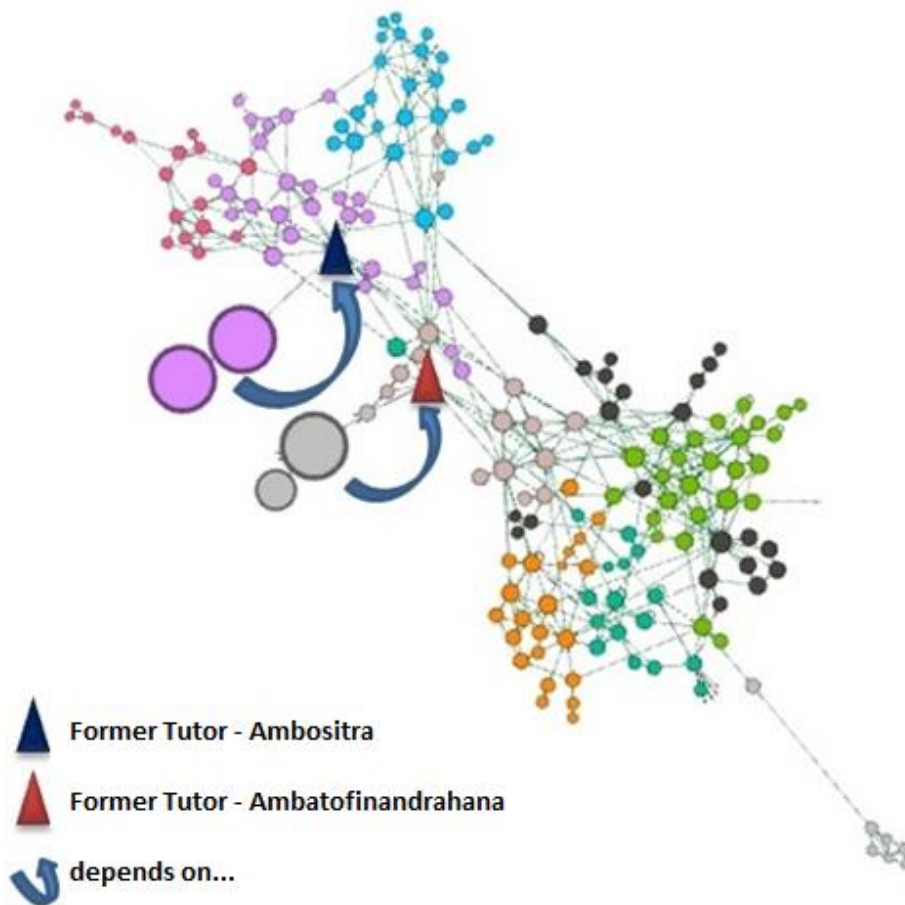
While the analysis of the type, distribution and contributions of leaders is indispensable to comprehend the nature and sustainability of the network of former IFADEM participants, looking at those individuals who are characterized by their apparent isolation and compare them to well-connected individuals is equally important. It allows identifying vulnerable spots in the network and analyzing information on the reasons for this vulnerability.

In order to identify these, the network was computed according to the closeness centrality of actors. As exposed in detail in the chapter on the methodological approach of this research, closeness is a network research concept that measures each node based on its 'closeness' to all other nodes within the network. The score is the result of the calculated average of the shortest paths. While high degree centrality has shown which former IFADEM trainees are popular and able to influence a high amount of *surrounding* peers (degree centrality) or important as they can transfer or withhold information and hence the collaboration flow (betweenness centrality), looking at the closeness scores of IFADEM members allows assessing their relative position of power or vulnerability with regards to their position within the network. The farther an actor to the rest of all other actors – the shorter the paths – the less influential and the more dependent they are.

Knowing that an individual with only a few connections has more chances to have a larger path through the network (Cherven 2015), and knowing that the hitherto identified leaders in terms of information transmission are well situated within the network and given that closeness is an inverse measure of degree, the newly computed node sizes were, as expected,

radically different from those visible in the previous graphs. Indeed, the previously large nodes became small and a few small nodes significantly bigger (Graph 7).

Graph 7: Network of former IFADEM trainees: Detection of individuals with high closeness-centrality scores vs individuals with high scores



Source and interpretation: Social network based on the Call Detail Records of each still active participant during a 6 months period in 2013-4. Visualization of the relationship among former IFADEM trainees with a focus on the shortest paths of nodes to other nodes. The shorter the path, the bigger the node. N=171

2.4.1 Closeness centrality confirms the solidity of the network

When looking at the network as a whole, it can be ascertained that the majority of nodes within the two network components are approximately the same size. Knowing that the distribution of eccentricity is limited, a high distribution of closeness centrality is not expected

and closeness centrality scores confirm this intuition: With an average closeness centrality of 0,23 and a mode of 0,0 (standard deviation = 0,17) it is possible to affirm that the network is fairly homogenous, comprised of former IFADEM teachers who are – besides a few exceptions – all in a rather well placed position towards each other: Out of 202 active members in the network, 99 individuals have an closeness score ranging from 0,12 to 0,3 compared to 10 individuals with a closeness score of 1 (largest possible score). Given that the large majority of the network has a value closer to 0 than 1, this allows to confirm once again that the network of former IFADEM trainees is a well-connected network (Mutschke 2010).

The calculation of the average closeness centrality scores of the respective groups within the two main components of the graph (Ambositra, Fandriana) confirms this homogeneity: Only one group, located in Ambositra, has an average closeness centrality score of 0,3. This is an interesting finding, as it shows that while trainees from Ambositra usually have fewer connections, this does not impact negatively on their position towards each other. In contrast, high closeness centrality was expected for group 10 because of their isolated and peripheral position, resulting also in a high eccentricity score. This expectation was confirmed: This group of trainees from Ambatofinandrahana has by far the highest closeness centrality average (0,6). Overall, given that low closeness centrality is known to favor collaboration within a network, this relative homogeneity can be interpreted as a positive sign for the mobile network of former IFADEM trainees (Wu et Duan 2015). It indicates that the majority of former IFADEM members are in fairly equal positions to reach out to each other by phone, and have theoretically multiple choices from whom accessing access resources. As seen in sections 1 to 3, this collaboration is enhanced within those groups which distinguish themselves from other by particularly high cohesion among former participants.

While there is overall a fairly homogenous majority in terms of closeness centrality, certifying again stability and sustainability, the identification of a few exceptions occupying either particularly favorable or vulnerable positions. Focusing on their characteristics allows retrieving additional explanations on either supportive or hindering factors for membership in this collaborative network.

2.4.2 The consequences of geographical and social isolation during the training

It is common that members of network located at the outer edges of a network are highly likely to have high relative scores, as they require more steps to reach all other nodes in the network (Cherven 2015). This is also true for the here visualized network of former IFADEM trainees. The concerned individuals, located at the upper-left area of the network, are from Ambatofinandrahana (grey nodes) and Ambositra (purple nodes). In the first case, this confirms the already existing impression that individuals from Ambatofinandrahana are not only geographically isolated, but also more isolated from the rest of the network when it comes to mobile supported exchanges and collaborative dynamics taking place within the network. The previously cited importance of network coverage issues, paired with the geographical isolation from other training location seems to be clearly a negative factor that hinders the possibility of these individuals to take influence in the exchanges and to collaborate with other members of the network.

Furthermore, in the case of the two individuals from Ambositra, characterized by high closeness centrality scores (purple nodes) it can be ascertained that these individuals belonged to trainees who had been trained in a different training wave than the one originally assigned to, e.g. because they had been sick when the training wave was organized. Here, the high importance of experiencing a common training experience for training wave members has to be underlined. It allows to comprehend how important it was for a large number of participants to continue exchanging both by mobile and face to face, e.g. at school or in the village. Hence, it appears very plausible that those who were trained in the ‘wrong’ training wave, were hence sort of isolated from their colleagues of their district – who were in the ‘correct’ training wave. It may explain why these teachers only had a couple of connections and subsequently find themselves in an isolated position compared to the rest of the community: They did not have the opportunity to create close relationships with other IFADEM trainees of their district and schools, the motivation and reasons to remain in contact were hence lower.

Visually, the chain of dependency of these four individuals can be easily identified: The teachers from Ambatofinandrahana are highly dependent from their better connected peers in Ambatofinandrahana and, most importantly, from their former tutor. This also applies to the

two individuals (purple nodes) who are however from Ambositra, where neither network coverage nor geographical isolation can be considered as significant challenges. A closer look at their identifies reveals however that in one case, the individual belongs to those network members who had been labeled as having used only moderately their phone during the training as well as only rarely participated in the quiz campaign. This can be interpreted as a rather passive teacher who takes only peripherally part in exchange dynamics of the network.

Concretely, in both cases, the high closeness centrality scores does indicate dependency on their tutors and their willingness to involve them as well as a lack of influence and hindered possibilities of collaboration (Doran, Doran, et Mazur 2011). Already vulnerable due to their low degree centrality, the long paths to other former IFADEM network members – and vice versa – have also negative consequences on the ability of these teachers to access resources, information, or support (Moolenaar, Daly, et Slegers 2010).

2.4.3 Key actors on a local level: The case of Chef ZAPs and tutors

The closeness scores centrality of Chef ZAPs and former tutors was expected to be particularly low (indicating a high closeness centrality) for two reasons: They are crucial for the information flow which indicates a favorable position within the network and, in the case of the Chef ZAPs, they occupy the role of group-leaders for almost every group. Subsequently, they appeared as important for the network as a whole.

When comparing their respective average scores of Chef ZAPs, their scores are however not much different, and even slightly higher (0,26) than the network average. This indicates that, from a ‘network as a whole perspective’, they are not necessarily more centrally positioned than any other former IFADEM teacher. In the case of the Chef ZAP this indicates that they are indeed key actors, but their contributions happen rather on local level within and in-between a few groups (i.e. reflecting their interaction with schools within a dedicated zone and former trainees within that zone). In turn, tutors appear to be well connected to each other because of their professional obligations but are not necessarily in a position from which they could reach the most quickly other former individuals. Even though they have tutored groups of teachers during the training, it seems that they are overall closer to colleagues who have also been tutors than to former trainees. The interviews findings strengthen this explanation;

tutors and teachers respectively explain that they were closer to colleagues from their professional category.

2.5 Characteristics and contributions of leaders according to network members

The analysis of degree, betweenness and closeness centrality have allowed to detect within the graph those individuals who can be considered as leaders of the post-training IFADEM network, taking into account their score and network (i.e. overall popularity, the power to transmit or withhold information as well as to influence their immediate environment). It could also be ascertained that in many cases, the work position of these individuals (e.g. being a Chef ZAP) favors their position.

During each go-network interviews, individuals – including persons who had been identified to be leaders within the network - were asked to indicate if, during their training period, they noted the presence of particularly engaged, leading individuals during the training, and if yes, to describe them (and when they indicates themselves, to describe themselves).

The first striking result was – besides one individual who was not a leader according to his network score – the concordance of leaders identified in the network of former trainees, and those identified by their peers as being leaders during the training. These results show that they are a factor of stability and continuity for the network, and that it is crucial to understand how, because of their characteristics and activities, they contribute to the sustainability of the network.

The analysis of the interviews revealed that network leaders distinguish themselves by particular strong content, language and, most importantly, social skills. Furthermore, they provided information on the activities, roles and contributions of these leaders for the network as a whole.

2.5.1 High content and language proficiency

Among the leaders who were interviewed, all distinguished themselves from the group. They didn't speak fluently French, but their proficiency was still much higher, needing less often

the support from the translator. All interviewees described their “leading group members” as individuals who had better content and language skills than the rest of the group. They were perceived to be “in advance”. These leaders were able, certainly because of their better French skills, to assimilate quicker than others the content of the workbooks and appropriate the different steps of the pedagogical practices present in the latter.

Network members were often impressed by their higher amount of vocabulary and their ability to explain to others grammatical rules, exercises in the workbooks and practical implementation of the workbooks. They observed also that these leaders did more than the others to prepare the tutored sessions, as shows this interview quote from a teacher talking about his group members:

Teacher: Yes there were some really remarkable people, they made their own teaching materials!

Because of their skills, leaders stood out of group. They were particularly respected, and perceived as credible and resourceful. In consequence, leaders were approached for support and advice, but also noted because they spontaneously offered help to others:

Teacher: They [leaders] really enjoyed the training, so it motivated them even more and they wanted so share

This could be identified both by non-leaders describing leaders, as well as leaders describing themselves, as I the following case:

Leader: I try to understand all that is in the workbooks and to explain it then to those who still have difficulties with the vocabulary... sense of initiative.

Another leader of the former IFADEM-network describes an activity that illustrates well this pro-activity and knowledge sharing mechanism that led to the organization of efficient and appreciated activities:

Leader: I took the initiative to reunite the other persons of my group prior to the small monthly gatherings, in order to discuss difficulties and to exchange together; and after the monthly meeting once again... so we did a before and after meeting, the latter helped to debrief what we had learned during the tutored session.

Indeed, even more than because of their content and language skills, leaders seemed to be perceived as leaders because of their personal characteristics and social skills.

2.5.2 Strong social skills and emotional intelligence

The personality of leaders, when interviewed, was in most cases immediately detectable. As found by York and Bell, they seemed to have a personal, inherent capacity to influence their environment. During the interviews, leaders were particularly enthusiastic about the fact to be selected, at ease, outgoing and joyful. Descriptions and self-description revealed that leaders are characterized by a high sense of generosity: It makes them happy to share knowledge and support peers. Helping others seems to be natural, normal to them.

Leader: As I understood the content, I wanted to share, I was happy doing so, feeling pleased...

This generosity increases their popularity, adds up on their original importance and creates ties, as shown through the following quote:

Teacher: This person [the leader] solicits the others, 'if you need help you can contact me, I am there to help' and then people automatically lean on her

In addition to their pro-activity and generosity, these leaders characterize themselves also because of social skills that allow them to convey efficiently support and information. Indeed, interviewees indicate that they are impressed by leaders "dynamic character". Leaders are perceived as "audacious" and "not shy".

Both during and after the training, they are described as people who "constantly pushed themselves" and "wanted answers".

The described social skills of IFADEM leaders also provide additional information on the reasons for their sustaining leadership: They are provided with skills that impact positively on the community as a whole. IFADEM leaders are described as individuals with "good listening skills" and who know how to "resolve conflicts" as well as "available and flexible". Furthermore, as described by their environment, their soft skills directly impact also on their professional competences:

[The leaders are] *open-minded, and very often when you are open minded, this has an impact on your competences.*

There appears to be indeed a direct link between their highly developed social skills and professional, particularly managerial competences. As explained by one leader – a Chef ZAP – who explains that “*leading...is a natural gift since my childhood...I managed associations, municipalities*”.

Overall, interviews with leaders and their description by their connections show that they are personalities with strong social skills and emotional intelligence. As observed by Moore, the latter takes shape in form of awareness of potential and needs, enhancing the efficiency and acceptance of their leadership. As revealed by the interviews, these network leaders are not only respected for their mastering of knowledge, but also appreciated for their sociability. The presence of leaders with social skills and emotional intelligence impacts positively on the network as a whole as they enhance ‘bonding social capital’. Research in organizational psychology has shown that bonding social capital – close relationships among individuals with communalities like the shared IFADEM experience – ultimately increases professional motivation of employees and higher performance (Carmeli et al. 2009), and contribute to strong internal cohesion and fluid knowledge sharing as observed in the case of the here analyzed network (Cohen et Prusak 2001; Woolcock 1998).

2.5.3 Leadership activities within the post – training network

Already identified as leader during the training, these leaders continue to occupy their leader position, mobilizing their competencies and skills in the aftermath of the training. Besides the fact that they continue to be called and reach out to former training members, they also organize meetings with former trainees and encourage collaboration among peers. In addition, they also appear to be particularly convinced about the use of the mobile in class and more generally, student centered teaching practices. Leaders (when they were teachers) reported that they used the audio-file in the classroom, registered their students and made them listen to motivate them to “*come out of their shell*”. They seem to contribute to the network not only by stimulating good practices; they also ensure the information flow within the network.

From the training onwards, it appears that they have occupied pivotal positions, and are not only trusted by teachers, but also privileged interlocutors for the administration. This pivotal

position – similar to the one described in the case of Chef ZAPs, is stable and does not change, even if the leader moves to another location:

Leader: The Chef ZAP calls me and I give him the news, and he transmits the news over there [regional school administration]. The Chef ZAP takes over. I was the central point there [in my village, during the training] and now that I left we have hold on to this functioning.[...] Even in the new school, I have the role of a focal point.

