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Collective Professional Development for the Integration of ICT in Higher Education

an expansive learning approach to overcoming the barriers in ICT integration at the national university of Costa Rica

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COLLECTIVE PROFESSIONAL DEVELOPMENT FOR THE INTEGRATION OF ICT IN HIGHER EDUCATION

**AN EXPANSIVE LEARNING APPROACH TO OVERCOMING THE BARRIERS IN ICT
INTEGRATION AT THE NATIONAL UNIVERSITY OF COSTA RICA**

PART 1

**BY
WILLY CASTRO GUZMÁN**

DISSERTATION SUBMITTED 2017



AALBORG UNIVERSITY
DENMARK

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Part 1

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CV

Willy Castro Guzmán received his Master in Management of Information and Communication Technologies at the Universidad Nacional, Costa Rica (UNA) in 2004. Since 2000 his work has been related to the field of education and technologies in education with special focus on online learning. He is the former leader of the institutional department for ICT integration in education at UNA (UNA Virtual). His professional practice has been related to the administration and development of learning management systems, as well as pedagogical support for professors and professors training for ICT adoption. He has participated in conferences and presentations at national and international congresses.

As a university professor, he has lectured at graduate and undergraduate level in educational technology, computing, information technology, computer engineering, the department of librarian science and documentation, and business administration.

His research interests are in the areas of higher education, integration of technologies in education, technologies for development, professional development and human development and motivation.

ENGLISH SUMMARY

In this thesis, I explore, analyse and reflect on the individual practice of adoption and the collective practice of integration of technology in teaching and learning in a Higher Education Institution.

The study addresses the connections between ICT adoption in Education, the barriers of ICT integration, and the teacher professional development as means to promote adoption. With the recognition of the potential of ICT in education, the study reflects the appropriateness of the dominant traditional approach to the first and second-order barriers to technology and attempts to overcome this restrictive view in order to stimulate fundamental changes that can facilitate the contribution of technology for transforming of teaching.

The study consists of two parts. The first phase is an exploratory study for understanding the ICT-based teaching activities and ICT-based training activities of faculty professors. The use of Activity Theory facilitated the understanding of professors' constraints of the adoption of technology and the institutional constraints of ICT integration. The main purpose of the first phase was to establish a more extensive research angle using the Activity System as the analytical tool to gain a better understanding of the phenomenon.

The second phase is an intervention process. The theoretical and methodological approach to competence development and facilitation of ICT deployment was "expansive learning" and "change lab". This method is a formative intervention type within the tradition of Cultural-Historical Activity Theory and brings significant changes in comparison with more traditional approaches in professional development to ICT adoption. The results of the intervention supports the idea of the need for changes in professional development to develop the professors' agency to address time-limited constraints and challenges in ICT adoption and integration.

The two phases are connected to each other through "Expansive Developmental Research" as a methodological approach. They jointly produce a coherent dissertation that addresses the research problem and to answer the research questions.

DANSK RESUME

I denne afhandling undersøger, analyserer og reflekterer jeg over den individuelle praksis ved ibrugtagning og den kollektive praksis ved integration af IKT i undervisning og læring ved en videregående uddannelsesinstitution.

Studiet adresserer sammenhængen mellem IKT-ibrugtagning i undervisning, barrierer for IKT-integration og udviklingen af lærerprofessionen som middel til at fremme ibrugtagning. Ud fra en anerkendelse af IKTs potentiale i undervisningen reflekterer studiet over hensigtsmæssigheden ved den dominerende, traditionelle tilgang til første- og anden-ordens barrierer ved teknologi og forsøger at overvinde dette begrænsende syn med henblik på at stimulere til grundlæggende ændringer, der kan facilitere teknologisk bidrag til transformation af undervisningen.

Studiet består af to dele. Første fase er en eksplorativ undersøgelse med henblik på forståelse af videnskabeligt personales IKT-baserede undervisningsaktiviteter og træningsaktiviteter i forbindelse med IKT-ibrugtagning. Anvendelsen af virksomhedsteori øgede forståelsen af individuelle begrænsninger i forbindelse med IKT-ibrugtagning og af de institutionelle begrænsninger ved IKT-integration. Hovedformålet i første fase var at anlægge en mere omfattende forskningsvinkel ved at bruge virksomhedsteori som et analytisk værktøj for derved at opnå en bedre forståelse af fænomenet.

Anden fase er en interventionsproces. Den teoretiske og metodiske tilgang til kompetenceudvikling og facilitering af IKT-ibrugtagning var "expansive learning" og "change lab ". Denne metode er en formativ interventionstype inden for den kulturhistoriske virksomhedsteoris tradition og medfører betydelige ændringer i sammenligning med mere traditionelle tilgange til kompetenceudvikling i forbindelse med IKT-ibrugtagning. Interventionens resultater understøtter ideen om nødvendigheden af ændringer i kompetenceudvikling og professionel udvikling mod at udvikle personalets handlekraft ("agency") for at kunne adressere tidstypiske begrænsninger og udfordringer ved IKT-ibrugtagning og integration.

De to faser er forbundet med hinanden gennem "expansive developmental research" som metodologisk tilgang. De frembringer i fællesskab en sammenhængende afhandling, der adresserer forskningsproblemet og besvarer forskningsspørgsmålet

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Writing this dissertation would not have been possible without the contributions of many people. First, a special thanks to my supervisor, Tom Nyvang, who from the first moment has shown patience and wisdom in guiding me toward my goal. His academic and personal empathy became essential in supporting me appropriately as a novice researcher. His intention was always to give me valuable academic insights and at the same time to keep me on the path of my interests. He succeeded.

I am extremely grateful to Universidad Nacional, my academic and professional home, the place where, first as a student and then as a professional, I have lived almost 20 years of my life. At UNA, I have achieved many of my personal and professional goals. UNA made this dream possible in many senses. It financed my PhD. However, its support has been much more than just financial. Many people at UNA played a part in this dream coming true and they are in my heart. However, I express my special thanks to the professors, the institutional authorities and the institutional departments of DTIC, PEADP and UNA Virtual. All of them were fundamental to the study, not least, in the Department of Mathematics, Randall, Mariel, the 14 professors in the change laboratory, the students participating in the study and the administrative staff.

A special mention to Heilyn, who played the roles of colleague, counsellor, friend, and especially as part of our family. She and Heine were a fundamental support through these three years. You made us feel part of your family, part of your hearts.

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DEDICATION

To God. Here I am just offering you back a little in return for all you have given me in life.

To my beloved wife Dinia, who from the very first moment promised to stay with me through along the way. Thank you for postpone your own personal goals to help to me to achieve mine. In life, silent work is the hardest. This is our PhD.

To my beloved daughter Nayeli, my sweet driving force, my energy. With our everyday adventures in Aalborg, we could write together a new dissertation about happiness. I will never forget our lovely times in Østre Anlæg, how you learnt to ride a bike, how you learnt to speak Danish in six months, how you became fluent in English, how you simply enjoyed everything. When I looked at you and your achievements, it made completing a PhD seem like a simple task.

To Alicia, our baby angel in heaven. You drew a smile on our faces for only 8 weeks, but you will be in our hearts for the rest of our life.

To Emma, our third baby, who came to put the final “s” in happiness for this family.

To my beloved parents, Alejandro and Susana. Because of you, I am who I am. From you I learnt about justice, persistence, compassion, effort, ethics and much more. You have been my best school for life.

To my beloved brother Gustavo. Because you were my academic model. Because of you, I chose the field of technology that has marked my professional life. You are the best brother anyone could have.

THE FRONT IMAGE

The image in the front page of the dissertation document is a tribute to the Costa Rican artist Herbert Bolaños who agreed the image to be used in the thesis. Herbert is also a recognized professor at Universidad Nacional. His work titled Weaving Cultures (Tejiendo Culturas) is a simple fabric composed of two threads, called warp (urdimbre) that supports the tension. The other thread called weft (trama) is who carries in its path the fantasy of all the fabric. The two directions form the foundation that will allow the artist to use it as a platform of construction to generate new forms of visual communication.

In the work weaving cultures you can appreciate a surface, a network, which is complemented by other materials, such as pulp to make paper and silk, which make visible the shape, color and the texture. This work is a visual proposal that reflects the need to strengthen ties between cultures, with the purpose of building a better world together. The warp represent the human being. The weft are the dreams and fantasies of each individual forming the society, to build harmony in our planet and inherit a better world for our future generations

The work was meaningful to me as it represents the collective dimension of reality, the existence of opposite forces, identities, cultures that requires to be weaving to overcome limitations in ICT adoption and integration but most important in all human complex activities. Thank you Herbert for your contribution to Costa Rican art and for accepting to be part of this effort.



Tejiendo Culturas, 2013

Technique: hand knitting with cotton threads and pulp

Real dimensions 150 x 100 cm

Herbert Bolaños, Universidad Nacional, Costa Rica.

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CHAPTER 1. INTRODUCTION

1.1. A MOTIVE FOR RESEARCH

1.2. THE PRACTICE AS A TRIGGER OF CONCERN

In 1986, the government of Costa Rica changed the live of many children in that generation and the coming ones. With the introduction of computers in primary schools, a new dimension of opportunities was opened for children. I was one of those. It is impossible to forget the best two hours of the week in the computer laboratory, where, sitting with a classmate, the creativity streamed forth supported by Logo Writer software. Since then, my life has been closed in relation to the use of technologies. I still remember the smell of the first computer that my father brought to home at the beginning of the nineties. Perhaps, the starting point for a professional life surrounded by technologies.

Since my first steps in working life, I have worked in a field resulting from the conjunction between education and the information and communication technologies (ICT). Both fields are broad and complex in themselves. At Universidad Nacional (UNA) at the end of the nineties, the profile of the computer science engineer was thought as the most appropriate one to assume and lead emerging initiatives in online learning as the prevalent expression of the integration of technology in higher education (Murphy & Rodríguez-Manzanares, 2014). As a graduate in computer science, I assumed responsibilities related to the administration of the learning management systems (LMS), and teachers and students training to use these LMSs.

In 2007, I was committed to coordinate the institutional department in charge of promoting the integration of ICT in teaching and learning, or ICT unit (Cifuentes, 2016). In 2014 and with almost 14 years of experience in the practice of education and technology, teacher professional development, development of policies and guidelines I have been dealing with relatively narrow impact and many complaints from the different institutional departments. The work experience was fundamental to the emergence of questions and assumptions about my labour that later evolved into interest in formal research.