The interviews indicate also that leaders do not only provide support and ensure information flow; they are also those who connect the IFADEM network to the local school administration and other teachers who are not ‘Ifademiens’. In this regard, their leadership and activities seems also to benefit non IFADEM participants:

Leader: I’ve given my contact to non-Ifademiens outside of our school, so they can reach me when they need help.

Simultaneously, they contribute to the sustainability of the network as they prevent its isolation. The mechanism is the same as the one described earlier in this chapter: As much as there is no component within the IFADEM network entirely cut off from the rest of the network, the IFADEM network as a whole is neither entirely cut off from the surrounding teaching workforce and school administration.

To summarize, these leaders are not only popular and influent, they ensure information flow from and to the IFADEM network, allowing its members to improve the access to additional resources. IFADEM leaders’ description and self-description allows confirming that they contribute in a crucial way to the sustainability of the network. Their reported role and activities are in line to those assumed by their respective degree, betweenness and centrality scores. Their positive attitude towards innovative practice of these leaders is a crucial finding: As exposed by Law (2008) in the 2006 SITE study, the presence of leaders and their attitude towards innovative practices is crucial. These leaders – particularly when they are, like in the IFADEM case, Chef ZAP or pedagogic councilors – influence the use of pedagogical practices, are more likely to provide technical support and encourage technology use, fostering hereby innovation within their surrounding teachers’ pedagogical practices (Ottestad 2013; Law, Pelgrum, et Plomp 2008).

3. Group affinities, activities and contributions

The first section of this chapter has shed light on the patterns and key actors within the network of former IFADEM trainees. This analysis allowed understanding the nature and characteristics of a network characterized by different degrees of cohesion. All network members benefit, but not to an equal extent from the possibility to collaborate, access resources and develop innovative usages. The sustainability of the network appears to be related to its structural stability, i.e. lack of dependency from a few actors, and the presence of leaders ensuring rapid information flow and / or able to accumulate and share particularly efficiently information. A particularly interesting finding is the fact that former tutors and Chef ZAPs play a key role for the sustainability of the network because of their professional functions, their pivotal role in-between teachers and the local administration. This role is enhanced by their high physical mobility.

The analysis has also shown a network organized in multiple interconnected groups and revealed both the existence of an instrumental and expressive network. These come along with multiple contributions – albeit unequally intense – for network members, including enhanced access to resource and innovative practices.

The subsequent section focuses on the presence of these groups, characterized by strong group-cohesion needs. Their composition has been analyzed with regards to group affinities. Understanding these group affinities shall allow to obtain a better understanding of the functioning and purpose of the network, analyze the contributions for network members and their activities, as well as to comprehend to which extent these groups ultimately influence on the sustainability of the network.

More precisely, three areas of possible group affinities were analyzed with regards to the question to which extent they influence the creation of groups and resulting contributions for group members: Socio-economic and infrastructural homophily, a shared training experience and phone usage during the training.

This choice was justified both by recent research findings, indicating that teachers are more likely to interact with teachers who are similar to them with regard to gender, age, experience, ethnicity, grade level, subject matter, physical proximity, beliefs about teaching, and prior professional relationships (Bidwell et Yasumoto 1999; Coburn 2005; Moolenaar, Daly, et

Slegers 2010; Penuel et al. 2012, 2007). In addition, this choice follows-up on the interviews which revealed on one hand a strong group feeling to be 'Ifademiens' but on the other hand also particular close relationships with a certain number of individuals only.

From a methodological perspective, Gephi's modularity function was used to identify the groups of the network. Within the two mayor areas of the graph, 8 sub-groups could be identified. Two other groups distinguish themselves from the rest of the network. Albeit connected to the rest of the network, they occupy an isolated position.

3.1 Detection of socio-economic homophily as explanation for group composition

The previous studies have shown, to uneven extent, factors like gender, work station and infrastructure impact on the usage of the phone. Given that socio-economic homophily is a frequently observed phenomena in social network research, but not systematically considered as crucial for the quality of teacher collaboration, it appeared indispensable to assess their importance and impact on the network of former IFADEM participants (Campbell et al. 2013; Weindling 2005).

3.1.1 Gender distribution per group

The combined analysis of the call detail records and trainee characteristics had revealed that gender is not a significant factor of sustainable phone usage after the end of the training (chapter 6). However, it appeared possible that gender influences group composition, as network researchers have often identified gender to be a significant factor when it comes to analyzing the tendency of individuals to associate and tie relationships within a network (Moolenaar 2012; Hawe et Ghali 2007) When it comes to gender distribution within the network of former IFADEM participants, almost every group is composed of both female and male individuals, but only one group (Nr.9) is perfectly even (50% of women and men). Group 4 and 10 are characterized by the highly or totally dominance of one gender: Nr. 10 is composed to 100% of women, and Nr. 4 to 92%.

Table 34: Proportion (%) of women and male group members

Group Nr.	1	2	3	4	5	6	7	8	9	10
Female	56%	47%	59%	92%	43%	41%	56%	59%	50%	100%
Male	44%	53%	41%	8%	57%	59%	44%	41%	50%	0,0%

Source: Retrieved from the dataset of participants characteristics merged with the dataset obtained from the social network analysis (group identification); N= 171

Two explanations may be valid when it comes to understanding the cleavage between group 10 and the rest of the network: It is the smallest group and located in the both very rural and poorly network connected area Ambatofinandrahana. While it appears possible that in this area, where IFADEM participants were mainly male, female participants preferred to gather together, the most probable explanation is certainly their high isolation. As discussed earlier, the latter has considerably influenced on their cohesion and the absence of male individuals who continue to use their phone explains here the gender homogeneity of the group.

A majority of female teachers can also be observed in the case of group 4, but for a different reason: They are located in Ambositra, the semi urban and together with Fandriana one of the less isolated areas of the training project. While men are overrepresented in rural areas, women in turn are for mostly health and family reasons less inclined to accept posts in rural areas, which explains why female teachers are overrepresented in urbanized areas (see chapter 2).

Overall, while the ego-network analysis indicates that those ties qualified as friends are mostly among individuals from the same sex, the interviews did not reveal community or group feeling influenced by gender.

3.1.2 Geographical proximity

The analysis of patterns had already shown that the two main components of the graph are respectively composed of individuals working mostly within one of the two school districts whose favorable infrastructure and raining conditions had allowed for a larger number of trainees to develop sustainable usages: Ambositra and Fandriana (chapter 5, chapter 6).

A closer look at the assigned work station within the different groups shows that each group is mostly composed of members from the same school district. More precisely

- Group 2, 3, 4 and 5 are almost solely composed of former participants belonging to the local school administration of Ambositra.
- Group 6, 7, 8, and 9 are almost solely composed of former participants belonging to the local school administration Fandriana.
- Group 10 is solely composed of members from Ambatofinandrahana.

The geographical homogeneity of these areas contrasts with group 1, which is almost equally composed of members that belong to one of three different school administrations. Knowing that group 1 is mostly composed of former tutors (pedagogic councilors), the presence of multiple assigned school districts can be explained by their need to exchange regularly for professional purposes. This group reflects neatly the homophily principle of ‘similarity breeds connection’ (McPherson, Smith-Lovin, et Cook 2001): As exposed earlier, tutors are indeed very similar: They are not only more qualified, but from a professional perspective they are also similar with a higher societal and hierarchical status than teachers or Chef ZAPs.

Otherwise however, the fact that geographical location is a common denominator is a result in line with multiple network research studies which identified geographical proximity as significantly influence on the creation of network ties. As for example identified by Daly, network researchers encourage a geographically embedded view of relations with the argument that close geographical proximity comes along with higher chances to develop ties. This has been observed both in Europe and, most importantly, in an African context: In an Ugandan study for example, close geographical proximity had shown to support the development of ties between headteachers as this allowed these them to increase their access to resources. This result is similar to the motivations exposed by former IFADEM teachers (A. J. Daly 2010; Hite 2008).

The importance of belonging to the same district, and knowing that face to face contact was reportedly another frequent manner to exchange with former IFADEM peers, confirms recent research findings indicating that among a network, the phone is not necessarily used to reach those who are far, but to intensify the contacts with those who are nearby. Indeed, Rivière explains that possessing a telephone does not necessarily favor establishing / maintaining

contact with call partners living in more remote areas; the phone would allow the creation and reinforcement of communities of those living near to each other (Rivière 2001).

It is also worth mentioning that the final evaluation had identified geographic proximity as important factor for group building already during the training. The fact that this factor remains valid over time can be interpreted as another sign of continuity and stability of the network and shows that the origins of sustainability find their source during the training period.

Knowing how strongly related geographic location and network satisfaction are (chapter 5) it appears indispensable to ask to which extent the degrees of satisfaction contribute to group building within the network of former trainees.

3.1.3 Low network satisfaction is compensated by density of contacts

The impact of satisfying network coverage on sustainable phone usage after the end of the training has been shown in chapter 5 and 6 and its importance on network cohesion evocated in the first section for this chapter. Knowing that the social network is mainly, but not solely, composed of members living in areas with satisfying network coverage access (Ambositra, Fandriana), it appeared interesting to analyze if differences in network satisfaction are reflected in the composition of group building. Do trainees with poor network coverage find a place in a group or do they mainly gather together, e.g. because they live anyway together in an area with poor network coverage?

The analysis of network satisfaction within and among the group shows: For each group of the network, the proportion of members who were fully satisfying with the network is dominant, in group 1, 2 and 10 it is even the only answer given. However, half of all groups (3, 6, 7, 8 and 9) contain several members that were not satisfied with the network but still managed to develop sustainable phone usage towards former trainees and join one of the networks' groups. This finding indicates that, while the network is certainly a crucial and decisive factor when it comes to be part of a community, there must be further incentives and motivations that explain that even those who are penalized by an unsatisfying network find a way to stay in touch with their peers. In the case of group 3, the explanation was provided during the interviews: Group members reported that they found solutions to their network problems (e.g. climbing up a hill, using another phone to be in touch with former IFADEM

trainees when they had no access at all): the perception of added value of the mobile network was so significant that they managed not to solve, but to contour the problem. Most importantly, the willingness and ability to contour an infrastructural issue in order to use a mobile phone is considered as strong sign of appropriation (Hahn, 2008).

In the case of the groups 6, 7, 8 and 9, all located mostly in the Fandriana area, it appears likely that the once again, density enhances the effect of collaboration and connectedness. It appears that the positive effect of being close (incl. face to face) to highly engaged and connected individuals, equaling a higher number of accessible resources, compensates their poor network situation.

To summarize, it appears that geographical homophily is certainly an important factor for group building, confirming the importance of density of connections, and the mutual reinforcement of the latter with face to face contacts, enabled by geographical proximity. This dynamic compensates for the lack of network coverage in some cases and allows those who managed to sustain to be part of the different groups. However geographical proximity alone cannot explain the creation of groups. If so, the network would be composed – besides the small group from Ambatofinandrahana – only of two large groups representing respectively Ambositra and Fandriana. Both training factors and phone usages need to be analyzed with regards to their influence on group affinities.

3.2 Training related characteristics and detection of affinities

Knowing how significantly the training experience influenced on the sustainable phone usage of former trainees (chapter 5), it appears important to analyze to which extent there is an influence of training mechanisms on group building: Indeed, the geographical homophily is very likely to be reinforced by the fact both training waves as well as the tutored training sessions had been organized in accordance to the school district of each participant. With other words, participants might not be only in the same group because they teach in the same school district, but because they tied relationships with peers during the training which was organized according to the location of their school district. This common experience within a

small group, coupled with the fact to have in addition to mobile contacts also face to face exchanges appears a plausible argument for group building.

3.2.1 Groups and inter-group connections reflect the training waves and the monthly meetings

The IFADEM training had organized three phases of training sessions at the National Institute for Teacher Training in Ambositra. The first training session took place at the beginning of training (End of August – Early Septembre), another session in the middle and another at the end of the project. As it was impossible to gather all participants together during each training phase, each session was divided into three waves who were trained subsequently, once the other group had left. These groups were organized according to their geographical location.

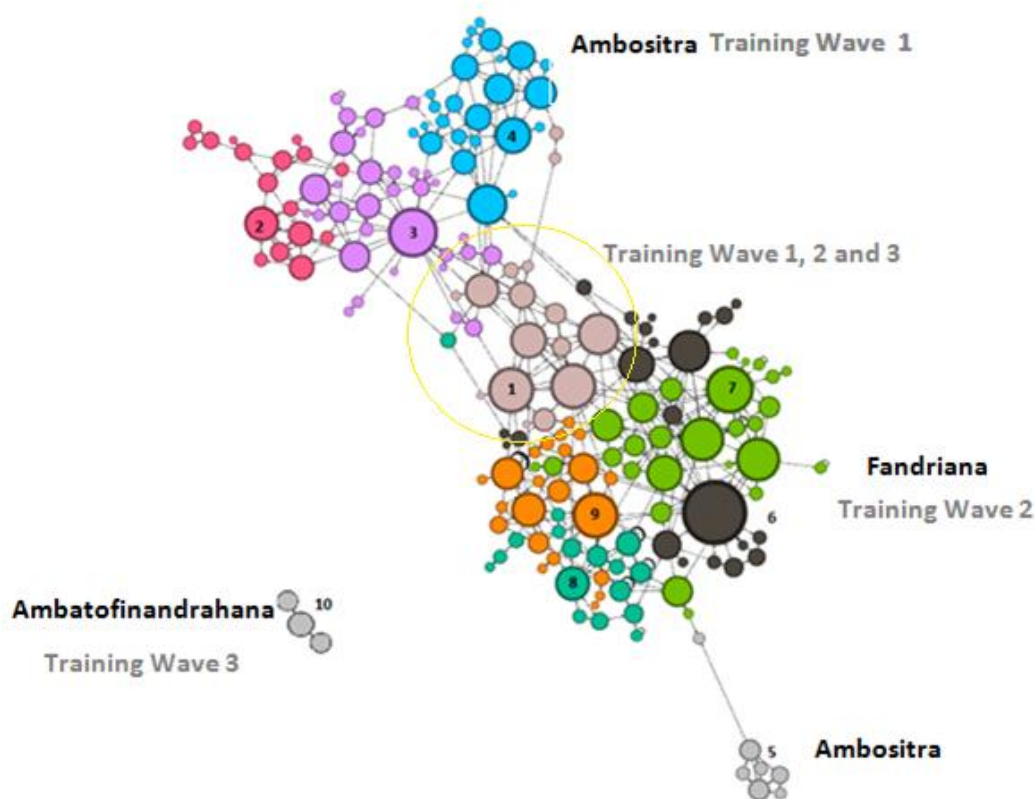
Table 35: Composition of groups according to their respective training wave (1, 2 or 3)

GROUP	Nr. 1	2	3	4	5	6	7	8	9	10	Total
Wave 1 (Ambositra)	5	14	24	22	6	0	1	1	0	0	73
Wave 2 (Fandriana)	7	0	0	1	0	14	15	14	18	0	69
Wave 3 (Ambatofinandrahana & Manandriana)	4	3	8	2	1	8	11	2	4	3	46

Source: Retrieved from the Call Detail Record of former trainees still using their phone in 2014, database merged with questionnaire results from 2013. N=171

Wave 1 comprised participants from Ambositra, wave 2 from Fandriana and wave 3 from Ambatofinandrahana and Manandriana. The last wave contained also 31 individuals who could not attend ‘their’ wave 1 or 2, e.g. because they were ill and had to join later another training wave. Around 150 teachers took part in each of the three waves during each of the three training phases. A look at the composition of each group of the network (Table and the training waves during which participants had been trained shows unsurprisingly that the majority of the groups in the upper area has been trained in wave 1 (organized for Ambositra members) and in training wave 2 (organized for those from Fandriana). At first sight, this seems to simply confirm the geographic homophily of training members (Graph 8).


Graph 8: Mobile supported network of former IFADEM participants – Training wave distribution










Source and interpretation: Social network based on the Call Detail Records of each still active participant during a 6 months period in 2013-4. Visualization of the relationship among former IFADEM trainees with a focus on the training waves in which the individuals of the graph components (upper and lower level, isolated component) have been trained in. Colors refer to a shared group, node size to amount of connections (degree). N=171

However, conducted interviews indicate that the feeling of cohesion – key for group building and sustaining – was not related to a shared district, but the common experience within a group. More precisely, interviewees declared that the modalities of the training waves favored this feeling of ‘belonging together’: A majority of trainees had to travel to these training days. As these took place too far from their homes to travel back in the evening, they were offered accommodation and free meals on the training site. This fairly outstanding common experience stimulated a feeling of community: Participants had time to share their experience and of course, discuss also private matters in the evening.

Table 36: Characteristics of members in group 1 (teacher or tutor / training wave / tutor belonging)



	ROLE	SCHOOL DISTRICT	TRAINING WAVE
	<ul style="list-style-type: none"> • Tutor Nr.01 + Teacher 	<ul style="list-style-type: none"> ▶ Ambatofinandrahana ▶ Ambatofinandrahana 	<ul style="list-style-type: none"> ▶ Wave 03 ▶ Wave 03
	<ul style="list-style-type: none"> • Tutor Nr.02 • Tutor Nr.03 • Tutor Nr.04 	<ul style="list-style-type: none"> ▶ Ambatofinandrahana ▶ Ambositra ▶ Ambositra 	<ul style="list-style-type: none"> ▶ Wave 03 ▶ Wave 01 ▶ Wave 01
	<ul style="list-style-type: none"> • Tutor Nr.05 + Teacher 	<ul style="list-style-type: none"> ▶ Ambositra ▶ Fandriana 	<ul style="list-style-type: none"> ▶ Wave 01 ▶ Wave 01
	<ul style="list-style-type: none"> • Tutor Nr.06 • Tutor Nr.07 	<ul style="list-style-type: none"> ▶ Ambositra ▶ Fandriana 	<ul style="list-style-type: none"> ▶ Wave 02 ▶ Wave 02
	<ul style="list-style-type: none"> • Tutor Nr.08 + Teacher • Teacher 	<ul style="list-style-type: none"> ▶ Fandriana ▶ Fandriana ▶ Fandriana 	<ul style="list-style-type: none"> ▶ Wave 02 ▶ Wave 02 ▶ Wave 02
	<ul style="list-style-type: none"> • Tutor Nr.09 • Tutor Nr.10 	<ul style="list-style-type: none"> ▶ Fandriana ▶ Fandriana 	<ul style="list-style-type: none"> ▶ Wave 02 ▶ Wave 02
	<ul style="list-style-type: none"> • Teacher • Teacher 	<ul style="list-style-type: none"> ▶ Ambatofinandrahana ▶ Fandriana 	<ul style="list-style-type: none"> ▶ Wave 02 ▶ Wave 01

Source: Retrieved from the Call Detail Record of former trainees still using their phone in 2014, database merged with questionnaire results from 2013.

The only exception is, once again and without much surprise, the case of group 1 (Table 36). Group 1 is composed of a large majority of tutors because of the already evocated reasons (professional homophily). In this group the presence of a few teachers from the different training wave can, in at least 4 cases, be explained by the fact that they ‘accompany’ the tutors they had been trained by during the training: This can be interpreted as the creation of particular solid ties with these tutors – more than with other training peers during the training.

In addition to the influence of the training wave experience, having participated in the monthly training sessions in the same village appears to be an even more important factor for group building.

When looking at the composition of each group and the location of the monthly tutored group meetings for each member, it appears that five groups (Nr. 2, 5, 7, 8 and 9) are composed of

particularly high amount of individuals who have been trained within the same monthly meeting locations. Group 3 is dominated by members who had been mostly trained in three different locations (Ilaka centre, Kianjandrakefina and Tsarasoatra).

While the others are composed of individuals who belonged to different monthly training locations, group 3 remains mostly composed of individuals who met during the training waves and whose monthly tutored sessions took place in villages which were located closely to one another (Table 37).

Table 37: Number of group member according to the location of their monthly tutored training sessions (tutors excluded)

Location / Network group	Nr.1	2	3	4	5	6	7	8	9	10	T
Ambalamahatsara	1										2
Ambatofinandra - Nord	1									3	4
Ambositra	1	9		15							26
Andina		1	1				1				6
Fandriana I						6	5	2	2		17
Fandriana III	1					6			1		8
IB				7							7
Ilaka Centre			9								9
Imerina Imady		6	2								8
Ivato		1	1								4
Kianjandrakefina			7	1				1			9
Mahazoarivo I							17		1		19
Marosoa					7						7
Miarinavaratra I						4		4			10
Sahamadio I				1		5	1	2			1
Sandrandahy I								8	17		25
Talata Vohimena							1				1
Tsarasoatra	1		8								9
Tsarazaza I	1					1	2				4
Total	6	17	28	24	7	22	27	17	21	3	185

Source: Retrieved from the Call Detail Record of former trainees still using their phone in 2014, database merged with questionnaire results from 2013.

With other words, it appears that the intense common learning experience during three days and the ongoing monthly meetings with a selected number of individuals - either directly during monthly training sessions or indirectly (close by training locations) - is as key explanation when looking for factors that bring members together in one group.

3.2.2 Tutors are important for the network - but are not the 'heart' of the groups

If a common training experience is considered as group building factor, a plausible reflex would be to suggest that the tutor is at the origin of the group. However, it is known already from the final evaluation that the network groups observed during the training was not build around 'their' different tutors.

Indeed a look at the distribution of teachers and tutors in each group confirms that in all cases but group 10, it is not so much the fact that an individual has been tutored by a specific tutor, but a shared training location which influences on the process of community feeling and group building.

3.3 Phone usages during the training

Finally, IFADEM participants differentiated themselves from each other by a different phone approach, both in terms of usages and intensity (see chapter 5 and 6). The objective of the subsequent presented section is analyzing to which extent these differences may have influenced on the group composition observed in the aftermath of the training. It also allows understanding inner-group contributions and activities, related to a different phone approach.

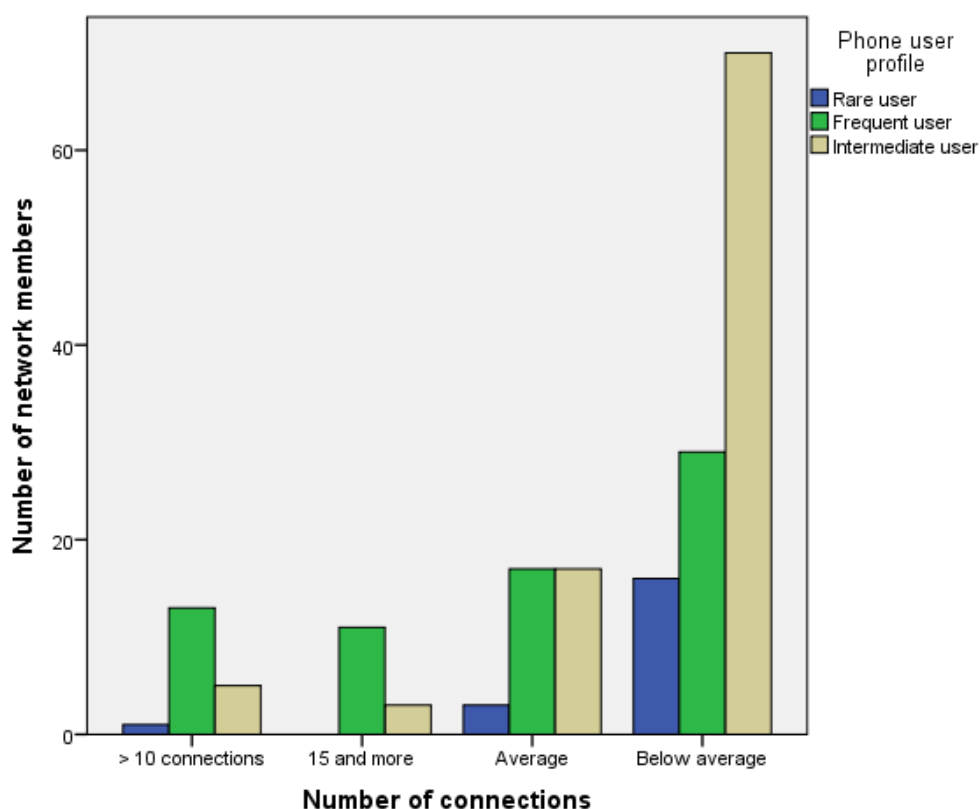
3.3.1 Distribution of phone user categories

Based on the findings of the previous quantitative analyses (cf. chapter 6), it could be ascertained that those users who have been categorized as being frequent or intermediate users are more likely to be still active once the training has ended. Besides their higher chance for sustainable usage, the different phone user profiles seem also to reflect different attitudes and expectations towards phone usage, innovation and motivation to connect to former training members. Before assessing to which extent group may be influenced by these factors, analyzing the link of phone user profiles and number of connections is informative (Figure 43).

A look at Figure 43 confirms that low phone usage during the training comes along with a lower range of IFADEM connections once the pilot has stopped. This is an expected result after the findings from chapter 6, which had found that intense peer to peer communication comes along with previous intense training engagement.

Given that higher density hitherto seemed to be related to large number of positive outcomes and high added value perception with regards to the phone, it was expected that the majority of frequent phone users would constitute the groups in that area.

Figure 43: Distribution of phone use profiles among categories of connections (below average, average, 10-15 connections and 15 + connections)



Source: Retrieved from the Call Detail Record of former trainees still using their phone in 2014, database merged with questionnaire results from 2013.

However, as identifiable in the subsequent table, frequent phone users are not only present in several groups, but constitute even the majority of groups in the Ambositra area, yet a less dense area (Table 38). This is particularly interesting as it may suggest that the quality of ties is higher in Ambositra than in Fandriana: Individuals are connected to fewer people, but they

invested more time and effort in these relationships than individuals in the Fandriana area. These have a high number of mobile connections but overall, used from the beginning on less often the phone to connect to former training peers. It appears possible that this is due to higher face to face contact, or the use of other mobile phones – a high number of individuals in this area reported to possess a phone at training start. In addition, another possible explanation arises from this finding: What if it was this very high number of mobile contacts that in the end slowed down the actual use of the phone? This phenomenon, a negative consequence of high possible contacts is described as ‘social overload’, and has been described in a in 1978 conducted environmental psychology study on the effects of residential density, and more recently, by studies on the effects of social networking websites like Facebook: Social overload describes the reaction of individuals who exceed, because of the contact with a large number of other individuals, their interaction capacity or ability to process relevant stimuli. Among observed consequences are alienation (McCarthy et Saegert 1978) and increasing discontinuous usage (Maier et al. 2012).

Finally, a look at Group 10 confirms that this group is definitely an exception, characterized by their high isolation, but also high motivation during the training and ability to overcome infrastructural challenges: Two out of three individuals were frequent users, no rare user is part of the group. Clearly, this group differentiates itself from others by its cohesion and resilience, showing that strong motivation leads despite network issues to sustainable connections.

Table 38: Distribution (%) of communication profiles among each group

Phone user category	Later inactive	Group Nr. 1	2	3	4	5	6	7	8	9	10
Rare	52			7	12		22	7	29		
Frequent	13	33	52	60	37	42	18	29	23	42	33
Intermediate	34	66	47	32	50	57	59	63	47	57	67

Source: Retrieved from the Call Detail Record of former trainees still using their phone in 2014, database merged with attributes database

3.3.2 Group and quiz participation: Ambositra groups differentiate themselves by higher assiduousness

This finding shows that user engagement during the training does not necessarily lead to a high number of connections afterwards nor influences group membership. Notwithstanding, it seems that one particular aspect, incorporated in the variable ‘phone usage’, differentiates the groups located in the less dense area, mostly in Ambositra from the rest of the network: They were particularly assiduous during the quiz campaign, proof of a high motivation. Indeed, rare or anecdotal participation rates were much higher among groups in Fandriana (Table 39).

This shows that Ambositra groups had exploited the phone as training tool more than users from Fandriana during the training, reflecting a different, more education oriented approach towards the phone. Again, the possibility that fewer but quality ties of higher quality may influence on this type of usage seems plausible. Overall, the distribution shows also that groups cannot be categorized according to a quiz engagement rate: All groups host also individuals who barely took part in the quiz campaign. Instead, it seems that group affinity and composition is influenced by a collective experience (i.e. sharing same training wave and/or monthly training locations), and reflects the instrumental nature of the network (see 1.3.3). The presence of ‘non-assiduous’ group members can be interpreted as the presence of individuals with less resources (i.e. skills, training), connected to highly assiduous group (resourceful) group members. This corresponds to the type of relationships often observable in instrumental networks, composed of ties which can be described as “*advice-seeking, advice-giving, and discussing work-related matters*” ties (N. M. Moolenaar et al. 2011, p. 6).

Table 39: Distribution (%) of quiz participation category per group

Quiz participation	Group Nr. 1	2	3	4	5	6	7	8	9	10
Anecdotal	16,7	5,9	10,7	4,2	14,3	27,3	22,2	29,4	9,5	33
Rare	16,7	17,6	14,3	4,2		40,9	22,2	35,3	14	
Strong	66,7	58,8	46,4	83,3	28,6	18,2	29,6	17,6	61,9	67
Moderate		17,6	25	8,3	42,9	4,5	25,9	11,8	14,3	
None			3,6		14,3	9,1		5,9		

Source: Retrieved from the Call Detail Record of former trainees still using their phone in 2014, database merged with attributes database

3.3.2 The consequence of group composition: All individuals manage to be equally innovative

Despite the differences with regards to phone usage intensity and quiz participation, it appears that the presence of these expressive ties among group member has led to innovative practices within all groups.

All individuals declared innovative usage of the phone in classroom already during the training period, according to the questionnaire distributed at the end of the training. Besides a few leaders, no significant difference could be identified during the interviews with group members from Ambositra, Fandriana or Ambatofinandrahana. There is no particularly more or less innovative group besides group 1, which seems to benefit directly from the close connection with the high number of former tutors and their skills (Table 40).

The fact that all expressive ties are de facto embedded within the framework of a common social experience – IFADEM – seems to explain why despite uneven phone usage, individuals developed fairly equal innovative practices.

Table 40: Distribution of answers per group (“I used the audio files in the classroom”), tutors excluded

Group	1	2	3	4	5	6	7	8	9	10
Used audio-files in class	83%	59%	71%	74%	85%	59%	59%	76%	85%	66%

Source: Retrieved from the Call Detail Record of former trainees still using their phone in 2014, database merged with attributes database

As theorized in social capital theory, members of each group are motivated by an instrumental need – of different intensity - to engage with others actors for the purpose of gaining better outcomes. The fact that they also share expressive ties, verbally expressed when they describe themselves as ‘Ifademiens’ and in some cases, additional ‘friendship’ ties, allows to enhance the outcomes of these resources (i.e. ideas, inspiration, best practices), once accessed (Lin 2002). While not all individuals are equally connected, the relative stability and healthiness (see section 1) of the network facilitates the share of social capital in form of collaboration. In consequence, mayor gaps with regards to improvement and evolvment of practices of group members are avoided (Koka et Prescott 2002).

Summary of chapter 7

The social network study conducted in this chapter focused on what appears to be the key contribution of the IFADEM training: The genesis of a sustainable, collaborative and mobile supported network composed of former IFADEM participants. The analysis focused firstly on the structure of the network as a whole, before looking at the role of outstanding individuals (leaders / vulnerable individuals) and dynamics that underlie the composition of groups within the network.

The visual and algorithm based analysis of the networks' structure indicates the presence of a single and well-connected, hence a 'healthy' and stable network. The network is fairly homogenous, which means that it is possible to affirm a collaborative potential. The majority of IFADEM members is theoretically able "*to sustain productive collaborative relationships over time*" (de Laat et al. 2007, p.99).

The structure analysis indicates also that the network is composed of various groups. This group oriented structure reflects the training structure of the IFADEM experience. The network is constructed in a way that it allows for fairly efficient information transmission, particularly within the groups. These are characterized by a strong density and cohesion.

Furthermore, the analysis of aspects like density, combined with the ego-network analysis, allows to ascertain that there are different natures and purposes of ties: The network of former IFADEM participants is indeed composed of both expressive and instrumental ties, which strengthen the network because of their respective underlying motivations: While expressive ties favor the overall climate within groups and the network and stimulate the willingness to explore innovative practices, instrumental ties are maintained as they allow for the acquisition of competences and knowledge. Most importantly, these categories reflect once again a socially-embedded use of the phone, active in both the professional and private sphere of former participants. The collective experience has favored professional connections and friendship, multiplying the nature of information that can be exchanged.

Density differences indicate that some areas are particularly favored, i.e. have more choices when it comes to connecting to their peers and access information. Interestingly however,

even vulnerable areas are characterized by a high internal cohesion, a consequence of a 'shared isolation' experience that ultimately acts positively on their perception of collaboration.