As a member of the administrative responsibilities of supporting the faculty professors, I used to lay upon the shoulders of professors the responsibility for reduced adoption of technology. In other words, I assumed that my department actions were correct and enough to create the necessary conditions for an adequate adoption of technology by professors. A sort of standard sufficient solution that was misunderstood and misused by professors.

The assumptions turned into deeper reflections when I found disparities in professors' adoption of technology. In dealing with professors' adopters of technology and those who were not, I started questioning the reasons for such differences. With no systematic data beyond that observation of the practice, the assumption of motivation became an important focus of interest in taking the initial steps toward formal research. Furthermore, as part of the university management team, I have been aware of the substantial investments in technology and professors training in the last decade. The presence of institutional conditions for ICT adoption supported my assumptions regarding the responsibility of faculty professors for not adopting or for an incipient and insufficient adoption of technology.

The primary aim of the ICT unit at UNA is not only to achieve quality in the pedagogical uses of technology. Equally important is to increase the number of initiatives of adoption. Not only in individual professors' initiatives but also in the academic department initiatives. Despite the current institutional strategy and more than one decade of efforts by the ICT unit, the results appear to be insufficient toward a transformation in education with technology. The lack of results increased my questioning on why, despite the investments in technology and professional development, there are no further initiatives of technology adoption for teaching and learning among individual professors or among institutional academic departments. Moreover, the existing initiatives seem to remain static. Furthermore, I observed in my experience a predominance of discursive intentions among professors and managers toward the adoption of technology, but a lack of professors and departmental actions toward the adoption of ICT in teaching and learning. The curiosity or perhaps the obsession to find answers to a problem in my daily professional practice led me get into the process of research. In sum, the trigger for developing this research process was essentially motivated by my practice in the position of leader of the ICT unit at UNA supporting the academic work of faculty professors to adopt ICT in teaching and for learning processes.

My interest in facilitating and promoting further adoption and integration of technology is not to diminish the importance of an adequate pedagogical use of the technologies. Moreover, it must not be interpreted as a technological determinist (Ryberg, 2013) viewpoint in which extending the coverage presumes a guarantee of transformations in education. Rather, it should be acknowledged as a contribution to facilitating the required conditions for an appropriate adoption and integration of technology according to the particular requirements of the institutions and the surrounding context.

A preliminary overview of the literature indicates that the lack of results and impact of ICT adoption among faculty professors is not particular to UNA. Instead, similar results and challenges are reported in studies around the globe. With this preliminary overview of substantial investments in technology and training, and with very little impact on adoption, my initial questioning was aimed at the role and importance of

intrinsic motivation and how professional development develops intrinsic motivation among higher education professors to adopt ICT in teaching and learning.

1.3. DELINEATING THE RESEARCH PROBLEM

A body of literature has addressed the conceptual definition of the field of technology and education (Murphy & Rodríguez-Manzanares, 2013). According to Januszewski & Molenda (2008) educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources (p. 1). Reiser (2001), refers to the field as instructional design and technology, including processes such as design, development, implementation, evaluation, and management of processes and resources to improve learning. Ely (2008) remarks that the terms “educational technology” and “instructional design” are often used interchangeably. However, he acknowledges in educational technology a broader term including, for instance, the administrative dimension of education institutions. In the case of instructional technology, it seems to be used in the concrete process of teaching and learning. Veletsianos (2010), approaches the field as emerging technologies in education, and describes it in terms of tools, concepts, innovations and advancements utilized in diverse educational settings to serve varied education-related purposes, including concepts as distance, face-to-face and hybrid forms of education.

Technology-Enhanced Learning (TEL) is an influential concept in the United Kingdom and in some other countries in Europe. According to Kirkwood and Price (2013), TEL is used in connection with the application of ICT for teaching and learning including the concept of e-learning. Bayne (2015), in her critical analysis of the concept, draws the attention to the importance of the need to be more careful regarding the terminology in concepts used to describe the field. To Bayne (2015), TEL omits the social dimension of learning and teaching activities and gives to the technological artefact the powerful quality of being capable of enhancing the complex process of learning independently of social contexts (Hamilton & Friesen, 2013).

Recently, the concept of networked learning has made its appearance on the scene. It has been argued that networked learning is related to approaches such as e-learning, online learning, virtual learning and Web-based learning (Jones & Dirckinck-Holmfeld, 2009). The role of technology in networked learning intends to enhance learning through the promotion of connections between learners, between learners and tutors, and between a learning community and its resources (Goodyear, Banks, Hodgson, & McConnell, 2004). Networked learning seems to be a broader approach in the field than TEL, recognizing that even infrastructure is formed by organizations, socially communicated background knowledge, general acceptance, reliance and near ubiquitous accessibility and not only by hardware (Bygholm & Nyvang, 2009, p. 31). Moreover, networked learning’s theoretical approach is influenced by cultural-historical approaches to learning (Engeström, 1987; Vygotsky, 1978) and other social

theories of learning such as that of Wenger (1998). At this point, I identify similarities between my approach to research and networked learning from the perspective of avoiding a reductive study of technology, but its appropriation in the social practice of teaching and learning.

Lievrouw & Livingstone (2002) understanding of educational technology as the interactions among artefacts and devices, activities and practices, and context is enriching. First, because they view of technologies in themselves and in how they are designed and made before they reach educational settings. Second, because the importance of the activities, about what people then do with the technologies in educational settings and for educational purposes (including issues of human interaction, organizing, identity and cultural practices). Third, regarding the social arrangements and organizational forms that surround the use of the technologies in educational settings and for educational purposes (including institutions, social structures and cultures). Summarizing, with regard to the concepts, the study aims to have a viewpoint of technology beyond a mystical power of enhancing learning with the mere adoption of technological resources. Instead, in the same line of reflection of Bayne (2015), as an attempt to reflect against instrumentalism and essentialism in educational technology research (p. 10).

By its nature, the field of education and technology is challenging. It is not at all static, but rather its dynamicity is noted from its definition, in the plurality of concepts and understandings and in practice. The aim of this section is twofold. First, it looks at the conceptual frame of the field, and second it supports in setting out the scope of the study.

The dissertation is not a direct contribution to the conceptual framework of educational technology. Conversely, it is a potential vehicle to facilitate and improve the adoption and integration of the different standpoints in education and technology. Regardless of the conceptual understanding of technology in education, the reality is that any framework will face obstacles to achieving individual adoption and institutional integration. Based on my professional practice and the initial formulation of the problem, my initial position here is that by solving the existing limitations, a major integration of technology in higher education will occur. Toward an accurate delimitation of the scope of the study, the focus is placed on the use of information and communication technologies to achieve the learning objectives of the educational curriculum. The approach is closer to the concept of instructional technology, in the sense of a narrower approach of using technology in the process of teaching and learning (Ely, 2008). However, it is not reduced to the underlying behavioural approach implicit in the concept of instructional technology (Ely, 2008, p. 246).

An alternative to narrowly delineate the research problem is excluding what is not part of it. What is not included in the research project can be summarized as follows:

- The study is not oriented toward exploring how technology improves learning or the activity of learning. Instead, the study starts from the assumption that technology has the potential to improve teaching and/or learning.
- The study is not oriented toward determining the effectiveness of a given technology in a given field of knowledge.
- The study is not oriented toward assessing the impact of ICT use in education. Instead, it takes advantage of previous studies of such impact.
- The study is not oriented toward promoting the use of ICT as a tool to facilitate teacher professional development (TPD). Instead, it sees TPD as a means to facilitate integration and adoption.

1.4. THE RESEARCH PROBLEM

In the last decade, the political, cultural, economic and technological changes at the global and national levels (Pesik & Gounko, 2011) have influenced the universities regarding values and governance, economics and financing, and the substantive action of teaching and research. Moreover, a global knowledge-driven economy (Carnoy & Castells, 2001; Middlehurst, 2001), a knowledge-based society, students' demographic changes (Marshall, 2014) and technological development (Middlehurst, 2001) are triggers of new trends and challenges for universities. Some of the challenges are related to the growing demands of students, a global demand, a marked directed education, the closer links and partnerships with business and industry (Bosetti & Walker, 2010), and the imperative of developing students' technological skills. The changes addressed by universities are oriented, among others, toward changes in the curriculum, the development of policies, and to quality assurance and accreditation processes (Krücken, 2014). Peculiarly, the information and communication technologies in higher education are not only an essential challenge and trend in themselves, but a facilitator tool for coping with other challenges, such as massification, quality, internalization, research and management (Jacob & Hellström, 2014). It can be argued that technology plays a double role, as a challenge and trend in itself, and a means to achieve some other challenges and trends.

As a challenge and trend in itself, the educational innovation with technology is not solid as expected (Balasubramanian et al., 2009). For instance, in the case of online learning as the leading form of technology integration in higher education, Georgina and Olson (2008) state that the integration of online distance education modalities has been slow. Despite the efforts reported in the last few decades, some studies still evidence a complex scenario for ICT adoption and integration. Ben Youssef and Dahmani (2008) identified three possible explanations for this limited adoption:

- The long processes of appropriation required to observe any significant change;
- The lack of organizational change despite large investments;

- Students are acquiring new skills and new competencies closer to the needs in the job market and perhaps less so to performance in curricula (p. 9).

Likewise, the assessment of the effects of ICT in education has been complex, perhaps because of the lack of clarity on what is expected of technology, or its role in the transformation of education. According to Kirkup and Kirkwood (2005), neither radical change nor transformation has been achieved in education because of technology. Moreover, a disconnection between the results of research and how the institutions are addressing the problem is perhaps a reason to explain the lack of better results (Kirkup & Kirkwood, 2005). Eng (2005), argues for further in-depth longitudinal studies to discover the impact of ICT on learning. However, further research in practice is essential, not only to understand the factors limiting ICT integration but also regarding creative alternatives to overcome these limitations.

1.5. THE PROBLEM IN CONTEXT

The universities face not only the pressure of global trends but also local-context challenges at the national and institutional level. The Universidad Nacional, Costa Rica is not alien to this reality. UNA is Costa Rica's second-largest state university in terms of the number of students. As a public university, it has autonomy regarding academic issues, its form of government and administrative issues (Universidad Nacional, 2015). The Universidad Nacional is guided by principles of humanism, transparency, inclusion, probity, environmental responsibility and transformative knowledge (Universidad Nacional, 2015, p. 11). The principle of transformative knowledge refers to a creative, innovative teaching and research to educate analytical, critical and propositional citizens to improve individual and social human conditions. In this regard, UNA has given to the information and communication technologies an essential role. The Universidad Nacional conceives the uses of technology for educational purposes as a way to (Universidad Nacional, 2016):

- Promote innovation in academia
- Facilitate the decision-making for the management of the technologies in academic activities
- Enrich the educational process and diversify learning strategies
- Support the processes of regionalization and internationalization of curricula
- Promote innovative teaching-learning processes and curricula.

According to Castro, Corrales, Delgado, Zúñiga, and Aragón (2014), the Universidad Nacional created an institutional department to promote ICT adoption in education in 2002. The aim was to facilitate the coordination between the incipient institutional initiatives in online learning and the higher-level management. In 2005, the department was named UNA Virtual and given the responsibility of promoting a critical, reflexive and creative incorporation of technology resources in academia (Castro et al., 2014, p. 241). Over the time, UNA Virtual identified three pillars to

achieve its objectives: the pedagogical, technological and administrative dimensions of ICT integration. To support these three pillars, the managerial level of UNA has facilitated the work of UNA Virtual through important investments in technology infrastructure and professors' training strategies (Castro & Corrales, 2012). The professional development system for ICT adoption is based on the development and acquisition of technological and pedagogical skills in professors. An assessment report issued by UNA Virtual and covering the period from 2005 to 2012 acknowledges the importance of professors' training and highlights two essential results: a substantial offering of courses and a number of trained professors close to 700 in seven years (Aragón, Delgado, Zúñiga, & Chavarría, 2013). Despite the relevance of the training, the report indicates that the coverage is not sufficient and recommends larger coverage through decentralization and empowerment of academic departments in the processes of training. The report also suggests the creation of systems of control and follow-up to support the professional development initiatives in transcending and putting the learning into practice in the classroom. Furthermore, the types of courses and methodologies maintain a teacher-centred professional development strategy as the way to achieve the goals of adoption and integration.

In the context of UNA, there is a lack of research studies reporting on the impact of ICT in teaching and learning, and regarding the role and impact of professional development as a facilitator of adoption and integration. However, the report of Aragón et al. (2013) highlights benefits and areas of improvement. The report indicates a positive learning of technological and pedagogical skills for technology in teaching and learning as well as further initiatives of virtual and hybrid courses. However, it emphasizes the relevance of increasing professors' commitment in the course of training. The report evidenced differences of perspectives between the provider of training and the participants regarding the lack of commitment:

"The objective of the virtual course was not achieved, due to the low participation of the academics, although there was flexibility with time and space as a virtual course. The participants justified the low participation because the activities related to the end of the semester, extracurricular activities, and academic workload." (Aragón et al., 2013, p. 39)

The lack of commitment and results were evident further in the report despite the conditions and facilities offered to professors. However, the professors called for a major institutional strategic participation and influence in terms of adequate policies and guidelines.

As a concrete example of a training course and the impact on practice, the report indicates:

"However, very few incorporate the portfolio into their courses, misusing the technological resources that the institution makes available for them. Regarding the implementation by teachers this is not much visible." (Aragón et al., 2013, p. 39)

The following table shows the relation between trained professors and professors' implementation regarding the digital portfolio-training course.

Year of training course	Number of participants	Number of implementations
2008	48	0
2009	18	4
2010	26	5
Total	92	9

Table 1. Professors trained in digital portfolio vs implementations from 2008 to 2010 (adapted from Aragón et al., 2013, p. 42)

A relevant final recommendation of the report is the need for further results in practice. In other words, that the results and impact of processes of professional development are shown through the development of initiatives in practice.

1.6. THE RESEARCH FOCI

An initial matter of concern is regarding the professors' adoption of technology and the institutional integration of technology. While some models of adoption of innovation define stages related to individual adoption (Toledo, 2005, p. 179), the five-stage model for computer technology integration into the teacher education curriculum indicates five stages in terms of institutional integration. Undoubtedly, individual and institutional dimensions are related in the sense that promoting a larger institutional scope would mean more professors adopting technology. However, the initial process of adoption does not guarantee institutional integration and as a result, transformation. For instance, a professor who has already adopted technology could continue progressing through the levels of adoption. In other words, he/she can go from beginner to expert. However, the specialization of professors does not necessarily result in a major institutional scope.

As a practitioner and a researcher, part of my concern was regarding how to support the aims of transforming education through technology. As transformational knowledge is a principle at UNA, can it be achieved by the mere individual adoption of technology, even under the assumption of a pedagogically correct adoption of technology?

Thus, the initial focus of concern on the use of technology in education is regarding institutional integration upon individual adoption. An individual adoption could bring

important results and transform the practice of a professor, of a classroom and of a group of students. However, the institutional transformation is limited.

A second focus of interest arises from my initial assumption of the lack of professors' motivation as a limitation to a major adoption of technology by professors. My interest in motivation was then extended by the existence of two types of professors regarding technology adoption at UNA. First, professors that adopt ICT based on their own decision and their own motivations. For them, professional development or external rewards are not the main driving force behind adoption, but rather a complement and an opportunity for further knowledge development. The behaviour of these professors challenged me to question what encourages such behaviour, and how they obtain and maintain motivation.

The second group of professors are those not using technology. Professors in this group need external forces or external motivators to adopt ICT. In some cases, not even external motivations facilitate changes in the professors' daily practice. Another questioning is about the extent to which UNA is able to sustain increasing schemes of financial reward or professional development programmes to cover about 1500 faculty professors. Moreover, the complexity of the range of fields of knowledge, the many technologies in the market and the possibilities of pedagogical adoption must be taken into account.

As a practitioner at the institutional management level, I started questioning the scope, effectiveness, impact and types of adequate models and characteristics for sustainable TPD for ICT adoption. In the last few decades, the literature has highlighted the lack of, and the low quality of, training as a limitation to adoption (Pelgrum, 2001; Schoepp, 2005). In addition, professional development activities can be assumed by professors to be a requisite for adopting ICT or as a means to obtain external rewards through wage recognition and growth at the career level. The institutional system of professional career at UNA assigns points for professor recognition (Mendez, 2015).

As I pointed out above, providing professors with technology and training conditions has not been enough to accomplish major results. Thus, the main focus was initially placed on the internal dimension of the professors as a core problem, specifically on professors' motivation, no matter if internal or external, as a driving force or energizer of behaviour (Kleinginna & Kleinginna, 1981) to adopt technology. In sum, a second focus of concern is about professional development as a tool to facilitate adoption and integration by increasing intrinsic motivation.

A third matter of concern is the concept of motivation. According to Ertmer (1999), in terms of the categories of barriers, lack of motivation is a second-order barrier to change. Lack of motivation is one among other second-order or intrinsic barriers in literature (Almekhlafi & Almeqdadi, 2010; Goktas, Yildirim, & Yildirim, 2009). The lack of interest, lack of confidence, resistance to change, lack of skills, and negative

attitudes and beliefs expand the framework of potential internal barriers affecting professors' individual adoption of technology in the classroom. The existence of a framework of potential internal barriers made me expand the focus from motivation to second-order barriers and the lack of motivation as one among them. A deeper understanding of Ertmer's approach to barriers opened the door to expand the third focus even more toward the external barriers of ICT adoption. What at the beginning of the study was motivation as a focus of research became professors' second-order barriers to ICT adoption as the third matter of concern in the study. Thus, the ICT integration in education, the second-order barriers of professors to ICT adoption and teacher professional development as a means to overcome such barriers are the three areas making up the focus of the study (see Figure 1).



Figure 1. Three-part foci of the study.

The influence of context in the process of adoption and integration is of relevance for the study. In my working experience, I denoted important differences among professors from different fields. The experience of practice is supported by some studies indicating that institutional characteristics and culture influence professors' adoption of technology (Buabeng-Andoh, 2012; Groff & Mouza, 2008). The reflection to seek an adequate research question turned from an individual internal approach to the potential influence of culture and context. It has important implications in terms of decisions regarding the theoretical framework and the methodological approach for the inquiry. Hence, my initial concern in the study is declared in the following initial main research question:

- How can professional development help institutions to overcome second-order barriers and motivate teachers to adopt ICT in higher education?

CHAPTER 2. A REVIEW OF INTERRELATED FIELDS

In Chapter 2, I briefly present the broadness and complexity of the field of education and technology through a non-exhaustive introduction of the conceptual framework. Then, I present the problems identified in the context of the research study and finally I delineate the research foci of the study. I also stated my initial position as a researcher and the significance of the working practice in the research questions statement.

In this chapter, I present a review of literature on the three areas forming the foci of the study: ICT in education with particular emphasis in the benefits of ICT in teaching and learning, the limitation in adoption of technology and the teacher professional development (TPD) as a means to promote ICT adoption.

The methodological process of a hermeneutic framework for a literature review (Boell & Cecez-Kecmanovic, 2014) (see Figure 2) supported the review of literature. The cyclical-expansive approach of the hermeneutic framework allowed me to conduct an initial review in the area of ICT in education. The results and the expansive characteristic of the framework made me realize the connections with the other two areas of research foci.

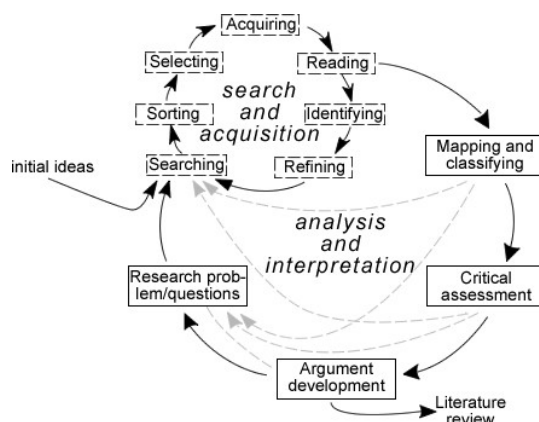


Figure 2. The hermeneutic framework for literature review (adapted from Boell & Cecez-Kecmanovic, 2014).

As mentioned above, the first application of the framework was related to the integration of technology in education. After a first run of search and acquisition, I

became aware of the existence of a diversity of approaches to the field, such as: conceptual definitions, concrete experiences of adoption, benefits of technology in education, and successful adoption projects in specific areas of knowledge. However, the most relevant result of the first iteration was regarding the limitations in the process of adopting technology. At this point, I moved into the cycle of analysis and interpretation understand in deep the connections between the limited results found in the first search and the limitations or barriers to ICT adoption. The results regarding the limited results of adoption were consistent with the research problem. However, my hypothesis regarding intrinsic motivation as the central factor to be addressed to promote adoption was confronted by a large corpus of literature related to classifications and lists of barriers affecting the adoption of ICT.