The analysis shows also that some individuals occupy particular favorable positions, and can even be described as network leaders. While some are characterized by a particular high number of connections, and hence high power of direct influence, others distinguish themselves as those able to convey rapidly information through the network. As found by the previous studies, it appears that the professional context of these individuals and their role in the local school community influence on their leader position: From a hierarchical and managerial perspective they occupy a both pivotal and superior position, increasing the number and nature of contact partners. Former tutors' and Chef ZAPs' high autonomy, mobility and familiarity with managerial tasks explain their almost 'natural' vocation to be leaders. Most importantly, these leaders are important for the network's sustainability and efficiency: They are well distributed all-over the networks and within the groups, and contribute to its collaborative dynamics, as well as the ongoing development and transmission of innovative practices. Also highly important is the fact that their role in the local community ensures that the network of former IFADEM participants remains always connected to the rest of their school environment.

The fact that there are also 'normal' teachers who turned out to be leaders of the network led to an analysis of non-observable characteristics. According to the self-perception and description of leaders, these key actors are characterized by a high social intelligence, a pro-active and supportive attitude. They are generous and respected because of their professional and language skills, but also because of their accessible personality. These leaders influence the use of pedagogical practices, are more likely to provide technical support and encourage technology use, fostering hereby innovation of pedagogical practices among those teachers who them (Ottestad 2013; Law, Pelgrum, et Plomp 2008).

Finally, a closer look at the motivations and dynamics underlying the group composition reveals that geographical homophily is certainly an important factor for group building. It confirms the importance of density of connections, and the mutual reinforcement of the latter with face to face contacts, enabled by geographical proximity. This homophily is particularly

important as it compensates in some cases the lack of network coverage and explains the 'survival' of groups in particularly challenging areas.

The social network analysis of groups shows also that the intense common training experience (both during the large, 3 days lasting meetings as well as during the monthly sessions) led to the creation of strong ties, to which individuals seek to hold on after the end of the training.

Chapter 8 – Study 4: Discourses of organizing stakeholders: reflection of internal and external tensions

At the beginning of this dissertation, the analysis of the literature, followed by a study of mobile teacher training pilots, has revealed an absence of follow-up research and scale-up of pilots. While these pilots have per definition been designed to experiment with the introduction of a particularly device and training model, this lack of follow-up limits the conclusions that can be drawn from the evaluations focusing on short-term outcomes of the pilot. This absence of research with a broader temporal scope is considered as problematic, given that contributions that pertain to educational phenomena evolve over time. It seems hence reasonable to consider that medium-term contributions and changes pertaining to mobile teacher training pilots need to be analyzed over time.

Willing to conduct a longitudinal analysis, the IFADEM pilot project has been studied with regards to its outcomes over two years after the end of the initiative. This case study has allowed identifying a range of sustainable contributions of the mobile supported training, located both in the private and professional sphere of former users, and including the continuous use of the phone they had received. In turn, this identification has allowed understanding factors and motivations of former training participants underlying these contributions.

Overall, focusing on former participants this study has shown that a longitudinal perspective on outcomes of mobile teacher training is useful and information-rich.

In this regard, it appeared indispensable to approach the question of medium-term contributions and pertaining factors for sustainability through the lens of organizing stakeholders, i.e. those who fund, organize and evaluate mobile teacher training. 16 interviews were conducted for this analysis (Table 10).

Indeed, when considering the benefits of medium-term perspectives, while noting that pilots remain under researched once they terminate, the question arises:

In such a context, how do those organizing stakeholders define the success of a pilot? Does the apparent short-term approach of pilots influence their perspectives on sustainability and scale-up, often presented as ultimate objective of a pilot? Which factors are, from their perspective, key for short-term success and sustainability or in contrast, source of failure?

Table 41: Roles of interviewed project stakeholders (N=16)

Type of organization	N=16	Role / Job title
International Organization	6	Project assistant; Chief project manager; Programme director; Head of Unit
Private Sector	2	Chief researcher; Department director
Ministry (in the project country)	3	Chief of department; Project coordinator (2)
Non-Profit-Organization (NPO)	3	Project manager; Chief project manager; Deputy director
Self-Employed	2	Consultant

As will be exposed in the following, the interviews held in order to retrieve information on their perspectives led in addition to the identification of colliding discourses and strong tensions, ultimately influencing on the design and sustainability of pilots.

➤ *Methodological implementation process*

In order to understand their perspective, 14 interviews were hence conducted with stakeholders working in public and private organizations. All interviewees currently are or have been in the past involved in the design, implementation or evaluation of distance teacher training projects, involving portable technology, e.g. tablets or a mobile phones.

This in the following in detailed discussed results of the analysis shows that stakeholders perceive institutional and organizational factors to be both the obstacle of success, while becoming in turn majorly the goal of the pilot itself. The training related factors they perceive as crucial reflect this strong institutional oriented approach and the willingness to achieve short-term goals. Finally, the perspective on teachers' role and capacities reveals the co-existence of a both moral and practical oriented discourse, shedding light on a dilemma type situation in which stakeholders are situated in and contribute to.

1. The power of the ‘pilot project system’ and its influence on definition and perceived obstacles of project goals

1.1 Priority to achievable and exploitable short-term success

When asked for success definitions of projects, the domination of short-term factors was striking. Short-term success factors to be approached via a quantitative lens, looking into the ‘consumption’ of the tool: The higher the usage of the phone, the more successful the project is considered. This measure is not only reported as being valid for the project the interviewees had been working on, but considered by several interviewees as short-term measure applicable to all ICT based training projects. As suggested by one interviewee, these projects shall, depending on the tool, measure “*how often technologies were used in the class, and how often teachers are using the technology to prepare a lesson, how often is the teacher using a community platform with other teachers, how often are the students actually using the devices in the classrooms.*”

In addition to these measurable indicators, short-term successes factors appear also pertain to the overall positive experience and feedback from training partners and involvement. Interestingly the notion of cost-efficiency also reappears often in interviewees references to success, indicating a strong awareness of organizational and financial constraints:

Deputy director: [Short-term success is given]... *if teachers have completed the training. If the evaluations show that teachers have learned something. [...] It's a success if you have worked with talented people. If you identify innovation, changes in the relationship of teachers and their hierarchy. It's also a success if you manage to have a cost-efficient project.*

In contrast to the fairly precise and measurable indicators, it can be ascertained that interviewees remained rather vague when they defined success referring to teachers’ acquisition of knowledge or competences – officially the main goal of the pilot they are respectively involved in.

Here, it is important to underline that throughout the interviews, the tone of respondents changed. Approaching the end of the interviews, and apparently feeling more comfortable, respondents suggested that the success factors they had presented earlier were actually strongly influenced by both political and organizational factors. Interviewees created the

impression that they confided opinions they considered as rather sensitive and not necessarily well accepted.

For example, an interviewee explains that short-term success indicators are those “*you will achieve anyway*”, suggesting, like other interviewees, that rather than testing a training model for the viability of its approach or even a possible scale-up, the objective of the pilot was to achieve definitely achievable short-term goals. According to them, this achievement was guaranteed through the mobilization of “*artificial*” resources which would de facto not be available on the long term. Interviewees indicated that in consequence, the context of the pilot is not comparable to the context a training model would have to evolve if it would go to scale. Interviewed actors suggest a sort of reality gap between pilot and scale-up context, and criticize the sincerity of discourses pertaining to the justification of pilot projects:

Head of unit: A pilot always success, let's be honest... because you make sure you do the necessary to succeed: actors will be mobilized, content will be ready on time, mobiles are delivered, teachers take part in the training, drop-out is low, and at the end, the evaluations as well as the external evaluations will be positive - all this.... and it happened [in our case]. You put the necessary money on the table. Sure, money doesn't explain all, but still; and if you have issues, you'll make the experts come.... all this, you won't have in real life... So: A pilot always succeeds [...]. The political feedbacks are ALWAYS positive. Good. This allows organizations to say 'ok, we take care about education!' it allows states to say then 'look, we test the training models'. But in the end, we lack of scientific questioning on what we do... ”

The comprehension of this context, characterized by pressure and tensions, facilitates to understand why short-term success factors are fairly precisely enumerated by interviewees, in contrast to medium or long-term indicators. Indeed, short-term indicators dominate in interviewees' declarations, and are perceived as being chosen because of their organizational achievability and political exploitable character. In addition, the interviews revealed also an interesting contrast between these perceived short-term success factors and, when later asked to define these, the perceived indicators of sustainability. As indicated earlier, interviewees remained vaguer and generalist when it came to explaining how they would measure success on a long-term, or how they define sustainability in the case of their projects. Overall, the possibility to define ‘universal’ indicators or measurements for sustainable contributions for participants of mobile training was implicitly presented as not possible in the interviews, because of context specific specificities. One interviewee explained for example her difficulty

to formulate long-term indicators as they “*really depend on the country*”, suggesting also that the lack of follow-up came along with the full transfer of decision making concerning the pilots from the project implementers to the institutions in the pilot country – a shift perceived – or presented? – as somewhat hazardous and uncertain.

1.2 Medium-term contributions: Awareness among partners as project objective

Moreover, while short-term success was defined with references to quantity of the tool usage by teachers, the description of a medium-term success was not only formulated in hypothetical terms but stakeholders referred also mostly to changes on an institutional level when talking about sustainable contributions, and only rarely on changes on teachers’ side.

Chief project assistant: *And with regards to this project, we created a local application, so we **assume** that they are systemic because it developed by the telephonic institution. For the other project, as I said, we developed a website and we **assume** that they are systemic. [The ministry] understands their needs, they want to sustain....we are **hoping that** government will sustain.*

As shown in this extract, the success is here defined as increased awareness about the potential of mobile teacher training among the local ministry, put on a level with continuous positive outcomes for trainees. However, the same interviewee declared later that no follow-up or scale-up activities had been planned. There is both a contrast of official project goals i.e. teachers improvement of skills, and declared expected contributions i.e. awareness on the institutional level. Furthermore, there is also a contrast between these expected contributions and described practices i.e. absence of follow-up. Actually, interviewees use the term ‘follow-up’ to describe a practice that pertains more to an immediate evaluation.

Project manager: *Yes yes, in terms of scalability, I mean in the beginning we thought of sustainability. So in the case of this project, we decided to introduce also a social network, as a kind of open account or public account anybody can continue to use it. After the project, we immediately followed up and there were thousands of users.... but we didn’t follow up later....*

As already indicated, interviews showed that in the achievement of sustainability is perceived when there is knowledge transfer from the organizing bodies to the local implementing team, mostly the Ministry. This transfer of knowledge and competences, which is presented as a key objective, appears to be perceived as a form of a ‘natural’ trigger of sustainability, some

stakeholders explaining that as they “*helped [the ministry] to develop the education programme, to change...so [the project] is automatically sustained...you need you find the right entry point and try to change some part of the system*”.

This higher awareness and competences on a ministry level seems to be presented even more as achievement and desirable project goal as other initial objectives, e.g. the involvement of actors on a micro-level, are perceived too difficult to achieve. As shown in the following extract, it seems that after an unsuccessful experience, stakeholders adjust their medium-term success indicators accordingly:

Chief coordinator: At the beginning we tried to work with the local teacher training institutions.... but it's very difficult. We bring them [local actors] together. [...] at least we really reach the awareness of this group of people [in the ministry] towards mobile learning, otherwise they won't continue to learn about the mobile learning... I think we really reached the awareness and sustained the life in terms of mobile learning.

Again, the uncertainty of their actual medium-term outcomes of their pilot was striking in many interviews, so was the impression that medium-term contributions do not correspond to a demand, which may explain that stakeholders had no precise idea of “*how medium-term contributions could look like?*”. However, besides higher awareness, the fact that pilots inspire in turn the launch of other pilots – with short-term objectives – in other countries or regions is perceived as a symptom of sustainability, as medium-term contribution, success and even as ultimate overarching goal of a pilot:

Programme director: ...on the other hand, at least when you look what happened in the case of our project, 'it gave birth' to others. For example, during the last call for pilot proposals, there is another project from the same country that re-uses our projects fundamentals, but they set up the pilot entirely themselves, they took into consideration the recommendations that the external evaluations had formulated [for our project]. You can really feel that they now master the concepts; they do it themselves – that is the goal of these initiatives!

Overall, interviewees' declarations show that the exposed success indicators and descriptions of sustainable contributions are perceived as success as they are, on the contrary to scale – up, perceived as realizable, achievable. Indeed, scale-up is systematically described as difficult (“*It's difficult to generalize...*”), and often not even mentioned at all before being asked.

The interviewees create also the impression that over the course of their careers they fell back on 'easy to achieve' and short-term aspirations because of a progressively increasing perception that neither sustainable contributions on a teacher level nor scale-up were not achievable.

This impression that these success and sustainability definitions are the result of a 'content yourself with' process, is reinforced by the fact that the enthusiastic presentations of indicators are followed by declarations with a tone of regret, even resignation:

Deputy director: And for me it's a real success that the ministry later proposed a new project [during another call for funds]. Doesn't this mean that they feel now able to do a project kind of alone, something that had been done by others in the past? Well you can find many reasons of success. But yes, sure...you can ask yourself what is going to be left in the end.

The interviewees created indeed an ambiguous impression: On one hand it appeared that stakeholders tried to remain positive about the fact that there are possible positive contributions within the ministries, but that they initially hoped for more impact or contributions. On the other hand, they seem to be sometimes embarrassed by the fact to not present concrete medium-term contributions or impact, and seemed to feel that they had to excuse this:

Chief of department: At least, the people we worked with in that country, now they come every year to this conference, it means that at least they continue to learn, continue to be interested.

1.3 Project partners: perceived as obstacles to contributions, sustainability and scale-up

While interviewees situated sustainable success on an institutional level and changes in the local educational planning sphere, the same institutions were simultaneously perceived as key obstacles to sustainability. The previously mentioned ‘country specific context’ and the evocated need to develop a context embedded project seem to be related to the perception that otherwise, local ministries and partners may block the development of the project. In several cases, the dominance of financial interests within these ministries is implicitly suggested; local institutions sometimes clearly perceived as harmful and hindering when it comes to introducing innovations:

*Deputy director: You can't just start a revolution if you want to implement real pilots with systemic ambitions. [...] Innovation is always a problem; innovation comes necessarily at one point or another in contradiction to something existing in their system. If you go frontally, it won't work. Sure, as long as you sprinkle money on the project, it'll work some time... but in the end you won't obtain results. So we **try to limit damage, limit their power of causing trouble** by integrating in what exists. The hierarchy has an important influence on this type of pilots.*

More than being an obstacle, partner institutions in the country where the pilots are implemented perceived as key factor for the overall lack of measurable, sustainable success and contributions on a local level, and ultimately the scale-up of mobile training pilots.

Subsequently, stakeholders seem to feel that they are ‘forced’ to fall back on short-term success factors and vague, easily identifiable but not measurable traces of sustainable contributions on an institutional level. The impression that they are both discouraged and in the meantime, do not hold themselves or their institution for liable, is particularly strong when referring systematically to institutional reasons why a pilot, which had shown potential for scalability couldn't finally attain this stage:

Project assistant: Scaling up, that's the difficulty. [Our] project doesn't even think about it anymore. [I know today that] the main question is: Can this type of training model be part of national strategies?

When asked to precise the nature of these “institutional obstacles”, interviewees reported four categories of issues affecting negatively the design, implementation and possible follow-up of

the mobile training pilots: Lack of commitment, time, human resources and absence of a common strategy and communication.