A second cycle of search and acquisition was carried out on the topic of barriers. During the cycle, I realized the double role of professional development as a barrier and enabler in ICT adoption. This role encouraged me toward a deeper review on professional development as a means to overcome barriers for ICT adoption in education.

A third run of the cycle was carried out on this topic. The flexibility and variety of connections that are facilitated by the application of hermeneutic cycle were essential toward a comprehensive literature review in a complex multifactorial phenomenon. Important to mention is that the revision of literature was ongoing during the research process in order to permanently contrast the empirical results to existing and new literature. The iterations of the hermeneutic framework in search, acquisition, analysis and interpretation enabled me to develop consistent arguments to enrich the debate between the literature, research questions, the research problem, the empirical results and analysis. The literature review was also critical in a process of tuning of the research questions.

2.1. ICT IN EDUCATION

The benefits of ICT in teaching and learning process are perhaps encompassed within the pedagogical debate dealing with the added value of technology in learning, the measuring of the impact of ICT on learning and attainment, and the demonstration of a cause-effect relationship between the use of ICT and better learning and student attainment (Wellington, 2005).

In one side, plenty of literature points out the benefits of using technology for teaching and learning purposes (Balanskat, Blamire, & Kefala, 2006; Harrison et al., 2002; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). According to Newton and Rogers (2001), the use of technology in an appropriate way and context can add value to learning. Balanskat et al. (2006), for instance, reported benefits in both students' improvements in attainment and in teaching as a support to enhance interactivity. A survey research in a higher education institution in Nigeria, including professors and

students' perceptions, found benefits from technology in relation to expanding access to information and improving the quality of instruction. Furthermore, it increases the speed of covering the courses, and leads to better conducting of assignments and monitoring. It also increases students' involvement in learning and collaborative work (Asiyai, 2014). Similarly, Jonassen David H. & Jonassen David H. (2003) relate the use of technology to the promotion of collaborative learning and learning by cooperation. Further benefits have been discussed in literature on technology as a facilitator of communication, supporting problem solving (Grabe & Grabe, 2001; Plomp, 1996; Voogt & Pelgrum, 2005) and as a means to promote new approaches to learning and teaching (Afshari, Bakar, Luan, Samah, & Fooi, 2009). Furthermore, other benefits have been reported in the improvement of memory retention, increase of motivation, new ways of interaction between students and teachers; and facilitation in students more opportunities for feedback and reflection (Manjula, 2012).

Benefits of information and communication technologies have been also reported in the learning of specific fields of knowledge. In the learning of mathematics, for instance, ICT has demonstrated potential for practicing number skills and exploring patterns and relationships. It supports the visualization of complex structures and pushes students toward higher levels of thinking and understanding. Moreover, according to Witte and Rogge (2014), it reduces students' misconceptions through facilitating graphic illustrations.

In the field of teaching sciences, Mcfarlane and Sakellariou (2002) identified a beneficial contribution of technologies as a provider of virtual spaces for experimentation using the same principles as in a laboratory. Moreover, technology can support the simulation of real processes to reinforce the relationship between theory and practice. According to Webb (2005), in the study of science, technology can have effects on the promotion of cognitive development, student experiences and students' self-management, and in facilitating the collection of data and presentation.

Despite the reported benefits, some difficulties have been found in research regarding the design and carrying out of studies showing the impact of ICT on learning (Wellington, 2005). That is, perhaps, one of the reasons why the debate on ICT in teaching and learning has a more reticent sector concerning the benefits and impact.

Some studies evidence skepticism not only regarding the benefits, but also about the impact of ICT for educational transformation (Wellington, 2005). Important differences have been found regarding the reached scope and the real impact of technology (Underwood & Dillon, 2011). Groff (2008), for instance, considers the use of computers in the classroom to be disheartening, and a study by Kirkup and Kirkwood (2005) states that teachers involved in ICT projects improve their existing practices, rather than radically changing them. For Yang (2012), ambitious changes are needed to realize the expected transformative outcomes in education with ICT.

Other studies refer to the limited results and impact of ICT in education. In 1995, Leidner and Jarvenpaa (1995) evidenced the gap between ICT integration in education in respect to other sectors such as business. In 1999, Ertmer, Addison, Lane, Ross, and Woods (1999) argued that despite a dramatic increase in the number of computers, the integration of technology in the curriculum had not been accomplished. Cuban, Kirkpatrick, and Peck (2001) found that even in contexts where technology and resources are not a limitation, the adoption by professors was not substantial. They pointed out the importance of fundamental organizational changes and teachers' preparation to improve the adoption. However, although the management level of the organization is doing its job through the development of policies and significant efforts in professional development, ICT adoption and integration in teaching and learning have been limited (Buabeng-Andoh, 2012).

The historical path and the current problems in ICT in education indicate that, despite the benefits of its uses, there are significant limitations and no clear evidence of transformation in education. Such limitations became significant to the study. In literature, the limitations are better known with the concept of teachers' barriers to ICT adoption. My initial interest in intrinsic motivation found a natural relation with the category of second-order or internal barriers to teachers. However, the literature regarding barriers points out to a broad range of barriers affecting professors' adoption of technology beyond motivation. Moreover, external barriers are also limitations. The next section is a review from a broader perspective of barriers as a framework to understand the paradox between the substantial efforts of research and institutions toward ICT adoption and the limited results.

In sum, the study recognizes the potential benefits of technology as a mediator for learning purposes and as an ally to achieve the transformation of teaching and learning. I subscribe the words of Livingstone (2012) regarding the potential benefits of ICT in education in which the single effort of integrating technologies in the traditional classroom producing moderate improvements as pupils motivation and it would be a valid enterprise. However, I also recognize the large number of limitations affecting the integration of technology in traditional teaching and learning. Limitations will be present, perhaps in higher levels of complexity in the route or routes toward the expected transformation in education. Indeed, the limitations become a focus of interest in the study. The following section analyses in depth the barriers of ICT integration in education as one of the areas in the research foci.

2.2. BARRIERS IN THE ADOPTION OF ICT IN EDUCATION

The limited impact of technology in education has been mainly approached, in research, from the viewpoint of teachers' barriers to technology. The concept of "barrier" is the most common in referring to those factors that hinder professors' adoption in teaching and for learning. However, concepts such as obstacles, limitations, obstructing factors, preventing factors, challenges and impediments

(Pelgrum, 2001; Richardson, 2011) are also present in literature with no significant differences in the core meaning.

The study of barriers of ICT adoption in education has contributed with an extensive list of barriers, categories and proposals to overcome. A longitudinal study by Hew and Brush (2007) constructed a list of around 120 barriers organized into six categories: resources, knowledge, skills, institution, attitudes and beliefs, and assessment and subject culture. A more detailed categorization is presented by Groff and Mouza (2008) defining legislative factors, district/school-level factors, factors associated with the teachers, factors associated with technology-enhanced projects, factors associated with the students and factors inherent to technology itself. Wood, Mueller, Willoughby, Specht, and Deyoung (2005) identified limitations related to teachers support, context and access, students, computer hardware and software and external problems. According to Berge (1998), the limitations in online learning were related to technical and cultural issues.

Furthermore, Balanskat et al. (2006) describe barriers in terms of the micro, meso and macro level: the first related to teachers' attitudes and ICT approach, the second related to institution, and the third related to the system. Brinkerhoff (2005) divides them into resources, institutional and administrative support, training and experience, and attitudinal or personality factors. On the other hand, Ertmer (1999) proposes the categories of teachers' first-order and second-order barriers to technology adoption. Ertmer's approach to barriers is based on Brickner's (1995) understanding of barriers to change as the extrinsic and intrinsic factors that affect teachers' innovation efforts (p. xvii). Because change is one of the conditions for achieving the promised transformation of education, the first-order and second-order barriers of teachers to integrating technology seem to me an adequate starting point to approach the research problem.

The first and second-order barrier approach comprises quite well the categories previously mentioned. For instance, the categories of resources, administrative support and training (Brinkerhoff, 2005), the technical (Berge, 1998) and the organizational (Pajo & Wallace, 2001), are included in first-order or external barriers. Equally, attitudinal or personality factors (Brinkerhoff, 2005), personal barriers (Pajo & Wallace, 2001) and factors associated with teachers (Groff & Mouza, 2008) are covered by second-order or internal barriers of teachers.

First-order barriers to technology integration are defined as being extrinsic to teachers (Ertmer et al., 1999). According to Ertmer et al. (1999), the overcoming of first-order barriers allows small changes in practice. Examples of this type of barrier are lack of equipment, lack of time and lack of support. On the other hand, second-order barriers are intrinsic to teachers. They are considered to be fundamental to major changes in practice. Second-order barriers are related to teachers' beliefs about teaching, computers and change. A lack of motivation among professors, for instance, has been

categorized as a second-order or intrinsic barrier to teachers (Almekhlafi & Almeqdadi, 2010; Goktas, Yildirim, & Yildirim, 2009).

The literature has been primarily oriented toward the study of barriers from the teachers' perspective and perceptions (Hennessy, Ruthven, & Brindley, 2005). In other words, the teacher as the unit of analysis. For instance, Brinkerhoff's (2005) categories of barriers are the result of teachers' perceptions after participating in a professional development process. In a study aimed at identifying the barriers to E-Learning, Panda and Mishra (2007) applied a survey method to 150 full-time university professors in order to explore their perceptions. Furthermore, Goktas, Gedik, and Baydas (2013) applied a longitudinal survey design to 401,288 primary school teachers, and Ertmer, Ottenbreit-Leftwich, and York (2007) studied barriers to, and enablers of, exemplary teachers using technology.

The study of barriers from the teachers' perceptions has mainly produced lists of internal or external barriers. Table 2 and Table 3 present the first-order and second-order barriers found in the reviewed literature for this dissertation. The left-hand column indicates single barriers or groups of similar barriers and the column on the right expresses the number of occurrences in the reviewed literature.

Barrier	Occurrence
Lack of resources (lack of computers, lack of hardware, lack of appropriate software, lack of access)	28
Difficulties in integrating ICT in instruction (lack of skills to integrate in curriculum, curricula are not ready to use technologies, ICT does not fit in curricula, course content and instructional programs)	13
Lack of time (for training, design, excessive workload)	26
Training-related barriers (lack of training, insufficient training, not enough opportunities, inappropriate training styles, low quality)	30
Lack of technical support/technical faults	16
Lack of faculty rewards (incentives, compensation or promotion)	3

Lack of sharing best practices	10
Lack of support (institutional, administrative, leadership support, financial support)	15
Lack of technology plans/policy	7
Institution characteristics (culture)	3
Student-related factors (motivation, sabotage, digital divide)	1

Table 2. Frequency of first-order barriers in reviewed literature

Barrier	Occurrence
Teachers' lack of interest (motivation)	4
Lack of teachers' confidence (self-intimidated by technology)	13
Resistance to change	10
Teacher do not realize the advantages of using technology	7
Anxiety (ICT is unstable and always changing)	3
Lack of teacher competence (skills, knowledge)	15
Negative attitudes and beliefs toward technology in education	13

Table 3. Frequency of second-order barriers in reviewed literature

A few studies have explored the problem of barriers from different angles to the teacher-centred approach. In their study, Mitchell and Geva-May (2009) developed a policy document analysis and Lowther, Inan, Daniel Strahl, and Ross (2008) considered student performance assessments as the subject of the study. Moreover, Park and Ertmer (2008) included administrators and technical support staff. In a case study fieldwork, Huda and Hussin (2010) focused on the organizational level by interviewing vice-rectors. Similarly, Goktas et al. (2009) included deans, teachers and prospective teachers in their analysis. In order to study the factors that obstruct or stimulate teachers in using ICT, Drent and Meelissen (2008) obtained data from the

school management level, teachers and students. Despite the shift in the subject of study, they remain individually focused and present the limitations from a subject perspective.

A more comprehensive perspective of analysis was developed by Laferrière, Hamel, and Searson (2013), using an activity theory framework with human activity as the unit of analysis. As a result, the barriers were described in terms of tensions and contradictions. They were found in the relations among different actors, policies and with specific and contextual elements not evident in current literature on barriers. The results highlight the importance of further comprehensive perspectives of analysis from the administrative, infrastructure, organization, context and cultural perspective. Expanding the unit of analysis could eventually lead to the appearance of new barriers, a better understanding of the whole phenomenon or innovative ways to overcome existing limitations. Such an approach would be necessary to understand the multilevel dimension of the complex social reality (Singh & Hardaker, 2014) in ICT integration in education. What is more, Wood et al. (2005) argue that the mechanisms that support changes, as well as the barriers causing limitations, are not yet completely understood.

2.2.1. BARRIERS AND ENABLERS. TWO SIDES OF THE SAME COIN?

As presented in Table 2, the five most common first-order barriers are the lack or low quality of training, lack of access to technological resources, lack of time, lack of technical support and the lack of institutional support. As regards the second-order barriers, the most recurrent in literature are the lack of teachers' competences, the lack of confidence, the negative attitudes and beliefs, the resistance to change, and the fact that teachers do not realize the advantages of ICT in teaching and learning (see Table 3).

Some studies have devoted significant attention to second-order barriers as causing more difficulties than first-order (Ertmer et al., 2007; Unal & Ozturk, 2012). A study with 12 professors at K-12 level showed that the teachers' beliefs and attitudes toward the relevance of technology to students' learning had the biggest impact on success (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012). Furthermore, according to Blackwell, Lauricella, and Wartella (2014), overcoming second-order barriers deserves special attention. The attention towards second-order barriers as the final frontier for technology integration (Ertmer, 2005) contrasts with the revision of literature on teachers' perceptions of barriers, where teachers and professors mainly point toward external barriers as causing limited adoption.

The study of barriers has led to the study of enablers of ICT adoption. Enablers are factors that allow, facilitate and support teachers' awareness, willingness and actions of ICT adoption. For instance, the corresponding enabler for the lack of hardware barrier is the facilitation of access to hardware. Studies on barriers and enablers have

supported the creation of conceptual models to overcome barriers to ICT in education. Surry, Ensminger, and Haab's (2005) model for integrating instructional technology in higher education is based on the five elements of resources, infrastructure, people, policies, and learning and evaluation. Four out of the five elements are oriented toward attending to extrinsic barriers, while the element of people is oriented toward attending to the needs, hopes, values, skills and experiences of the people related to the process of integration of technology.

Other studies describe self-gratification, training, technical support, professional incentives, peer recognition (Panda & Mishra, 2007), higher quality in service training, decreased course load, more budget, appropriate design and technology plans (Goktas et al., 2009) as effective enablers. In a recent study, Goktas et al. (2013) listed 11 barriers of teachers to adopting technology. Nine of them were first-order-type barriers and two were second-order barriers. This study is an indicator that in spite of years of attention to first-order barriers through investments and training, they are still valid. The same study listed potential enablers, such as the allocation of budget, specific units for peer support, support offices and personnel for teachers, higher-quality pre-service training, support for teachers and having technology plans. To me, it became quite evident and perhaps simplistic that for a limitation such as a lack of budget the expected solution is to assign a higher budget. Regarding a barrier such as a lack of technology plans, the adequate solution in a binary form is the development of institutional plans. However, my experience in practice indicates that such solutions are not always possible or easy to address.

This holds true similarly for second-order types of barriers. For instance, Ertmer et al. (2007) argue for putting the stress on intrinsic enablers more than extrinsic ones. However, there is a risk of falling into the same binary barrier-enabler relation. Here the types of questions arising were about the “how” more than the “what”. As I said before, it may be obvious that to reduce the lack of motivation the answer is to promote, improve or develop motivation. However, how that motivation is fostered deserves major attention.

As noted above, the study of barriers has been primarily oriented toward discovering teachers' perceptions of first-order and second-order barriers limiting teachers' adoption of ICT. Consequently, the proposals for overcoming barriers have followed mainly the same separate logic of attendance. On the one hand, strategies as implementation of institutional or contextual conditions have been proposed to overcome first-order barriers. However, such strategies have been understood as to be implemented by “someone else”. The teachers have almost nothing to do to solve external barriers. According to Hew and Brush (2007), to overcome a barrier such as a lack of resources the strategy is to obtain the necessary resources. In terms of second-order barriers, it is proposed that a limitation such as negative attitudes and beliefs can be solved through institutional support and professional development. Thus, the strategies for overcoming second-order barriers are intended to be used to solve

external conditions such as professional development that cannot be taken for granted. Perhaps it is necessary to appropriately consider the influence of context and culture. For example, the enabler to reduce the class loads for teachers in order to free up school time (Hew & Brush, 2007) is not, for many educational institutions, an action that can be just taken unilaterally and with no consequences. Conversely, in a simpler case, it depends on multiple actors at multiple levels of the institution.

With the acknowledgment of the existence of barriers to ICT integration in education, what are the tendencies in the study of such barriers?

2.2.2. TRENDS IN STUDIES OF BARRIERS

Research in the last few years has placed special emphasis on the study of second-order barriers. Ertmer (1999) indicates that intrinsic barriers can cause more difficulties than extrinsic ones. In this regard, the study of Blackwell, Lauricella, Wartella, Robb, and Schomburg (2013) on the interplay between extrinsic barriers and attitudes shown that extrinsic conditions and intrinsic attitudes can predict uses of technology among teachers. They argue that, no matter what technology, if personal attitudes toward technology are strong, then teachers will use it more often. The belief of teachers that ICT supports the students' learning can be considered an internal predictor of using technology. However, the results are still contradictory. In their study, Hue and Jalil (2013) found that, despite the positive attitude of teachers, the frequency of use of ICT was not very positive.

At this point, I observed a gap between the beliefs of teachers and the results in practice. Likewise, Liu (2011) reported in his study that most teachers with a learner-centred beliefs do not apply constructivist-based activities, which is in my view an important entry point for using technology. Thus, Liu proposes the perceived contextual factors as potentially affecting teachers' behaviour. Kim, Kim, Lee, Spector, and DeMeester (2013) have also highlighted the lack of research regarding the links between teachers' beliefs and the practice of technology adoption. They suggest the necessity of further studies in this regard as a way to overcome the second-order barriers. They came up to these findings with experienced teachers in technology adoption as subjects, for whom second-order barriers were not the significant. Instead, the first-order ones were more relevant. These findings place the first-order barriers back to the scene.

Ertmer et al. (2012) place the implications of their research regarding barriers, primarily in professional development. Teacher professional development has been, over time, an ally of ICT adoption in education. However, its role is twofold and complex. It is at the same time a barrier and an enabler. The next section will discuss TPD for ICT (TPD-ICT) adoption as the third component of the research foci (see Figure 1).

2.3. TEACHER PROFESSIONAL DEVELOPMENT FOR ICT ADOPTION

2.3.1. A BRIEF CONCEPTUALIZATION OF TPD

Teacher professional development (TPD) is the term used in this dissertation to refer to concepts such as staff development, faculty development, academic professional development, teachers' training, continuing education and self-improvement, among others (Coto, 2010). Perhaps, in practice, the predominant understanding of TPD is in terms of activities, such as the formal and structured courses or activities as well as the informal development of professional skills that occurs in the workplace (Dall'Alba & Sandberg, 2006). Knight, Tait, & Yorke (2006) shifted from an event-based perspective toward a situated social practice. They consider professional learning as the result of the interplay between individuals and the environment and the development in part of situated social practices. Some scholars define professional development in terms of its aims to improve practice, to develop strengths and skills, and to manage change (Bligh, 2005). Caffarella and Zinn (1999) identify three types of activities in professional development: self-directed learning experiences, formal, professional development programmes, and organizational development strategies.

2.3.2. PROFESSIONAL DEVELOPMENT TO OVERCOME BARRIERS

In Chapter 3, I presented the state of literature about the ICT adoption in education and about the existing barriers hindering the adoption. The third area of the study is related to professional development to facilitate ICT adoption. As mentioned in Chapter 2, my professional practice has been closely related to processes of professional development for ICT adoption among university professors. An essential concern in practice was the lack of a relation between training efforts and the impact on professors' practice. Similarly, the literature has pointed out the increase in access to technology and professional development opportunities (Gray, Thomas, & Lewis, 2010). Nevertheless, the results of research regarding teachers' failure to adopt technology in the classroom persist (Blackwell et al., 2014; Ertmer et al., 1999, 2012; Zhao, Pugh, Sheldon, & Byers, 2002).