The lack of commitment from the partner institutions was perceived as key issue, as interviewed stakeholders agreed that most of all, they had to ensure institutional buy-in and hence relayed on commitment:

Chief coordinator: *Commitment from the decision makers within the system is essential. We can only be there to help in a certain way. We are not running the education system. There has to be buy in from the political side, there has to be a long-term commitment because education projects are not quick.*

However, stakeholders described their impression that their willingness to adapt to a local education system ultimately influenced the project, as the institutions in the local education system were themselves influenced by political calendar. The already exposed need to deliver short-term results appears clearly:

Chief project manager: *So that's one of the key pieces and when I say political commitment I really mean financial and resource commitment. Sometimes these kinds of decisions can be politically driven and that means they [the ministry] want to see short-term results because they are concerned about elections, you know, things like this, show some impact very soon.*

As can be seen in this and the following extract, the need for commitment is associated with the need for higher allocation of time – contrasting with the short-term experimentation that pertains to pilot projects:

Consultant: *and what we know from across the world is the getting real change in education is long time thing, it takes time and it takes hard work and you can get amazing stuff to happen but it doesn't just happen like that! [Finger snaps]. So, I guess that's one of the other factors: Time. [They need to be more] willing to commit the time.*

In addition, a systematically reported issue is the lack of 'stable' human resources, individuals who can overview the project and its outcomes for a longer period. The insufficient number of involved people is perceived to be in turn linked to the previously exposed issue of lack of commitment:

Programme coordinator: *There is a huge institutional problem. These projects, they are often run [in the ministry] by a single person, so institutionally, there isn't much implication.*

This weakness and instability of human resources on the partner side is considered as not only influencing negatively the design and implementation of the problem, but reportedly explains, amongst others, why the pilot doesn't move to a scale up

Chief of department: *The problem with a project that relies on only on person within the institution is that all disappears when the person leaves.*

The “all” is not only the end of the training, or the possibility to scale-up, but also the knowledge and competences that has been transferred and which is a desirable objective for the interviewed stakeholders. The lack of commitment and human resources is perceived as “cutting of” learned lessons and competences needed for the realization of sustainable contributions and scale-up. Even more, as neatly shown in the following extract, stakeholders feel not only that the project has been sort of abandoned because of absence and turn-over of human resources. In addition, interviewees explain that short-term characters of projects are a consequence of the short-term character of underlying partnerships:

EvLC: *So do I get it right, nobody works on this [project] now, or knows what happened to it?*

Chief project manager: *Nobody at all, there is nobody I can introduce you to.....I am the only memory of this project. In this country they are very decent people [in the ministry], they are very polite but I am not quite sure whether the guys [we worked with] is still in the position.... In the other country, there, they also changed the person [who was in charge of the project there]; the person retired and got a new job. And in the third case...His contract expired.*

Finally, a lack of common project strategy and functioning communication among partners is often perceived by interviewees as affecting negatively the project on the short and long-term. Uneven expectations towards the pilot reportedly led to tensions. These tensions appear to be an obstacle to a constructive, long-term relationship because “people don't have the same strategy, not the same ambitions”. Also, the stakeholders interpret communication issues as the result of insufficient interest and implication, and appear frustrated that in consequence, no sustainable relationship is established:

Chief project manager: *This project has been tricky because the people we got to know there, the people working in the institutions, are very bureaucratic, they don't work well, we had to push them every time... I am not sure if they can help you to reach the teachers...These people you know they come to see us, what, five times? Ten times? Every time they come here they repeat the same questions. We sent them the report*

and then they didn't comment whether they received, and next time they come and they ask for the report! This happened three times!

The lack of strategies is also related to the previously exposed issue of human resources that work on the project locally: The low number of human resources apparently leads sometimes to the absence of roles which are perceived as indispensable for the implementation of the project. One interviewee reports disorganization as a consequence of an absence of this type of human resource strategy, as this type of human resource makes sure that somebody “*identifies at each step what has been done and what needs to be done.... indicators for each step are necessary!*”.

Indeed, the absence of strategy is exposed as an obstacle to a proper evaluation of the pilot, which can in turn be interpreted as another possible obstacle to a sustainability contributions and scale-up.

1.4 The ‘pilot project business’ as an instrument of international development strategies

Interviewees explained that the previously exposed institutional issues on the pilot partners’ side are not the only factor impacting on their work – and ultimately their perception. Again, it has to be underlined that throughout the interviews, stakeholders progressively changed their tone of declaration: After a phase which seemed to correspond to the recitation of the official pilot goals, they seemed to use the interview to confide themselves and shared a feeling of progressively emerging frustration, disillusionment and lucidity, while maintaining a self-presentation of not being responsible.

Finally, this ‘confession process’ attains a culminating point when they finally describe how organizational and political constraints influence ‘their’ pilot projects. Sentences became longer, tensions palpable and after hesitation, several individuals ended up talking during minutes without interruption, describing in an emotional and frustrated tone what they seem to perceive as ‘pilot project business’ in development policies. They admit a certain hypocrisy pertaining to pilot projects, but also reiterate their declaration that partner institutions are responsible for many organizational issues. The following interview extract is a striking example, both in terms of lengths, similar to a monologue, and content:

Deputy director: *There are many explanations... firstly, well, it's not as if you had to spit on pilots. After all, there is still a scientific approach, particularly in terms of technology we have to learn many things. And there are pilots... [hesitates] Because we don't have a miracle solution. Because we know perfectly what we are supposed to do - providing teachers with two years of training before they start their work – but nobody has the money to do it. Because children continue filling the schools, and there are not enough teachers! We know that it'll never happen [the 2 years training]. And in light of the demography of these countries, you know, the ideal situation will never happen. For at least the next 10 years, teachers will continue to enter the classroom without training! So you multiply the pilot projects because at least you can see if you mess up or don't mess up [if you follow your idea]. Nobody has the money, nobody has the political will to change everything, to say "let's throw it all away, we start all over". Because there is an international competition between countries, between the global players, between the different pedagogical philosophies; because there is no consensus at all. Because it's the only way to KNOW... I don't have a satisfying answer... the projects pile on top of each other. Countries have an interest in multiplying pilots, because everybody gets a piece of the cake. It generates per diems. The technical directorates within these ministries know to make sure that everybody gets a bit. It's cynical but... they don't have any interest that one particular approach [tested in a pilot] ends up being imposed, because that would limit the funding possibilities, the missions. And that, that's an obstacle. We have seen that. It's a strategy. The projects pile -up on each other.... Will this form a substrate on which ideas will grow, or will it be a cesspool that sticks on the shoes... I don't have an answer. At least what changes currently is that the different financial partners start talking to each other, before it was pure competition... that changes things.*

This extract sheds light on a side-effect that is somewhat 'swept under the carpet': Actors involved in the design and implementation of training pilots seem to perceive themselves as part of what they call a "perverse system" which creates an environment making the design and development of sustainable contributions almost "impossible". Having to deal with constraints related to financial management of the project, and obliged to report back to donors with clear, measurable results seems to lead to the overall feeling of being both pressured by and left alone with the management of the pilot. As shown in the following extract, stakeholders seem to be aware that this obligation to comply with both the donor system and the local school calendars risks affecting the quality of their work:

Project manager: *....if you want your project to work, and not only spend money and justify budget... yes because there is that too, you are more evaluated according to your capacity to respect the timelines for disbursements than for your results, but well,*

that's the perversity of the system [...], it's true that in all development projects the political schedule confronts the pedagogical schedule, and they do not have the same schedule!

These organizational, financial and political constraints, within each of their agencies and organizations, seem to favor the co-existence and sometimes confrontation of multiple, similar projects:

Programme manager: *There is not enough communication...everybody seems to work on their own. For example when it comes to teachers, recently the ministry organized a workshop on that subject, and it appeared that many partners [international organizations, NGOs] provide teacher training...but the content isn't the same! The modalities aren't the same! There is not synergy at all...*

These declarations are consistent with Depover's critique of the 'project approach'. The project approach had been implemented since the 1960 by international donor agencies. Despite the emergence of sectorial approaches with fund programme and policies and not specific projects, it remains an omnipresent phenomenon. *"Within this type of approach, each donor implements their own project, mostly without much control by national authorities and without carrying much about what other donors' do."* This approach has led to the *"multiplication of pilot projects in various domains (e.g. [...] teacher training via radio or TV) which unfortunately rarely survived after the end of international funding"*. In addition, the project approach is criticized because of their donor agency oriented set-up, leading to low development of local resources. Most importantly, Depover observes factors and consequences that reflect interviewees' declaration and the previous study results (chapter 1): *"the importance given to the disbursement of funds and their rapid utilization doesn't always allow for an appropriation of the project by beneficiaries. Also, this leads to a tendency to favor short-term oriented projects which impose on local structures and their functioning, complicating the projects' integration into the latter"*.

Depover concludes that despite the massive investment of foreign resources that comes along with these projects, *"this type of approach didn't brought structural improvement to education systems in developing countries"* (translated from Depover, Hainaut, et Jonnaert 2014, p.36-37)

2. Stakeholders perception of teachers reveals a double discourse

The interviewed actors reported a complex interaction of processes and issues perceived as obstacle to the achievement of sustainable contributions and scale-up of pilots. In addition, the interviews allowed also comprehending the perception that these stakeholders had towards teachers, their capacities and resulting needs with regards to the use of the phone.

This influenced also their position towards the role the phone should play within a training model. As will be exposed in the following, their declarations show that de facto they consider the role of teachers to be rather passive and capacities limited, which however contrasts with a normative discourse that presses the importance of their active participation.

2.1 Exploitation of the ‘socially-embedded concept’ for higher project efficiency

When describing the advantages of mobile phones for teacher training, it progressively appeared that the introduction of mobile phones was rarely justified because of a pedagogical benefit, but mostly because of pragmatic reasons: They are “*easy to introduce*”. The concept of appropriation is used, but described effects are, once again, on a project or institutional level.

More precisely, organizing stakeholders shared the common perception towards phones being particularly suitable for teacher training because of teachers were used to them. They refer to this higher appropriation possibility as being a natural consequence of the increasing diffusion of mobiles phones in the developing countries they had been working in, and the increasing roles that the phone occupies in the lives of teachers. They pressed that they were aware that phones were “*socially embedded*” and that this embeddedness would along with a higher appropriation of the tool:

Chief coordinator: For teacher training, mobile technologies have a HUGE role to play in teacher training, a massive opportunity. Because so many teachers already use these devices. And what you often find is that a device that is very personal and very useful to a person as an individual, to a teacher, for e.g. they use to communicate, to stay in touch, to make payments, sometimes to stay in touch with their friends, to keep up to date the information, news or their favorite celebrities or whatever it is.

Interestingly however, when being asked about positive consequences of this familiarity, they explain that this higher appropriation would influence positively on the practical aspects of the training, e.g. lower the theft rate, because teachers have already an experience with the tool on a daily basis. While the IFADEM based studies could show that the hybrid character of the phone was a key factor for sustaining practices, it is interesting to note that only one interviewee stated explicitly that this familiarity would be positive for the learning process during the training. According to this interviewee, it facilitates the use of the tool for pedagogical purposes, and differentiates the phone from those tools which had been introduced for the first time to teachers in a training context.

Department director: *It's true that these tools have important social functions. When realizing these types of pilots, we have all realized that the **more a tool has a social function, the more you can give him a pedagogical function.** It's this mixture of a social and pedagogical tool that makes it work. We have seen that the telephones used in this project have a much lower loss or theft rate than for example the Mp3 in the other project [I have been involved in] or the radio and tape decks in the case of the other [third project], because it was the real property of individuals. You know, appropriation happens through their property instinct.*

Overall, stakeholders seem also to consider that, despite the social embeddedness of the phone, teachers need support to realize first that the phone has also an educational potential. Teachers are perceived as being potentially rather reluctant, mistrustful towards the phone for pedagogical practices because they have not 'understood' yet the potential of the phone:

Consultant: *Personally, it's a very valuable device to them but they have not made the connection that it also valuable in the education space [...] I think that teachers don't see that mobiles have educational values, they just see them as distractions, you know, like 'the children are flirting and chatting, gossiping but not listening really'.*

According to interviewed stakeholders, this awareness raising process does not only consist in providing more skills and insights on possible pedagogical usages, but also stimulating teachers' motivation, attitude and perception of usefulness. Particularly pressed by the two stakeholders from the private sector, it is presented as crucial that teachers perceive the tool as a support:

Head of unit: *I think also one of the key predictors of sustainability it's actually the attitude of the teachers, it's not necessarily the skill level it's the motivation and the attitude towards using technology. They see it as something that's goanna help them; that's really critical. That's something which is really important.*

This perception that teachers' competences are low and perspective that their attitudes towards mobiles in education must be 'redirected', seems to be directly linked to the overall presentation of a both 'realistic' and 'ideal' project design, officially suitable for scalability. Indeed, throughout each interview, a shift in tone and enthusiasm could be observed: While stakeholder do on one hand refer to teachers' familiarity with phones and the related potential of phones for training, their enthusiasm becomes more nuanced when asked for their perception of scale-up – referring again to teachers' insufficient skills. The presentation of blended learning approach is for example presented as a sort of pragmatic compromise, justified by the possibility to adapt to the disparate digital skills level among teachers:

Department director: In terms of being able to scale up, well I think for teacher with very basic digital literacy you have to have something face to face, but once you get to a certain level of proficiency, I think to be able to meet the challenge of scale that what we have, in terms of numbers of teachers who are not sufficiently trained around the world, I think having a blended training model has become more and more critical.

In that case, it is particularly interesting to note that a blended model approach seems here to be considered as key factor for sustainability not because of the pedagogical benefits of the approach, but rather quantitative perspective, guided by the willingness to achieve higher efficiency in terms of the number of teachers trained.

This creates again the impression that the interviewed stakeholders perceive themselves as actors with only a limited power of influence and within a system that dominates them via financial and political constraints. Ultimately, these constraints seem to influence their overall approach to pilot design as well as their expectations towards essentially short-term contributions.

2.2 Teachers and *extrinsic* motivation: A declared key factor for a successful project

When expressing their perception of key factors for in a first place, a positive training experience and secondly, the generation of sustainable outcomes, stakeholders mentioned frequently the importance of *extrinsic motivation*.

More precisely, stakeholders seem to perceive the intrinsic motivation of teachers participating in a training programme as insufficient to ensure ongoing engagement. They feel that teachers are mostly attracted by the desire to possess a new tool, but once the ‘*gadget honeymoon*’ is over, they don’t expect teachers to be able to continue to motivate themselves. Interviewees suggest that stakeholders believe that teachers do not perceive the training as added value, but rather as an additional workload. Thus, the creation of external stimulation appears indispensable to them. Overall, declarations like the following give the impression that stakeholders’ perception of teachers has progressively been tarnished; their expectations towards teachers’ motivation are rather low.

Head of unit: Motivation....It’s a big issue because in the beginning of any kind of learning project, the initial motivation of teachers will be very high because we usually offer a smart phone they otherwise can’t at all afford and suddenly you have brand new gadgets in hand.... everybody will would be motivated, just like us when for the first time we got access to a laptop! But after one month usually the motivation will decline. So even if we organize some capacity building activity, they will think it’s kind of extra work load. It’s difficult unless the local mechanism the local system you know pick up the initiative or create some incentive for school principal to recognize the innovation. Unless you do this, definitely teacher motivation will decline.

Several declarations seemed not only to reflect a resigned, even pessimist perception of teachers’ underlying motivations within a distance training context. Interestingly however, when reflecting on their year long experience in distance training, stakeholders acknowledge indirectly that neither the tool nor the content is a key success factor of an efficient training experience, but the fact to create ties between trainees and trainers: By doing so, they refer de facto to the importance of intrinsic motivation, corresponding among others to the need of relatedness.

Chief of department: If you leave teachers alone with the resources to train themselves... even if these resources are absolutely awesome, even if it matches perfectly, it will lead to nothing. Because they will abandon, because they have other things to do... only a very few very motivated will go through the training... when it comes to distance training, this is an important aspect, you’ll find it in every distance

training model. The need to introduce motivational, to stay in touch, I mean in between the groups of trainees, the coaches or the tutor...

Overall all however, the interviews provide the impression that there are low expectations towards teachers' capacity to motivate themselves, stakeholders seem to feel that the training itself is not an objective that will be appealing enough for teachers. Interviews create the impression that stakeholders do recognize teachers' difficult daily lives (e.g. in terms of workload) but also think more generally, that they are not autonomous, capable individuals. This could be also observed when stakeholders provided examples of motivational factors which, according to them, would influence the success of a project. Stakeholders mentioned mostly external factors (described as "carrot and stick") pertaining to extrinsic motivation: Certification and career progression are presented as key to motivate teachers, to convince them about the utility of the tool for professional purposes. However, the purposes seem to be again short-term oriented, as they stress that they need to help to "go through" the training:

Consultant: The recognition of the training is a condition of success. You have to create conditions that allow recognizing the newly acquired skills of those who have taken part in the training. Because you need a carrot. This 'carrot and stick' can take shape in a multitude of forms... it can be 'you have entered this training, this is worth this or that test when you pass the examination to progress to a higher level'.

In addition, they described also teachers as individuals who are impressed by the technology, pressing the need for a simple technology without which teachers would not be able to conceive it as facilitating tool and ultimately "get excited" about it.