Undoubtedly, to the extent that professors do not adopt technology, the expected contribution of ICT in transformation of education is even more distant. The central role of the teachers in the field is perhaps the reason why the investments of educational institutions have been oriented toward improving teachers' conditions for innovation. Teachers have been given with the essential role of being the frontier for applying technological innovations to the teaching and learning process (Goktas et al., 2009). Moreover, Ertmer & Ottenbreit-Leftwich (2010) link the technological levels of teachers with the development of skills in learners in the 21st century. What is more, the decision on whether or not to use, or how to use technology for instruction, rests essentially on the shoulders of teachers (Ertmer, 2005). Given that central role

of teachers, the institutional policies and plans acknowledge teachers' training as one of the operational components of ICT promotion in education (Kozma, 2008), particularly at tertiary level where pre-service education for future university teachers is non-existent.

However, the mere existence of professional development models or initiatives cannot guarantee technology adoption (Buabeng-Andoh, 2012). Rather, the lack or low quality of professional development has been described as one of the most important barriers to ICT adoption (Al-Senaidi, Lin, & Poirot, 2009) (see Table 2). Despite plenty of attention placed into the study of barriers and TPD, the debate is still ongoing and further research is required to understand how TPD approaches can contribute to overcoming the barriers limiting the adoption and integration of technology.

2.3.3. TPD FOR ICT ADOPTION. MODELS, APPROACHES AND PROGRAMMES

Research in the last decade indicates an increase in the number of models, approaches, strategies and programmes in educational institutions regarding teacher professional development for ICT adoption (TPD-ICT). A rising trend is the use of the Technological Pedagogical Content Knowledge framework (TPCK) (Koehler & Mishra, 2008) as a professional development approach for ICT (Chai, Ng, Li, Hong, & Koh, 2013). In this regard, Voogt, Fisser, Pareja Roblin, Tondeur, and van Braak (2013) point out that one of the main uses of the Technological Pedagogical Content Knowledge framework from 2005 to 2011 was to develop lessons or courses for teachers' development on how to teach in a technology-rich environment. In Bangladesh, Khan (2014) developed a TPCK-based professional development programme of pre-service, in-service and ongoing phases. Mostert and Quinn (2009) applied it in a professional development process for university teachers in South Africa and Finger, Jamieson-proctor, & Grimbeek (2013) argue the importance of the TPCK conceptualization in informing programmes for preparing future teachers for using technology. Despite its increasing use, some studies have criticized TPCK because of its lack of explicit definition (Rogers & Twidle, 2013), theoretical and lack of clarity in the empirical findings, precision and connection among components (Angeli & Valanides, 2009).

Beyond the spread of TPCK as a professional development approach, other model frameworks and programmes have been proposed. The digital literacy model for in-service teachers (Almås & Krumsvik, 2007) covers the development of skills, knowledge, creativity and attitudes regarding practical proficiency and teachers' self-consciousness. Van Niekerk and Blignaut (2014) presented a framework that integrates the influence of leaders as an indicator of ICT integration in teachers. Bradshaw, Twining, and Walsh (2012) developed the Vital model of TPD in ICT, which empowers teachers to identify their own TPD focus infused by peer support and collaboration. According to the authors, the model gives teachers the space to

integrate ICT in their practice, and to promote the realization of the current knowledge, planning, doing, reflection, sharing and peer collaboration.

Recently, some studies have aimed to reduce the gap between training and practice. The DBRIEF model (Dix, 2007), for instance, aims to reduce the gap between educational research and teaching practice through design-based research to promote, sustain and understand innovation in an educational context. Curwood (2013) applied the design framework with foundations in distributed cognition theory to examine a technology-focused learning community. Similarly, Coto (2010) combined a design-based research methodology with an approach based on Communities of Practice (CoP) and Project-Oriented Problem-Based Learning (POPBL) to promote change in teachers for ICT integration in higher education. Other studies reported the use of CoP as an effective professional development for ICT adoption (Coto, 2010; Kopcha, 2012; Mostert & Quinn, 2009). According to Glass, Vrasidas, and Βρασιδάς (2005), the use of Communities of Practice (CoP) grew in the decade from 1995 to 2005 as a resource for professional development.

Action research has recently been used as TPD with the aim of developing a holistic and flexible approach to ICT adoption. The use of action research seeks to develop teacher' ability to continue learning and to adapt to technological change (Phelps & Graham, 2008). Other approaches complement the mosaic of TPD-ICT. Plair (2008) applied mentoring or peer support especially for veteran teachers. Similarly, in Turkey, Kabakci, Ferhan Odabasi, and Kilicer (2010) applied a one-to-one mentoring based on transformative learning theory with special attention to the figure of a mentor who shares ICT experience with the participants in TPD. Furthermore, Kopcha (2012) reports positive results of mentoring for professional development, especially in the development of positive beliefs, as will be discussed later in this section.

2.3.4. TPD AND SECOND-ORDER BARRIERS TO ADOPTION

As stated before, the limited results in the adoption of ICT are correlated to the existence of internal or external barriers in teachers. Teacher professional development is an essential mechanism of educational institutions and researchers in studying and in overcoming barriers. In his study, Uslu (2012) aims to investigate the effects of TPD on technology integration and the attitudes of teachers toward ICT integration. After a pre and post-test, the results showed a surprising worsening of teachers' attitudes towards ICT integration after the TPD programme. The second part of the study measures the level of retention of TPD effects after six weeks. No significant differences or changes in teachers' attitudes were reported after six weeks. As with the majority of professional development initiatives, Uslu's professional development intervention was not purposefully oriented toward changing teachers' attitudes, but rather toward developing technical skills and ICT integration skills.

Similarly, a study conducted in Greece reported the results of the impact of a TPD-ICT intervention on teachers' perceptions and beliefs (Jimoyiannis & Komis, 2007). The TTICTE professional development programme was oriented toward offering teachers basic ICT knowledge and skills, in order to be able to make effective use of computer applications in their instruction. As in Uslu (2012), the intervention was not fully oriented toward the change of attitudes or perceptions. The results showed that teachers perceive ICT as necessary but there is not a clear view regarding pedagogical aspects of using it. Nevertheless, the majority of participants acknowledged the importance of knowing how to use ICT in teaching and learning.

Other studies report positive results of TPD-ICT, especially in teachers' acquisition of skills. McGarr and O'Brien (2007) found an increase of ICT use in experienced technology teachers after a postgraduate award in ICT in education. The findings suggest that although the course had an impact on teachers' use of ICT in general terms, it remained similar to the level at the beginning of the course. The results, again, bring into discussion the barrier related to the adequacy or lack of quality in professional development. Similar findings were reported in Brinkerhoff (2005), where teachers, after participating in a long-duration TPD-ICT programme, perceived an increase in their technological skills, gained confidence toward technology and acknowledged an alteration of their teaching practices. Teachers refer to a more positive attitude toward technology integration. However, the study does not demonstrate subsequent results about long-time effects of TPD. Kopcha (2012) combined teachers' mentoring and teacher-led communities of practice approaches. The results manifest a benefit of mentoring in addressing teachers' barriers to vision and access, and developing positive beliefs toward technology. However, the study highlighted the barrier of time as a negative influence. According to the theory on barriers, time is an external barrier, which is not under the teacher's control to be solved. Yet, the study reported a consistency in teachers' achievements one year after the TPD-ICT.

TPD-ICT faces particular challenges in contributing adequately to overcoming barriers to ICT adoption. According to Giavrimis, Giossi, Papastamatis, and Giavrimis (2011), successfully involving teachers in TPD-ICT demands taking advantage of ICT to use it in course preparation and teaching, taking advantage of ICT in personal life taking advantage of ICT to communicate with colleagues. The study of Giavrimis et al. (2011) showed that the reasons for teachers to participate in TPD include escaping for a period of time from the school environment, enriching their personal curriculum vitae, facilitating personal development, and because it is mandatory according to the authorities. These factors are only part of a wide spectrum of potential limitations of TPD-ICT to achieve major impact in ICT adoption. In the following section, I will present some of the more significant findings of TPD-ICT from the reviewed literature.

2.3.5. TPD FOR ICT INTEGRATION REVIEW

Most of the empirical research on the field shows positive results of TPD in ICT adoption (Goktas, Yildirim, & Yildirim, 2008). However, TPD is still one of the main barriers to technology integration in education. One possible explanation is the wide diversity of studies, research approaches, aims, levels of educational institutions, methodologies of intervention, and professional development approaches, programmes and contents.

In respect to the length of TPD activities, some research states the inadequacy of a one-size-fits-all type and short-term TPD-ICT (Uslu, 2012). This is contrasting with findings in Aduwa-Ogiegbaen (2009) where workshops, conferences and seminars are one of the preferred types of TPD-ICT, followed by courses in instructional technology. Conversely, Wang, Hsu, Reeves, Coster, and Longhurst (2014) and Plair (2008) argue for long-duration TPD in order to master technology skills, to offer teachers the necessary time for reflection in their learning and pedagogy, and to design relevant activities. Rogers and Twidle (2013) support the idea that courses must provide tools to help teachers to examine beliefs, consider that a combination between personal hands-on experience and cooperation with other colleagues is a good alternative, and argue for a combination of short and long courses with distinctive objectives.

Goktas et al. (2008) argue for a link with the curriculum, and hands-on and in-depth practice, and Lavonen, Juuti, Aksela, and Meisalo (2006) place major emphasis on empowerment, communication and context. Curwood (2013) also points to context, considering learning as a social phenomenon and argues for a shared design between teachers and TPD facilitators to overcome the traditional design of TPD-ICT focus on ICT skills development to look at learning in communities, active learning and collective participation. Phelps and Graham (2008) propose a metacognitive approach to motivate teachers and improve the impact of ICT on the culture of schools, which, according to Uslu (2012), has a great importance in realizing the change targeted by the TPD initiative.

The areas forming the foci of the study are complex separately and even more so in their mutual connections. The dichotomies between the benefits or not of using ICT in learning, between teachers' internal and external barriers to ICT adoption, the double role of TPD as a barrier and enabler, and the impact or not of TPD for ICT adoption are the spaces of reflection resulting from the review that allowed the formulation of more accurate research questions.

2.4. BACK TO THE RESEARCH QUESTIONS

The revision of literature on the areas of the research foci and the overlaps among them positioned me in a new reality regarding the problems, the current debates and

challenges of the study. My assumptions were transformed into gaps of the field that require further inquiry to improve the adoption and integration of technology:

- The historical path of a limited impact of ICT to achieve radical changes and transformation in education;
- The gap between the research results and the institutional efforts regarding ICT integration in teaching and learning;
- The lack of understanding of the linkage between first-order and second-order barriers;
- The dominant teacher-centred approach in research regarding barriers and teacher professional development;
- The lack of impact of professional development on ICT integration;
- The lack of approaches in the study of barriers and professional development that consider interactions among technologies, people, and social organizational forms and contexts; and
- The narrow impact and scarce results in practice.

After the findings in the review of literature, I made some changes in the research questions. Furthermore, while reflecting on the review, I realized the need for taking intermediate steps to answer the main question through secondary research questions. To conclude this section, I present the primary and secondary research questions guiding the study. The answer to each secondary question was a building block in addressing the following. Each secondary question guides a corresponding research paper in this dissertation (see Table 4). Answering the secondary questions is essential in order to be able to respond to the primary questions of the study

2.4.1. PRIMARY RESEARCH QUESTIONS

The primary research questions guiding the study are:

- How does professional development help professors to overcome the existing barriers in the integration of information and communication technologies for teaching and learning?
- How the empirical results can be theoretically interpreted?

2.4.2. SECONDARY RESEARCH QUESTIONS

- How do higher education professors, using or not using technology, experience the first- and second-order barriers to the adoption of technology?
- What are the contemporary challenges in the adoption of information and communication technologies for teaching and learning purposes in higher education?

- What are the contemporary challenges of teacher professional development regarding the integration of information and communication technologies in the teaching and learning process?
- How does a professional development approach based on a change laboratory intervention motivate teachers to overcome the existing barriers of ICT integration in the teaching and learning process in higher education?

Secondary research question	Paper
<i>How do higher education professors, using or not using technology, experience the first- and second-order barriers to the adoption of technology?</i>	<i>An activity theory approach to studying faculty barriers regarding technology integration in higher education</i>
<i>What are the contemporary challenges in the adoption of information and communication technologies for teaching and learning purposes in higher education?</i>	<i>From professors' barriers to organizational conditions in ICT integration in higher education</i>
<i>What are the contemporary challenges of teacher professional development regarding the integration of information and communication technologies in the teaching and learning process in higher education?</i>	<i>Challenges of professional development for ICT integration in higher education</i>
<i>How does a professional development approach based on a change laboratory intervention motivate teachers to overcome the existing barriers of ICT integration in the teaching and learning process in higher education?</i>	<i>A change laboratory professional development intervention to motivate university professors to identify and overcome barriers to the integration of ICT</i>

Table 4. Connection between the secondary research questions and the papers in the dissertation

CHAPTER 3. THE RESEARCH DESIGN

3.1. REFLECTIONS ON RESEARCH PARADIGM

Creswell (2013) refers to the worldview as the philosophical ideas influencing research, even though they remain largely hidden. To me, the influence of a form of seeing the surrounding world was not so distant or hidden. Indeed, these ideas were always present in my mind as a generator of reflections while conducting the study. In that sense, I agree with Mertens (2007), regarding that the influence of a set of basic beliefs is evident in a researcher's methodological decisions. The reflection on the philosophical dimensions orienting the study was a demanding and thoughtful task for me as a novice researcher. However, it was enlightening. It became an initial and essential step that guided me toward more suitable and coherent decisions regarding methodology, methods and tools (Mackenzie & Knipe, 2006).

The conducted review of literature provided me with not only a list of limitations to address in order to improve the adoption of technology in education but a wide perspective of the phenomenon influencing the reflections on the paradigmatic position. Some of the more significant insights after the review indicated the necessity of research in practice approaches. The lack of results is evident in the historically rooted path of efforts showing limited results. Moreover, the literature shows the necessity of surpassing the adoption of technology as merely the sum of parts as technologies, people and context with the stress in technological essentialism (Bayne, 2015). Another important insight into understanding and inquiry is the importance of surpassing the teacher-centred approach in the study of barriers and in TPD-ICT strategies to overcome barriers and the unclear relationship between internal and external barriers to ICT adoption. The presented sources of problems coexist in the contemporary efforts for ICT integration and limit the aim of transforming education with technology making of it a complex problem. Transformation is not only the promised land in the field of educational technology. Rather it is an essential principle permeating the practice at the Universidad Nacional (Universidad Nacional, 2015, p. 11) and one of the aims supported by technology. Thus, the aim of transforming education, of a collective path, of a non-binary problem or proposal of solutions, the consideration of the particularities resulting from the social context and the influence of the historical background in the contemporary formation of the reality are crucial beliefs in the study.

My initial approach to research paradigms was through Wahyuni's (2012) analysis of paradigms and their fundamental beliefs (p. 70). Even though in an early stage of the research I found myself very close to constructivism due to the subjective and social construction of the reality, this reality is subjectively interpreted and presented by the researcher. According to Mascolo (2009), constructivism is related to the idea that

individuals construct their understanding of the world as a product of their actions in the world. However, one of the challenges of the current reality in the context of UNA is the lack of understanding of the position of others, of understanding the construction of reality of other participants in the activity in which I participate. The construction of new realities is not individual, but collective. The potential of transformation in this paradigm seems to be limited because of the lack of action of the subjects. On the other hand, pragmatism seems to be closer to the promotion of actions as a basic step toward transformation. However, its ontology is oriented toward the achievement of answers to the research questions. It is restrictive in terms of developing actions in research to find solutions as a form of finding answers to research questions. As shown in the literature, the limitations in the integration of ICT are not new. Limitations and barriers have been identified for more than a decade. However, alternatives to professional development have not achieved fundamental changes or transformations. Thus, a developmental approach seems to be necessary.

The recognition of a complex, multifactorial and multi-actor problem requires compatible views of a complex world and diversity of beliefs. In the initial stage of the study, I used Cultural-Historical Activity Theory (CHAT) as a research theory. An in-depth study of CHAT pushed me to consider its potential as a world view in the study as a support in setting down the intent, motivations and expectations for the research (Mackenzie & Knipe, 2006). In the following pages I reflect on the potential of activity theory (AT) for addressing the three basic beliefs of inquiry paradigms in terms of ontology, epistemology and methodology (Denzin, Lincoln, & Guba, 1994, p. 165).

3.1.1. ACTIVITY THEORY AS AN APPROACH TO THE SOCIAL CONSTRUCTION OF KNOWLEDGE

To consider Cultural-Historical Activity Theory (AT) as a potential worldview in the study did not suddenly come into my brain. It was the result of a process of literature analysis and reflection on CHAT, its antecedents and derived theories, as expansive learning. Deeper reflections on the potentials of activity theory as a research worldview were based on the reading of the article Comment on Blackler et al. Activity Theory and the Social Construction of Knowledge: A Story of Four Umpires (Engeström, 2000). According to Engeström, AT is an original and potentially powerful approach to the social construction of knowledge (p. 301).

The aim of the following lines is to raise fundamental concepts on activity theory that in my understanding act as fundamental beliefs guiding my study. I will briefly introduce Engeström's (2000) core reflection and reflect on how the basic principles of activity theory can be understood in terms of ontology, epistemology, axiology and methodology.

Engeström (2000) clearly points out significant differences between AT and other epistemological stances such as traditional realism, constructivism and constructionism:

Many assume that, as an originally Marxist approach, activity theory represents traditional realism. Others see activity theory as a form of constructivism since it emphasizes sign-mediated interpretation of reality. Finally, some others think that activity theory is in fact constructionism as it focuses on the acting subject's potential to create reality. I maintain that activity theory differs significantly from all the three epistemologies (p. 302).

Engeström's view of AT as an approach to social construction of knowledge is similar to Curtis and Curtis's (2011) meaning of epistemology as a theory of knowledge. They acknowledge that epistemology informs how research is shaped in its broad sense. In terms of a research worldview, Creswell (2013) maintains that epistemologies and ontologies can be used as equivalent to a paradigm or worldview. To Wahyuni (2012), an epistemology is one of the fundamental beliefs that form the corpus of a paradigm.

Of fundamental importance for Engeström's delineation of AT as an epistemology is, overcoming the problem of methodological individualism in realism, constructivism and constructionism to face current social transformations. Realism, according to Phillips (1987, p. 205), is "the view that entities exist independently of being perceived, or independently of our theories about them". According to Wahyuni (2012), realism and critical realism are closely related to positivism and post-positivism with both being dominated by an objective perception of the reality. Conversely, the reality in constructivism is socially constructed and subjective. Social constructivists believe that individuals seek to understand the world they are part of (Creswell, 2013). Meanwhile in constructionism, human beings collectively construct the meanings and shared assumptions of reality (Leeds-Hurwitz, 2009). In AT the construction of knowledge and reality is no longer individual. Rather, the reality is historically and collectively constructed between humans and artefacts in interaction with others, rules and within conventions of division of labour.

A second essential element in the construction of knowledge from AT is the identification and resolution of contradictions (Engeström & Sannino, 2011). Solving a problem or surpassing a contradiction implies the transformation of the actual system, in simple terms, a form of knowledge construction. The basic element of constructing knowledge by attending contradictions must be analysed in terms of the principle of the collective activity.

Wahyuni (2012) argues that the nature of a worldview is explained through the philosophical dimensions of ontology and epistemology and by the two basic beliefs of axiology and methodology. Based on Engeström (2000), I will attempt to expand

the understanding of AT as an approach to the social construction of knowledge into a set of fundamental beliefs potentially supporting the research study.

Reflections regarding the ontology

Ontology refers to the nature of knowledge. It is about how one perceives reality (Wahyuni, 2012, p. 69). A constructivist research worldview acknowledges a reality constructed by social actors. However, the researcher is the one who interprets a social world through dialogue with participants.

In AT, the nature of reality is perceived not only as socially constructed, but also historically and collectively constructed and interpreted. A historical perception of the current reality recognizes its formation through historical accumulation of knowledge. In other words, not isolated but connected to previous moments of the reality. Historical accumulation of knowledge leads to the perception of the potential of reconstructing the reality. Moreover, the reality is perceived as collectively constructed and interpreted.

Reflections regarding the epistemology

Epistemology is related to the development of knowledge and to the view of what constitutes acceptable knowledge (Wahyuni, 2012, p. 70). As mentioned by Denzin et al. (1994), ontology, epistemology and methodology are interrelated to each other. Epistemology from constructivism, for instance, relies on subjective meaning and social phenomena (Wahyuni, 2012, p.70), and a good social knowledge is based on inside perspectives or real social phenomena from the research participants (Wahyuni, 2012, p.71).

According to Engeström (2000), AT points out toward a collective construction of meanings and social phenomena. The collective construction of meanings relies on the rationales of the collective-mediated activity system as the minimum unit of analysis as a multi-voiced source of knowledge. In addition, acceptable knowledge is constructed on the basis of systemic contradictions.