Department director: So being recognized for that work as part of your professional development, connecting it to you career progression, I think is really a good way to make use innovation and to drive motivation and I think also lot of it just about demystifying the technology in making its simple enough and showing how can save time and how you can use to make part of teaching life easier. I think that's the key part as well because if teachers see it as an extra thing to do on top of everything else knowing that they already have some of the heaviest work schedules of most profession anyway, then it becomes really hard to get teaches exited. But if you start from that point to make your life easier, I think that's something that's key

Finally, interviewed stakeholders also shared the perception that teachers were not spontaneously interested in being involved, and that external incentives must be mobilized:

Project assistant: I think in terms of having teachers do data collection as part of their reflective process, or whether actually researching factors that impact on students... I

think you can do it but in my experiencing you need to pay teachers to do this, because it's an extra job.... and you need the appropriate support at the local level to teachers really understand the research methodology.

Overall, the interviews seem to confirm the short-term approach that stakeholders have had to adopt: All enumerated motivational factors are factors that are supposed to reach goals which have to be achieved by the end of the pilot: A high completion rate and forecasting the acquisition of new skills. The repetitive use of terms like “*go through it*” and “*complete it*” reflects once again this perspective, entirely focused on the period of the pilot. Interviewees gave the impression that they perceived the end of their pilots not as the possible starting point for new contributions, or starting point for a scale-up, but as the *actual* end of a process. This may also explain why long-term visions remain so vague, and factors for long-term sustaining contributions or scale – up, mostly unmentioned. Overall, these findings are particularly interesting considering that the interviews with former training participants had shown that medium-term contributions were strongly driven by *intrinsic* motivation.

2.3 Identification of a colliding discourses

When describing factors influencing both on positive contributions during the training and increasing the ‘scale-up potential’ of projects, the identification of local leadership and participation of local actors was often mentioned. More precisely, stakeholders mentioned the importance of “*teacher involvement*” and “*participatory approaches*”. The analysis of their declarations allow not only to identify a mismatch between claims and described activities, but also seems to indicate that the perception of teachers and their role in pilots influenced by the organizing stakeholders and whether they are a public organism or a firm from the private sector. Also, their declarations show that their expectations towards and perceptions of teachers’ capacities and motivations are not only low, and occupy a limited role in short-term oriented pilots. Two discourses seem to collide.

➤ *Justification for local involvement and participation: Efficiency versus empowerment*

All interviewees reported that it appeared indispensable to them to identify local leaders. Similar to their description about local ministries, the arguments in favor of the involvement of local leaders were all related to the willingness to reduce their possible “*power of nuisance*”.

Chief coordinator: You should also always motivate the school principal, the school leaders. Because if you ask the teacher to work independently, I mean to be part of the training independently, sometimes the school principal can become the negative factor. [...] If we do not include the principal, he will be jealous and try to sideline the teacher. Then, the teacher felt even more isolated mentally, psychology you know.

More precisely, the involvement of local actors and the local hierarchy, e.g. the school administration representing the immediate environment of the project, seems to be a source of recurrent concern for organizing stakeholders:

Programme manager: If teachers feel that their hierarchy is mobilized, it’s ok, it makes things easier. So during this type of pilots you spend much time explaining things to school inspectors, to the local administrative staff... you have to imply them one way or another...otherwise nothing will be done in the field. The final target – well ok, the final target are the students – but I mean YOUR final target, the teachers, if you want to reach them than you have to respect the intermediate step, which means mobilizing the hierarchy around.

Interestingly, declarations from the two interviewees of the private sector differ slightly from those of their peers from public organisms. According to them, the implication of local leaders and hierarchy is not only expected to ensure acceptance of the pilot, but also seen as necessary to ultimately lead to a mechanism that enables the pilot to sustain.

Chief coordinator: So in the case of this project, it is really the local team in the country, our team who is going in and training the teachers meeting the teachers working with the school and building up an ongoing relationship with them and setting in motion and after that it should really be the school that drives themselves. Our aim is to be sustainable, which means we shouldn't have to be there all the time accompanying, once we get the whole rolling.

In comparison to their public stakeholder colleagues, they seem to consider the implication of local leaders with a more positive approach, considering implication not as mechanism to avoid reluctance, but as driver that also enhances innovation. The interviewed stakeholders consider them as key for sustainable contributions, perceiving them as “*pioneers*” who “*will act as a model and share their practice*”. As later exposed, the possibility that views on teachers’ capacities differ according to the nature of the stakeholders (public / private) deserves further research.

All stakeholders pressed the importance of “*involving*” local actors in the design and implementation of the project, they simultaneously explained that this involvement was indispensable to “*convince institutions, teachers of the utility of the project, all those who are concerned by the project*”. Statements referred to the efficiency of the project e.g. “*if you don't include the teachers, you are lost. If you don't, you can't work properly*”. Progressively, the analysis of the interviews revealed that mismatch between the way ‘involvement’ was presented and justified – the active involvement of teachers in the design and implementation process of a pilot in view of their empowerment and enhanced learning experience – and stakeholders’ opinion and declarations of practices in this regard. This mismatch appeared repeatedly throughout the interviews.

The first striking sign of this contrast was the reflexive interpretation of the term ‘project beneficiaries’. Stakeholders were asked questions about the role of ‘project beneficiaries’, intending to know about their perception of their capacities and resulting roles. Systematically and spontaneously, interviewees referred not to teachers, but to pilot partners, mostly within the partner ministries.

Subsequently, this perception may also help to understand another contrast, this time between the official discourse when talking about ‘teacher involvement’ and the description of their actual practices, became visible. In the same interview, a respondent would first declare that teacher involvement should take place in form of active contribution of teachers to the project design and implementation, presented as “*indispensable*” to achieve acceptance, sustainability and generate positive educational outcomes. Later on, interviewees would then however describe only very limited or no teacher involvement at all, limited to mostly “*asking teachers questions*” during the needs assessment phase.

Programme director: [Yes, teacher involvement is important because] *you have to verify the technical conditions determining acceptance on the ground, you have to question teachers [...]. Well, we did not go that far...giving them an active role....*

When specifically asked what they thought about involvement in form of involving teacher in organizational and content design processes, they stated being aware about the possible benefits but perceive these practices very “*difficult*” or even “*impossible*”. They describe negative consequences of top – down approaches, e.g. inefficient information flow:

According to theories of innovation, it’s very clear, it has been highlighted that the participation of beneficiaries is a factor of success, but, well... you have to rely on the ministry. It’s a combination of both [ministry and teachers] actually.... but yes in the case of our project it was rather a top-down approach. We had a real problem actually, feeding actors [on a ministerial level] with information from the ground to assist their actions

Again, institutional constraints of the partner country of pilot projects were the most cited reasons when they seemed to realize that there was a gap between a rather normative discourse and their activities, contrasting with the latter:

Deputy director: *You know, the bottom-up approach is part of the constraints that international pilots face; it’s very difficult to put in place...*

The other actors agree and some add that the organizational and political framework of pilot projects is an obstacle to involvement of teachers:

Chief of department: *....it’s difficult, it’s expensive, it takes times, you are always pressed by politics, the donors, it has to be fast... nobody wants to hear that you need the time to discuss with people [on the ground] to verify things [...]*

Again, interviewees explain and justify that organizational and financial pressure creates a tight calendar that influences ultimately on the manner the project is designed:

Programme director: *You are trusted with a lot of money and you are aware of it, but nobody wants to hear that you need to take the time to discuss things with people, to verify [what works]. But time flies, and it's terrible.... when you have to deliver, you have to do so respecting the school calendar... and the pressure of the donors...*

Finally, it is interesting to note that several interviewees first plebiscite participatory approaches in general, but seem *de facto* to question teachers' agency, doubting that they are capable to occupy responsibilities within a pilot.

Project coordinator: *I think you can do it [adopt participatory approaches in a pilot project], but in my experiencing you need to pay teachers to do this, because it's an extra job.... and you need the appropriate support at the local level to teachers really understand the research methodology.*

This mismatch seems to be symptomatic for what Cleaver had described already 20 years ago in his work on the “*paradox of participation*”: Development actors find themselves caught in between two discourses: The first discourse is stimulated by the “*heroic claims that are made for participatory approached to development, these being justified in the terms of ensuring greater efficiency and effectiveness of investment and of contributing to processes of democratization and empowerment*” (Cleaver 1999, p. 597). This discourse considers participation as “*act of faith in development*” and is powerful because of the high moral value it represents. This discourse collides with the predominant, practical and technical oriented discourse concerned with project dictated imperatives of efficiency, with visible, manageable manifestations of collective action. Given the lower moral value of this second discourse this explains why it finds itself “*cloaked in the rhetoric of empowerment*” (ibid, p. 598)

Leal adopts an even more critical position and considers that since the mid 1980 “*participation ascended to the pantheon of development buzzwords, catchphrases, and euphemisms...and stands side by side with such giants as ‘sustainable development’, ‘basic needs’, ‘capacity building’, and ‘results based’*” (Leal 2007, p. 89).

In the case of the here analyzed stakeholders, it is however interesting to note that this ‘desirable’ discourse seems, as described by Cleaver, not be adopted consciously or cynically. Instead, interviewees do indeed seem to consider “*participation in itself as empowering,*

regardless of the actual activity undertaken” (ibid, p.598), before justifying the non-application with technical oriented discourse arguments.

The analysis of these discourses appears even more interesting in light of the predominant claims and expectations to develop highly user centered training models thanks to the introduction of mobile phones in teacher training initiatives. To which extent these discourses may ultimately influence on the design of these pilots, and affect the genesis of sustainable outcomes through choices as, for example, including or excluding teachers from taking actively part in a training pilot, seems to constitute an interesting task for future research.

➤ *Private sector stakeholders’ vision on teacher participation: Based on positive experience or also a normative discourse?*

The two interviewees from the private sector were the only stakeholders whose declarations concerning the concept of participation seemed to be consistent with the description of their practices. For example one interviewee explained that their project continuously relied on the voluntary application of teachers willing to become “*innovative teachers*” and join groups that contribute to the design and implementation of their training programme. While they describe like their public counterparts actions that aim to test the suitability of a tool or approach, both differentiate themselves from public peers as they report practices that subsequently involve the teachers in a co-development process of the content. However, involvement in the design or decision of other training modalities (e.g.; of organizational character) are not mentioned. A striking finding, when comparing public and private stakeholders’ declaration, was the use of a different terminology, revealing a highly different perspective on teachers which are less the “*beneficiaries*” but rather “*customers*”. As well depicted in the following extract, private stakeholders’ description of involvement mechanisms seems to reveal a different approach and perspective on both teachers and the design of pilots:

Chief coordinator: *Yes, exactly so that’s what we do, we try to follow up the process, and there are many ways to involve the user. You can of course do initial **market research** and go and talk to them understand their needs, you can do in-classroom observations...Some of these methods have been applied or done for certain projects. Classroom observation for example to see for e.g. to see how teachers teach English to early grade students or learners, and what are some of the **pain points**...and so you are going to observe in the classroom, you are going to talk to these teachers and then once you start developing some sort of **products**, you could, even on paper or just wireframes, present those to your user and have them mix through and see if the flow*

*and terminology and the interface make sense. [...]... and so at every stage, you are including them and we try to follow the **agile software development approach**, which isn't just for software development, it's more a product development, where you create something called **minimum viable product** which is a product that has just enough features to putting it out on the market and having a group of users use it, and suck in feedback into the designer development team that is shaped into how the product gets developed.*

The other private sector stakeholder seems to adopt also a positive, but different and more nuanced perspective on participatory approaches. It seems again this can be explained by the fact that their 'business' is different. Indeed, in the case of the following interviewees' project, the mobile content and tool has already been developed and is 'ready for distribution'. De facto, the term participatory approach is here used for the description of something that pertains rather to a self-reflection process, in which the project stimulates the teachers' capacity and willingness to explore different pedagogies:

Department director:a self-reflection about pedagogical practice; and so [the teachers] are experimenting with their own designed methodologies; and that is than a way of participative design approach, but it's focused on your individual job as a teacher. So thinking about teachers as designers of their own professional development; I think that's an interesting approach still not done enough!

In contrast, individuals from the public sector (academic institutions and international organizations), seemed to perceive the involvement of teachers as highly sensitive because possibly harmful. Cited examples were the emergence of tensions among teachers of different hierarchical positions, observed when these found themselves in a common content creation group. Moreover, involvement in content design was reported to lead to negative consequences on teachers' training perception if their involvement was in the end not considered as meet the quality needs of the content:

Project manager: They [the ministry] selected the Master Teacher, and then they have some tutors from the teacher training institution, who are coaching the teachers to develop the content. But the result of the evaluation show that it didn't work very well, because they are really, really scared ...it's difficult to develop the process.

Project coordinator: They also had an evaluation and validation mechanism which means they ask 10, or 20 teachers to develop the content and then they evaluate it. If validated, the content can be accepted and uploaded to this application. But very often, the evaluation and validation mechanism which means to ask those 10, 20 teachers to develop the content and then they evaluated them. If they validated them this content can be accept and uploaded through them initially. But very often, they rejected it so the teachers were demoralized. So it's relating to quality assurance of teacher generated resources... you know you always talk about user generated OER, including the teacher and student, but the quality assurance is the big issue. For example if we do not deal with the quality assurance well, it will demoralize the users.

Another stakeholder seems to see this type of practice also as possible problem, which can lead to hierarchical tensions:

Project assistant: Imagine if we had wanted to confide this [content creation] to groups of teachers that we would have identified before, we would have been in confrontation with those people who are usually in charge of content creation at the national training institute! This would have led to blockages, and conditions for failure!

More generally, public stakeholders' declarations show reluctance towards active beneficiary implication, mostly described with terms as “*not realistic*”, “*not necessarily feasible*” allowed to identify doubts regarding teachers' actual capacity to actively contribute to content creation or organizational aspect of pilots:

Head of unit: ...participation...you really need a certain level of competence to create content, competences that these teachers do not have.... it has to be a realistic approach, otherwise this consultation will waste a lot of time...

While the low number of interviewees from the private sector is regrettable in terms of representativeness, this contrast of declarations between private and public stakeholders still indicates an area for further research on the extent to which pilot projects partners' characteristics and management approaches impact on the perception and implementation of mobile teacher training.

Indeed, the descriptions of approaches used by IT firms, e.g. the agile software development approach, a process characterized by the collaborative effort of self-organizing cross-functional teams, may on one hand be interpreted as sign that private sector stakeholders, particularly those involved in the design of digital products, have a different, business oriented and more optimistic attitude towards the introduction of involvement of project beneficiaries.

On the other hand, it is also imaginable that their discourse and involvement activities are also part of their marketing approach: As explained, teachers are both beneficiaries and reportedly “*customers*”, and teacher involvement in this regard an efficient way to enhance the popularity of their “*products*” – particularly in the ears of those who eventually cover the costs of the product (the pilot): Development actors who are assumed to consider participation as natural quality label, e.g. donors, local ministries.

In this regard, this would mean that the logic of their discourse is *de facto* similar to the one of public development actors, only their audience changes. This hypothesis echoes the Leal's description of participation as a "*buzzword*", which has, according to the author "*gained currency and trade value in the competitive market struggle for development project contracts, an indispensable ingredient of the replies to requests for proposals that issued from multilateral aid agencies everywhere*" (Leal 2007, p. 89)

These findings show the need to analyze to which extent the nature of involved partners' may ultimately impact on the design and implementation of pilots projects and their temporal approach. Given that public-private partnerships are often at the origins of mobile teacher training initiatives, the effects of potentially contrasting – or complementary? – Approaches shall be analyzed further.

➤ *The 'double discourse' – symptomatic for a post-colonist development discourse?*

From a broader perspective, it also appears interesting to approach the analysis of these mismatching discourses and strong tensions through a post-colonial theorist lens. Indeed, the previously exposed interview extracts have revealed a frustrated, negative perception of partner institutions in the field. These are both perceived as a potential source of problem, and interviewees indicate that they are in charge of 'raising the awareness' of partner institutions - which in turn is perceived as 'complicated' because of the unstable characteristics of the partner institution.

This type of perceptions has been researched and identified by previous researchers, is commonly criticized as 'paternalist' and considered as symptomatic for post-colonialist discourses (Eriksson 2005). The in this study identified contrasts of rewarding presentations of partners and declarations like "*you put the necessary money on the table*", "*you try to limit damage, limit their power of causing trouble*", or "*during this type of pilots you spend much time explaining things to school inspector*", are not a new finding, neither are the rather negative, sometimes even condescending perception of teachers capacities and attitudes. They reflect what Eriksson describes as the collision of 'partnership rhetoric' with a self-identification as being 'superior' and opposed to a partner who is 'backward' and 'inferior'.

This type of self-identification corresponds to a majority of the 16 interviewees interviewed for this study. While only 16 individuals could be interviewed here, the low size doesn't seem to indicate that they are an exception. Communalities with previous studies exist:

Eriksson for example, in her Tanzania focused study involving a large number of interviews with development actors, came to the conclusion that interviewees describe local partner institutions systematically as “*unreliable, passive and irrational*”, a description that can also be found in the case of the actors interviewed for this dissertation. Another interesting similarity of this study with Eriksson's findings is the fact that partner institutions are systematically located on a “*other level of development and awareness*” (Eriksson 2005, p.167).

Eriksson also identifies similar contrasting discourses and the ambiguity of some declarations, inextricably related to the hesitation among actors before responding, and the overall feeling that actors ‘confided’ themselves. According to Eriksson, these tensions are driven by the fear of using terms or concepts which could be considered as euro-centric or racist. In consequence, tensions are palpable during the interviews and the result of colliding, contradictory discourses. According to Ziai, these findings are “*empirical evidence for the relevance of postcolonial theses on the construction of the enlightened Western self and the backward, non-Western Other*” (Ziai 2010).

Other researchers go even a step further and consider that this type of paternalistic approaches would be symptomatic for the ‘*missionary position*’ of development projects, Manji has analyzed the role evolution of NGO in Africa and consider development projects and their actors as a form of continuation of the work of their precursors, the missionaries and voluntary organizations that cooperated in Europe's colonization and control of Africa (Manji et O’Coill 2002).

Furthermore, the here identified double discourse has also been researched in the ‘Francophonie’ context, and provides an additional perspective on interviewees’ declarations. More precisely, it strengthens the impression that there is an ideological self-perception which influences both the discourse, but also the actions of interviewed stakeholders: Dufour, in her research on discourses pertaining to the relationships between France and Africa, considers

that discourses are disguised by humanitarian projects, economic and social development. According to her, these discourses, held by international organization, experts and politicians, do reproduce, recompose and readapt constantly an ideology of dominance. Similar to Manji, Dufour considers that the ambivalence and ambiguity of discourse does not only reveal partnerships which are in appearance guided by symmetric, mutual respect and complementarity, but are de facto governed by submission and domination.

From Dufour's perspective, development approaches of France within international settings are driven by a willingness to consolidate a power of influence – leading to frustration, when this influence is not implementable. In this regard, the observed frustration of stakeholders during the interviews could not only be interpreted as professional frustration, but also as a frustration enhanced by an ideological self-perception (Dufour 2010).

Like Leal and Baaz, Manji considers that this dominant attitude is adopted often unwittingly, but leads to negative consequences as it would lead to a loss of the authority of African states to determine their own agenda (Manji et O'Coill 2002). Concretely, the situation of power and influence, and the resulting submission of partners seems to be described by one interviewed stakeholder who works in a local partner ministry:

Chief project manager: *NGOs have destroyed the system with the system of per-diems. Now, people are used to getting perdiems which are much higher than the normal level [the level the government could offer]. A civil servant is paid x a day and NGO pays more. So now, when there's a project coming up, the first question people [here in the country] ask is 'Who pays?' and not 'What will we do?'*

The here described financial dependency and submission of partner institutions is then detailed further, in a manner that pertains indeed to a post-colonial development dynamic:

Chief project manager: *[...] in a certain way, the international organizations have shared the country between them: X got the south, and they make their projects there. And Y got the north, Z the west. And [our] government is ok with all the projects, because it means constant money coming in.*

In consequence, this would have created a dynamic where pilot projects are de facto not the first step for a potential scale-up, but a short-term artefact whose financial resources are consumed before it disappears:

EvLC: *So you said, there are many NGOs here..?*

Programme director: *Yes, and when the funding stops, the projects stop too.*

Another project coordinator, in a local Ministry describes from the target country perspective how the fact to “have” international donors, willing to regularly finance short-term projects, lead to a dynamism taunted by financial dependency and mistrust:

Project coordinator: *The thing is the government is still too weak to spend so much money for training, and as we have technical and financial partners they can finance these trainings. So we are all the time negotiating, establishing, designing training projects to convince the technical and financial partners.... they don't really trust the state. They have worked with [our] regional directorate because they don't trust the central level.*

This dynamic of ‘submission’ seems to be enhanced by the fact that, as evocated by the other interviewees, there are many donors and technical partners in each country. This would lead not only to dependence, but has negative impacts on the quality of initiatives:

Project coordinator: *There are many donors...sometimes it creates problems, I mean in terms of harmonization. And they have all worked in our country for a long time...so when want to start something, but they have already started something else before, it's difficult to say 'no stop, we want something else'...it's difficult because they have already released the money for projects...which are not uninteresting but which do not necessarily go in direction of a common goal.*

However, it has to be noted that a discourse of dominance and submission was also noted among partner institutions in the field. Particularly striking was the poor image they had their own teachers. In the case of an interview with a ministerial representative in the field, teachers were straightforward described as “lazy”, only interested in the mobile phones and not driven by the willingness to acquire knowledge or competences.

It appears clearly that for a comprehensive discourse analysis, a larger and diverse sample appears would allow obtaining more diverse findings. At this stage this type of study indicates that there are political, economic and micro-organizational constraints which may instrumentalist both discourses. These in turn may contribute to the reproduction of stereotypes and ideology of dominance may favor short-term oriented actions, i.e. pilot projects.

Summary of chapter 8

The last study of this dissertation sought to analyze how those who plan, implement and evaluate training pilot projects perceive the question of sustainable contributions, and which lessons can be learned from their view on success factors and constraints.

The study found that these actors perceive themselves as part of a system which constraints their scope of action; technical constraints and influences seem to directly impact on the project design and its short-term orientation. Indeed, evocated success definitions were all presented as achievable and, even more, always achieved, contrasting with vague descriptions of medium-term success. The latter seemed also be influenced by the same constraints, and local partner institutions as ministries were both presented as objective, where the change had to happen, and obstacle to the such change. The descriptions of these project partners seem to indicate an often difficult and sometimes patronizing relationship, with consequences both on the micro and macro level of development. Progressively, interviewees depicted a development context which can be qualified as '*pilot project business*' which uses project pilots as organizational and political instrument.

Finally, the interviews progressively revealed strong tensions within declarations; these tensions seemed to directly relate to the presence of contrasting discourses: The first one can be considered as normative discourse of high moral value, which used terms *en vogue* like '*participation*', '*sustainability*' and '*scale-up*'. While these terms are used, their rationale and concept presentations translate once again a perspective that focuses less on contributions than on the successful completion of the project. Indeed, this discourse collides with a predominant technical and organization oriented discoursed concerned with issues like fund disbursements, efficiency and human resource issues.

Ultimately, reported and described actions seem to be a direct consequence of the domination of the second over the first discourse. They reflect a reality whose consequences impact on the initial design of the project. In turn, because of choices made at the very beginning: e.g. project duration, used material, (no) involvement of local actors, the appropriation process of official training participants – teachers – and related contributions are impacted.

Discussion and perspectives

Intrigued by the gap between high expectations towards mobile learning for developing countries and the low evidence of the use and contributions of mobile phones in African teacher training contexts, this dissertation used a mixed methodology to answer the following research questions: Which type of contributions are favored by a mobile supported training projects? How do these contributions evolve over time and which factors influence the genesis of contributions in the first place, and their evolutions once the project has ended?

The pilot project 'IFADEM' which had trained 458 Malagasy teachers and tutors from 2012 – 2013 partly via mobile phones, was chosen as case study. It provided the possibility to access existing datasets and to generate new qualitative and quantitative data. From a temporal perspective, these data - sets covered both the training period as well as a dedicated phase afterwards (2013 to 2017). Most importantly, it allowed for the adoption of a longitudinal lens on contributions. This is an indispensable perspective when it comes to identifying and analyzing contributions pertaining to practices which depend on an appropriation process which evolves over time.

As a result, four studies were conducted, each approaching the question of nature and evolution of contributions from a different perspective. Still, their findings are mutual complementary, explicative and confirmatory. In the following, the key conclusions of these study results will be summarized.

➤ *A variety of non-planned contributions instead of expected project goals*

Firstly, the research revealed that the majority of identified and sustainable contributions of the IFADEM training were non-prescribed, i.e. had not been planned by the project organizing stakeholders. In contrast, only traces of sustaining contributions related to the initial project goals (pedagogical and language skills improvement) could be identified.

When analyzing the reasons for this limited achievement, it appeared that the lack of suitability of the training content – too complex– combined with a period of training which was insufficient to overcome this complexity resulted in a lack of comprehension and decreased motivation. This in turn limited the appropriation of practices and content taught by the training, and led to only limited improvement of practices and language skills. As shown by previous research, this type of finding shows that a lack of user centered training,

specifically tailored to users' needs and skills, decreases the chances of sustainable outcomes significantly (Huggins et Izushi 2001).

Interestingly however, this lack of achievement of project objectives contrasts with the wide range of contributions which could be identified throughout the three years of research: These contributions take place both in the private and professional sphere of teachers. Most importantly, the large majority of reported and observed practices, even years after the end of the pilot, involve the use of the mobile phone trainees had received during the training period.

These mobile phones continue to be used and allows for student-centered practices in the classroom, feedback mechanisms among colleagues outside the school, and more generally, a self-reflection process as well as the facilitation of administrative and supervision tasks. Most importantly, mobiles phones provide the key tool for ongoing teacher collaboration among former participants. All sustaining usages are perceived by teachers as indispensable. The perceived usefulness is associated with a readiness to cover related costs: While training communications were only free during the period, almost half of former participants continues to communicate at their own expense with former training peers.

Furthermore, the hybrid and nomad character of the phone allows for the continuous development and increased importance of mobile usages in the private sphere of teachers: It contributes to reduced teachers isolation, is used for entertainment but also to access information via functions like the radio. When analyzing the natures of these contributions and how they interact, as well as the factors that led to these contributions and those who influence their evolution, two key findings could be identified:

1. Usages are driven by autonomous motivation

When looking in detail at the nature of sustaining usages and contributions, these seem to be driven but what research defines as 'autonomous motivation', a combination of both intrinsic and internalized extrinsic motivation, aiming for the fulfillment of three human needs: the need for competence, the need for autonomy, and the need for relatedness (Gagné et Deci 2005). The identification of this type of motivation appears crucial from an educational point of view, knowing that teachers who feel autonomously motivated are found to have positive effects on student behaviors (Crehan 2017). More precisely, contributions seem to sustain

because of former participants' willingness to enhance the efficiency of their practices, or to make the same practices easier and pleasant. Moreover, the identified sustaining mobile usages allow teachers to connect to former training peers, colleagues in general and far-away living family.

More precisely, the sustainability of these usages appears to be directly linked to the perception of an added value, in the proper sense: The option to communicate by phone 'ads' independence from geographical distances, and simultaneously from other individuals. It increases the trainees' security by avoiding them travel. Knowing that administrative workload affects negatively time on teaching it is also important to note that the mobile usage now allow teachers to spend more time on teaching, thanks to a more efficient handling of administrative tasks and communications.

Overall, the presence of both professional and private usages among sustaining contributions reflect a phone that is socially embedded in users life, and most importantly, the result and symptom of an ongoing appropriation process: IFADEM participants have developed their own usages, and their 'relationship' with their phones is transformed. The phone is not anymore only a training tool used during 9 months, but makes now a different, extended sense to them.

Interestingly, this research has also shown that this perceived sense and hence contributions vary depending on the professional profile of participants: Individuals who have more autonomy and managerial responsibilities developed particularly diverse ranges of mobile usages. As found by self-determination theory research (Lam, Choy, et Cheng 2010), their role and responsibilities stimulates their motivation and encourages a wider and more innovative range of mobile usages than their peers. Later, these individuals are found to be the leaders of the mobile supported collaboration network of former 'Ifademiens': Those who ensure information flow within the community, and also ensure the connection of the network with external actors, i.e. thanks to their privileged position in the local school administrations.

Overall it appeared clearly that mobile contributions vary according to the context, which influences on the sense that former trainees will confer to the phone, and the extent to which it will be socially embedded. *Per se* however, all contributions are driven by the same intrinsic motivation.

2. The training experience has allowed for an appropriation process

It is crucial to understand the importance of intrinsic motivation as underlying factor for sustainable contributions, as it allows understanding why the end of the pilot did not affect much these usages: In a certain way it is possible affirming that these ongoing mobile contributions continue not *despite* the end of the pilot, but because they had never been depended on training specific, extrinsic motivational stimuli.

Still, this does not equal concluding that training period was ineffective. Instead, it appears that these ongoing contributions could emerge *because* of the training period, even if for unexpected reasons: While the training could apparently not achieve those contributions it aimed for, the 9 month training period was still determinant as it acted as a 'kick of appropriation process. Indeed, more than being equipped with a phone, it was the introduction of *the phone within a training experience* that allowed for the genesis of contributions: By placing the mobile phone in the middle of a reflection process, overall awareness towards possible mobile usages were enhanced, and by doing so, a fertile ground for the later ongoing mobile usages prepared. In parallel to the prescribed usages of using the phone for quiz participation and conversations with a tutor, training experience enabled teachers to improve their overall mobile literacy skills, and to discover progressively which type of needs the use of the mobile could possibly fill. In a certain way, the appropriation of the phone was 'boosted': This awareness and exploration of possible usage avoided what is sometimes called a 'honey moon effect': The progressive emergence of disinterest towards tools perceives as attractive at the beginning, but which ultimately are not embedded in users' life. In consequence, teachers did not lower their interest in the phone after the end of the training. The sustainability of these professional and private usages reflects the progressive mastery and appropriation of a tool in their daily life. Former participants sought to continue benefitting from the hitherto experienced added values of phone usage, mobile usages perpetuated and developed in parallel to the appropriation process. This process has previously been researched by various researchers like for example Mumtaz (2000) who found that a high value for technology and perception of usefulness leads to significant transformation practices.

This may explain, even though all individuals of the control group own mobile phones, their stage of awareness, of perceived usefulness towards phone is much lower or absent – and so are their mobile practices, be it for professional or private matters. Indeed, it appears that it is not that much the phone, but the collective experience within a training community that appears to be the trigger of this appropriation process. The fact that years after the training, participants perceive themselves as ‘Ifademiens’ and are perceived as such by their environment is a key symptom of this collective appropriation. More precisely, the experience among ‘Ifademiens’ strengthened the appropriation of phone usages, as understood by Wertsch, who defines appropriation as interaction of individuals with a context. Here, the IFADEM training was and provided a context of experience, and within this context, the ‘Ifademiens’ could collectively experience the phone and were collectively stimulated to reflect on this experience. This type of experience is considered as pivotal for appropriation, and found to be indispensable when aiming to introduce technology into teachers work sphere (Laffey 2004).

Most importantly, it appears that this appropriation process did take place without an intensive external support of project organizers. This leads to the hypothesis that identified contributions could have concerned all or almost all individuals – if some had not been excluded from the collective appropriation process because of insufficient network coverage, which transformed their phone into a useless device and excluded them from the IFADEM community.

This hypothesis appears even more plausible as, as other factors of possible influence were tested and subsequently rejected by the studies: All things being equal, neither the level of education, the gender nor the type of the phone or the acquired degree of familiarity with a phone favors or hinders teachers to appropriate the tool and continue to use it for work and for the private tasks later on. On the contrary, the better and richer the collective training experience, the higher the chances that individuals were able and willing to develop contributions which are of added value from a development, in particular, education perspective.

➤ *The genesis of a sustainable, collaborative and mobile supported teacher network*

The crucial role of network coverage appears as pre-requisite for an appropriation process appears even more when analyzing what appears to be one of the mayor contributions of the IFADEM training: The genesis of a sustainable mobile based teacher network composed of former IFADEM trainees. Indeed, the analyses showed that the common training experience has not only increased individually participants' awareness, it has set the base of a collaborative and autonomous teacher network. Provided participants had access to satisfying network coverage during the training, there were no other significant obstacles to join this network during the training period and experience regular mobile supported teacher collaboration. The importance of a collective appropriation process appears here clearly.

While during the training, this experience was first artificially stimulated through extrinsic motivational factors, i.e. financial advantages and daily SMS quizzes, it could be ascertained that mobile collaborations continued after the training and take form of a network: Without any organizational or financial support, former IFADEM trainees continue to collaborate via phone. In addition to this mobile supported collaboration, research showed that yeas after the training, former participants continue to meet each other in more or less organized and systematized manner.

Once again, the importance of intrinsic motivation appears clearly when analyzing the reasons for the emergence and sustainability of this network: While external incentives certainly encouraged the appropriation process of mobiles as tool for collaboration during the training, it is the creation of strong ties, and the progressive self-perception of being a community that explains the network structure of collaborations and its sustainability: Former participants do, in a certain way, sustain the training model as they network reflects the structure and role distribution put in place during the training. By doing so, participants fill their intrinsic need of relatedness and desire of continuing to acquire competences (Crehan 2017).

From another perspective, it is important to understand that the existence of this mobile supported teacher network contributes to the sustainability of mobile practice in general: The network conferred an additional, relational sense to the use of mobiles among former

participants and provides an ongoing framework for appropriation of the phone: Teachers continue to reflect on phone usages and appeared keen to extend the phone's role.

In summary it can be said that the results of the studies allow to argue that, provided the network is satisfying and favors an overall appropriation process, mobile teacher training are very likely to lead to sustainable outcomes in the area of social and education development.

From an operational point of view, these findings are also crucial as they indicate that public and private partners have an interest in investing in network infrastructure, as the continuous and extended use of the phone after the end of the training may be, amongst other, a source of revenue.

However, when considering these findings attesting of the promising character of mobile teacher training, and putting them in the context as perceived and described by organizing stakeholders, the importance of looking at the 'bigger picture' becomes clear: Indeed, there are strong indications that organizational, political and financial constraints on the 'macro-level' transform and instrumentalist pilots, which ultimately seem to impact on the design and contributions of a training project. The collision of constraints and interests seems indeed to potentially undermine the overall potential of mobile teacher training – and pilots in general.

➤ *Transposable findings: Relevance of the results for the Sub-Saharan Africa context*

While the four studies focused on one project in Madagascar, their findings allow drawing conclusions valid for mobile teacher training initiatives in Sub-Saharan Africa. Indeed, the project settings, the studied participants and the encountered challenges and their identified impact on contributions are fairly representative of a Sub-Saharan African context. Five key elements and findings allow affirming the latter:

1. Even though the majority of IFADEM teachers were civil servants, contrasting de facto with the reality of the African workforce to a large part composed of contractual teachers, the profile of IFADEM teachers is indeed representative of African teachers: They were mostly untrained, living in rural and even very remote areas, had no particularly high experience with mobile or other technology and were exercising in challenging infrastructural conditions.

2. The fact that for this kind of teacher profile, no effect of gender on sustainable phone usage could be ascertained is a crucial finding: As exposed earlier in chapter 1, women are underrepresented in those areas needing the most adequate teacher training as rural areas. This study has shown that they are de facto as likely as their male counter parts to develop sustainable phone usages after a mobile teacher training. With other words, female teachers are suitable beneficiaries of mobile teacher training programs.
3. Equally important is the fact that no effect of diploma on sustainable phone usage could be ascertained. Knowing that insufficient or badly qualified teachers are a key issue in Sub-Saharan Africa (cf. chapter 1) the absence of effect shows that mobile teacher training can lead to sustaining outcomes, even for teachers who have obtained only a lower secondary diploma. With other words, low qualified teachers are a suitable target group for mobile teacher training. Moreover, the fact that the type of mobile did not affect sustainable phone usage is a crucial finding: It shows that not the mobile as a technology per se, but the manner it is implemented during the training is determinant. This confirms not only already evocated research findings arguing that the context of mobile teacher training, not the tool, is key for sustainability. As affirmed by Hashemi, *“it is possible to claim that the devices learners use are hardly relevant; what is important is the notion of mobility and the construction of learning conversations in that process”* (Hashemi et al. 2011). Finally, the fact that that no specific model is needed to achieve sustainable outcomes, including teacher collaboration, strengthen also the argument that the existing and increasing mass of mobile phones among the African population – teachers included – , represents an educational potential. From an organizational, financial and educational point of view, this is an interesting argument, e.g. for those in favor of ‘bring your own device’ training models’.
4. The absence of significant impact of access to electricity is also considerable: It shows that mobile teacher training can be an adequate solution for the large number of African regions still suffering from a lack of electricity. While better electricity access remains obviously recommendable both from a social and educational perspective, it cannot be used as argument against the implementation of mobile training projects.

5. Another crucial and representative ‘African challenge’ is the already evocated issue of network coverage. The fact that network coverage was basically the only highly significant factors ending appropriation process and the generation of sustainable outcomes allows to confirm previous research which had found that a satisfying infrastructure, adequate technology and efficient preparation is predictive for technology adoption by rural primary school teachers (Howley, Wood, et Hough 2011). Even more interesting is the fact that saying that network coverage is the key obstacle equals saying that mobile teacher training can indeed be considered as long-term, appropriate and quality solution in the area of teacher training: Indeed, the improvement of network coverage in Sub-Saharan Africa is certainly not only a well – known and official development objective, but in addition, it is *per se* not that complex: the improvement of network coverage through material investment or enhancement of shared infrastructure agreements among operators, as they already exist in several African countries, is just one of the many discussed solutions (Ecofin 2014). The fact that mobile training generates ongoing communication and hence, revenue for telecom operators, can be exploited to design business models which allow companies to be guaranteed a return on investment when spending on infrastructure.

Perspectives for further research

Overall, this research has shed light on the medium-term contributions of a mobile teacher training projects and allowed to identify not only a wide range of continuous usages, but usages with proven social and educational impact. Much indicates that with some mobile teacher training can indeed be part of a solution aiming to provide a large number of teachers with the competences and motivation they need to provide quality education to their pupils.

This research has also allowed shedding light on remaining needs for further researches and paths which seem worth to investigate:

Further research is needed in order to identify further contributions pertaining to the use of mobile technology in training models and refine the conclusions on the manner phones are

ideally used to generate positive outcomes. This concerns both the content used and the role they occupy during the training.

Also, the analysis of similar training projects in other Sub-Saharan countries or other developing countries shall be performed in order to analyze to which extent cultural differences may influence on contribution, leading to further insights on the potential of mobile teacher training: The oral culture of Madagascar and as consequence, the importance of mobile communications among former participants may indeed be different in country with different cultural and infrastructural setting, or in the case of teachers who are already part of the 'WhatsApp generation'.

More generally it appears indispensable to exploit further what can be considered as real 'data set treasure' in the area of mobile training: Indeed, mobile communication generate both Call Detail Records and ARPU (Average Revenue per User) provide highly detailed information on both usages and relationships. In the case of the CDRs, they offer the possibility to look deeper into the practices during and after a mobile training, e.g. to refine the behavior of leadership in teacher training contexts. In turn, exploiting ARPU data would allow to not only retrieving important information on usage preferences. Closely related to their analysis is the research for organizational and financial models that ensure a higher resilience of projects and avoid their 'one hit wonder' status.

In this regard, the last study has clearly shown a need to conduct research on the self-perception of development actors, the relationships of partners in developing projects and the extent to which these influence on the expectations towards project goals, related implementations and outcome of a project. This analysis should take into consideration the public or private nature of involved partners, given that the number of public-private partnerships is considerable. A discourse analysis appears certainly interesting but can be challenging to perform, notably because of the difficulty to analyze discourses which are not biased by interviewee's awareness that a possible double discourse is expected.

A possible alternative path for research in that area would be, for example, a semantic analysis of call for tenders of international donor organizations and the related Terms of References of pilot projects: At this point, there is a considerable research gap in this field,

even though it appears that contributions are determined by expectations and the way they are formulated way before the project even starts.

Recommendations for futures mobile teacher training projects

Finally, the in this dissertation presented research results have allowed to elaborate a list of (non-exhaustive) operational recommendation for further mobile teacher training projects. More precisely, the following points were considered as key for the design and implementation of projects that seeks to generate outcomes of educational and social value and increase the sustainability of the latter by reinforcing the beneficiary's independence from project dependent factors.

1. Design an evaluation protocol that includes medium-term evaluation by local actors. Performance of a baseline **evaluation** in accordance to the project objectives including all participants. It appears recommendable to include the local administration in this process and train them as well personnel within the partner ministry to conduct and analyze future evaluations. This shall, after the end of the training period, increase the number of individuals being aware of the need to follow up if / when organizing project stakeholders are not available or interested anymore
2. Provide free communications, including data access, to all participants throughout the training period.
3. Expand and exploit the hybrid character of the phone: Encourage during the training the use of the phone for both professional and private practices (radio, mobile banking, applications, games...). Create a training context in which teachers are encourage to use the phone in a manner that it meets their need for autonomy, relatedness and knowledge acquisition, an appropriation process will be put in place. By doing so, private usages will favor the development of professional and pedagogical usages and ensure the sustainability of the latter. Recognize the phone's original vocation as tool for communication and include systematic voice based communication among teachers and tutors in the training model. Think about what teachers could do with tablets if they use them for data-independent voice communications and how this possibly may affect the appropriation process on the medium-term. Identify and select

training participants of every district able to provide support with regards to the functions of the phone. If necessary, train them, or include local vendors in the process.

- a. Provide tutors with training that suits their specific needs and teach them how they can use the phone for those tasks that are not related to the training period, e.g. supervision, training evaluation and management tasks (e.g. filming their trainees, sharing the sequences, use the Dictaphone for meetings or the agenda function etc.).
- b. Exploit simple but highly efficient and motivating mobile training strategies like SMS quizzes. Use the SMS quiz to create collective challenges and tasks.
- c. Combine the face to face and mobile based collaboration with a self-reflection and feed-back process, including the use of the phone: For example, include in the paper based training materials ‘mobile tasks’, like filming the organization of working in groups with students or the use of specific materials. Provide technical and organizational settings that allow teachers to share and reflect collectively on their practices (sending the video sequence to a tutor who collects it, in order to avoid insufficient space on the SD card, and who later organizes a collective screens session during the monthly meetings). Provide tutors with tablets to screen the different sequences, and teachers with little and cheap tripods so that they can position their phones during the lesson. Consider the use of functions like WhatsApp that involves data consumption but, if usable, allows for efficient sharing mechanisms.
- d. Expand the availability of content and put in place a project independent content creation process: As shown in the case of IFADEM, the limited achievement of project goals seems also to be related to the *underutilization* of the phone for content and practices training: A large and diverse number of teacher centered content is important for the training experience, also in order to avoid disinterest on the medium-term. The inclusion of both audio- and visual resources allows for the design of a rich training process that adapts to

the type of content and the way individuals learn, i.e. through visual, auditory or read / write and write learning. Most importantly, particularly when it comes to the appropriation of new practices, the possible to create content that encourages kinesthetic learning (learning through experience, i.e. role play) should be exploited.

- e. As all content might at some point in the future be overused and well-known, it appears crucial that a content creation process is put in place, i.e. through the involvement of selected participants in order to enhance the sustainability of the phone for self-training and as pedagogical device without the support from project organizers.
- f. If phones are distributed, chose a medium-range phone which is easy to use, quickly to recharge and that allows easily adding and deleting content on an SD card. Besides the key functions like SMS and voice, radio access and photo and video functions are crucial for teachers, as well as audio-recording and other organizational functions for tutors. Solar chargers need to be provided, as well as headsets and small speakers.
- g. The training shall support and encourage the overall feeling and self-perception of community and collectiveness through regular small and large meetings and other activities that influence positively on the training and appropriation process on the short and medium –term. The organization of collective knowledge and resource sharing activities both and without phone usage, appear also important to ensure sustainable sharing mechanism once the training phase has ended.
- h. Identify the future leaders of the post-training, based on both professional and human skills as identified by this and existing research. Exploit existing role distributions, e.g. select individuals with an existing manager role (e.g. pedagogic councilors and Chef ZAP) but also those individuals who developed and revealed their leader characteristics during the training
- i. Conduct extensive assessment of the network coverage quality in the target regions and identify of vulnerable zones. IF network coverage is an issue,

design a financial model that allows both public and private project partners to obtain a return in investment when investing in infrastructure for better network coverage, and which increases the sustainability of contributions through better infrastructural conditions and the involvement of local resources and actors.

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Résumé

Titre : La formation enseignante à l'aide du mobile en Afrique Sub-Saharienne : Quelles contributions et comment les analyser ?

Mots clés : formation enseignante, m-learning, TIC, ICT4D, e-learning, analyse de réseau

Partant de l'idée très ouverte de repérer ce qui subsiste d'une formation d'enseignants dans un pays en voie de développement (Formation IFADEM, maîtrise de la langue française à Madagascar), c'est-à-dire une analyse des effets durables d'une formation s'appuyant sur l'utilisation de téléphones portables, nous avons révélé différents processus peu à peu mis en place. D'abord, le détournement du mobile pour des usages à la fois dans la sphère privée et professionnelle des enseignants a pu être constaté, avec une appropriation progressive qui se consolide de manière inégale. S'appuyant sur une méthodologie mixte et en adoptant une perspective longitudinale, cette thèse montre que si l'accès à la couverture réseau est satisfaisant, l'expérience collective de la formation basée sur l'utilisation du téléphone portable permet d'amorcer ce processus d'appropriation. L'analyse montre que cette appropriation, la persistance des pratiques observées et déclarées et l'émergence de nouvelles pratiques, sont stimulées par la motivation intrinsèque des enseignants : le téléphone apparaît au cœur de pratiques qui comblent leurs besoins d'autonomie, de compétence et d'affiliation.

La création d'une communauté de pratiques, identifiée grâce à une analyse de réseau de leurs Comptes Rendus d'Appel (CRA), puis son maintien après la disparition des soutiens, en est une illustration clé. L'analyse de cette communauté permet également d'identifier l'importance de certains anciens formés, occupant des rôles clefs au sein du réseau considéré : ils contribuent à l'intérêt et à la valeur ajoutée de ce réseau, par exemple en encourageant l'innovation, en améliorant le transfert et l'accès à l'information. Ces leaders, en termes de nombre de liens, de position et de pouvoir d'influence, contribuent ainsi également à la durabilité de la communauté. Soucieux de tenir compte du contexte souvent complexe des projets pilotes organisant des formations, l'analyse des perspectives d'organisateur de ces projets a permis d'identifier de fortes tensions organisationnelles et conceptuelles. La conceptualisation même d'un projet pilote, axée sur le court terme, rend difficile l'observation de changements dans le temps, et dessert l'objectif affiché du pilote (tester un dispositif). Les acteurs font face à des dilemmes, dans la confrontation d'un discours moral et d'un discours pragmatique, et dans leurs attentes vis-à-vis des enseignants et la perception de leurs besoins. Si leur vision influence l'organisation des projets, cette thèse met en exergue un décalage avec les pratiques et les besoins des enseignants qu'elle contribue à mieux identifier.

Summary

Title: Mobile supported teacher training in Sub-Saharan Africa: Which contributions and how to analyze them?

Keywords : teacher training, m-learning, ICT4D, e-learning, social network analysis

This dissertation starts from a very open idea: identifying what remains after the end of a mobile supported teacher training pilot project in a developing country (IFADEM project, enhancement of French skills in Madagascar). The analysis of sustaining contributions after the organization of such a training project has revealed various processes gradually put in place. Firstly, the diversion of the phone use could be identified. The phone is used in both the private and professional spheres of former training participants and reflects a progressive and uneven appropriation process. The dissertation uses a mixed methodology with a longitudinal approach and shows that, provided that participants had access to a satisfying network coverage, the training experience has allowed for a collective and mobile supported experience of the training. This experience initiated this appropriation process. The analysis shows that intrinsic motivation stimulates that process and the sustainability of observed and declared practices, as well as the emergence of new uses: The mobile is at the heart of practices that fulfill their needs of autonomy, competence and relatedness.

A social a social network analysis of former participants' Call Detail Records (CDR) identified the emergence and consolidation of a community of practice emergence and consolidation of a community of practices, providing a key illustration of this process. The analysis of this community allows ascertaining the particular importance of individuals among former participants as they occupy key roles within the network: They contribute to the quality and benefits of the network for their members, i.e. they encourage innovation, enhance access and information transfer. These individuals are leaders with regards to their number of ties, position within the network and possible power of influence, contributing to the sustainability of the network.

Taking into consideration the importance of the complex context in which evolve these training projects, the analysis of project stakeholders' perspectives has allowed to identify significant organizational and conceptual tensions: The design of project pilots, and in particular their short-term approach, makes it difficult to observe the evolution of contributions over time. Ultimately, this approach prevents pilots to achieve their initial objective (test of a device or facility). It appears that organizing stakeholders face a dilemma: There is a confrontation of a both moral and practical discourse as well as a confrontation of expectations towards and needs of teachers. It appears that their perception ultimately influences the design and implementation of project. By showing the gap between the conceptualization of pilot projects and actual teacher needs and practices, this dissertation sheds also light on the medium-term contributions of such training projects.