Reflections regarding methodology

Methodology is understood as the model behind the research process (Wahyuni, 2012). Denzin et al. (1994) describe it as the way in which knowledge is accumulated. For instance, it is argued that methodologies in realism are about experiments and verification of hypotheses. Conversely, constructivist methodologies are hermeneutical and dialectical (Denzin et al., 1994, p. 165).

As activity theory considers the whole activity as the research unit of analysis, the methodology of research envisages and expands dialogue among the participants in the activity – a particular dialogue of multiple voices where not only human actors but also the artefacts and rules have a voice. Moreover, the multi-voicedness does not reside exclusively between the actors in the unit of analysis but also in the internal

speech, thoughts and actions of the individuals (Engeström, 2000). Furthermore, the extension of AT to include at least two activity systems as the unit of analysis gives AT the methodological opportunity to expand the scope and dialogue. The epistemological characteristic of inner contradictions gives AT the methodological possibility of iterative transformations as a way of accumulating knowledge.

Citing Mackenzie and Knipe (2006) on the influence of a set of basic beliefs on conducting research and on guiding the researcher toward coherent decisions regarding methodology, methods and tools, in previous lines I have briefly presented the potentialities of AT to set and accomplish such beliefs. The basic principles stated above guided me through the research process.

Since my initial contact with the theory, CHAT has been very influential in my work. As mentioned above, the basic principles of the theory act as a set of beliefs guiding research. However, because of the type of research problem and the aim of the research, I decided to embrace expansive learning (Engeström, 2015) as a theoretical and methodological framework. Expansive learning has its roots in Cultural-Historical Activity Theory (CHAT), which provides the essential consonance between the worldview and the theoretical and methodological direction toward research design.

3.2. THEORETICAL FRAMEWORK

3.2.1. ACTIVITY THEORY OR EXPANSIVE LEARNING?

The short answer to introduce this section is both. The history of Cultural-Historical Activity Theory can be traced through three generations. In the study, I place special attention to the second and third generation of activity theory. Engeström (2015) named the third generation of AT as Expansive Learning.

In the exploratory phase of the study, the second generation of activity theory was essential as an analytical tool. The activity system (see Figure 3) as the unit of analysis contributed as an alternative to the predominant teacher-centred approaches in research related to the adoption of ICT, barriers and professional development for ICT. The unit of analysis and the large framework of concepts in CHAT presented a challenge toward a deeper understanding of professors' practices in teaching and learning with technology as a mediator tool. Papers II and I were written using the second generation of CHAT as a theoretical framework and as an analytical tool. In the second part of the study, the intervention phase, expansive learning became more relevant. Expansive Learning theory as a developmental theory of learning laid the foundations of the transformative approach required in ICT integration to overcome barriers and in TPD-ICT. In this section, the main theoretical foundations of both generations of AT will be presented.

CHAT has its basis in the tradition of the Russian psychology of Vygotsky, Leontyev and Luria (Engeström & Miettinen, 1999), and in classical German psychology and in the writings of Marx and Engels (Engeström, 1999, p. 20). It has been conceptualized from a range of perspectives a: a psychological theory; an interdisciplinary approach; a descriptive, explanatory and generative theory; practiced-based, historical and future-oriented; a link between individuals and social structures; and as a theory of object-driven activity (Murphy & Rodríguez-Manzanares, 2014). Furthermore, activity theory is a meta-theory of human activity understanding in different planes of sociocultural analysis (Rogoff, 1990; Yamagata-Lynch, 2010). Wertsch (1981) characterized it as an ambitious theory in terms of its broad scope.

CHAT studies human activities as object-driven, historically rooted and culturally influenced but with the potential to influence the formation of culture. According to Wertsch (1981), an activity is a unit of analysis that includes both the individual and his/her culturally defined environment (p. viii). The relation between the internal and external world of the individual is not only an analytical or explanatory tool but a means to generate new practices and promote change (Sannino, 2011). The conceptualization of the minimal unit of analysis is central to CHAT and has been evolving over the years.

3.2.2. FIRST AND SECOND GENERATION OF ACTIVITY THEORY

Engeström (2015) categorizes the evolution of CHAT into three generations. The first generation is identified around the figure of L.S. Vygotsky and his concept of a human complex, mediated act (Vygotsky, 1978). In this generation, the subject in the minimal representation of the human activity unit of analysis is individually oriented (Engeström, 2015).

The second generation, inspired by Leontyev, pushed for an expansion in the unit of analysis to consider human activity as collective. Leontyev's concept of division of labour introduces the contribution of individuals' actions to satisfying common need. In his words, the need is satisfied through the social relations of participants (Leont'ev, 1978). Engeström's (1987, p. 78) graphical approach to Leontyev's understanding of activity as collective introduces a representation of the activity system (see Figure 3) as a foundational unit of analysis in the second generation of CHAT.

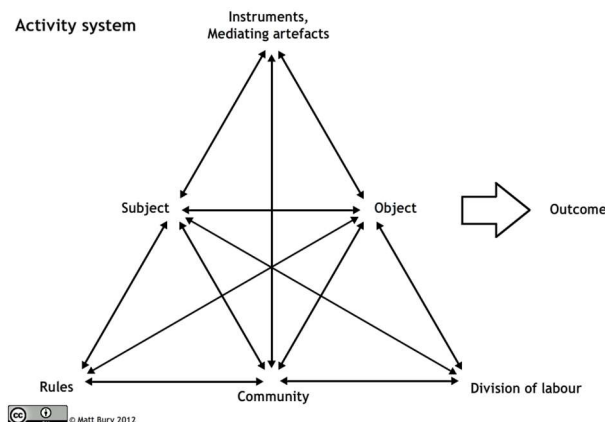


Figure 3. Activity system as representation of the minimal unit of analysis in second generation of activity theory.¹

3.2.3. EXPANSIVE LEARNING AS THEORY OF LEARNING AND DEVELOPMENT

Illeris (2009) has identified expansive learning as representing the school of activity theory. Moreover, he includes it as one of the most important contemporary theories of learning. A contemporary understanding of learning cannot be reduced to the traditional understanding of acquisition of knowledge and skills. The instructional approach to learning aims to control the process, which, in the words of Engeström & Sannino (2012) is a fallacy. The instructional approach to learning has dominated professional development for ICT adoption in recent decades. In contrast, the concept of learning today comprises emotional, social and societal dimensions (Illeris, 2009, p. 1).

Expansive learning was twofold in the study. On the one hand, as a theory to understand human activity in the complex context of teaching practice, and on the other, as a theory of learning to infuse new approaches to professional development for ICT adoption. Expansive learning postulates five principles regarding the unit of analysis, the multiple points of view of activity, the historical formation, the role of contradictions and the expansive transformation in activity systems.

The unit of analysis is conceptualized as a collective, artefact-mediated and object-oriented activity system within networked relations with other activity systems. The activity system (see Figure 3) is minimally formed by the subject, the object, the mediating artefacts, the rules the community and the division of labour as its constitutive components. The collective viewpoint in AT does not rely on the possible group formation of the subject, but rather on the substantive effect of the community

¹ By Matbury – own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=18600235>

on the activity and on the division of labour among participants. In CHAT, the subject is the individual or group whose viewpoint is adopted in the analysis (Engeström, 1990 in Murphy & Rodríguez-Manzanares, 2014). The object is the “raw material” or the “working space” at which the activity is directed (Engeström & Sannino, 2010). The instrument or mediated tools can be physical or mental and mediate subject actions over the object to achieve the outcomes (Engeström & Sannino, 2010). The community members are other individuals or groups sharing the object with the subject, and the division of labour comprises a horizontal division of tasks and a vertical division of power (Engeström & Sannino, 2010, p. 6). Finally, the rules are those explicit regulations, guidelines or similar that affect actions in the activity.

The second principle of multi-voicedness refers to participants’ multiple points of view, traditions and interests within and among activity systems. Multi-voicedness is a source of problems, but also of innovation (Engeström, 2001).

The principle of historicity recognizes the formation of activity systems as transformed over time. According to Engeström (2001), the problems and opportunities for development can only be understood against their history.

The unit of analysis, the multi-voicedness and historicity together facilitates the existence of contradictions as sources of change and development. The concept of contradiction historically accumulated existing tensions among the components of an activity system or between them.

The fifth principle is the claim of the possibility of expansive transformation in activity systems (Engeström, 2001).

Engeström (2001) argues that an expansive transformation occurs when the object and the motive are re-conceptualized toward radical new possibilities compared to a previous activity. An expansive learning process is represented in a cyclical form encompassing the seven expansive learning actions of questioning, analysis, modelling solutions, examining and testing, implementing, reflecting and consolidating a new practice (see Figure 4) (Engeström & Sannino, 2010).

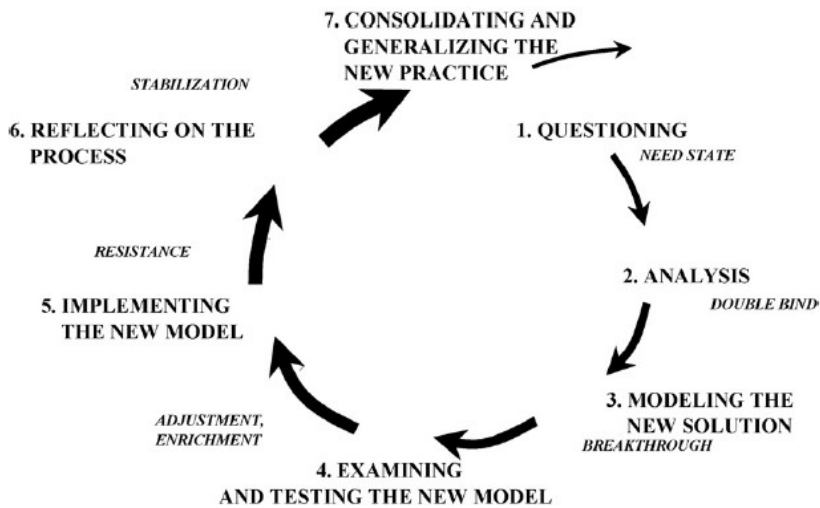


Figure 4. The cycle of expansive learning (Engeström & Sannino, 2010, p. 8).

According to Engeström and Sannino (2010), in expansive learning the learners learn something that is not yet there. In other words, the learners construct a new object and concept for their collective activity, and implement this new object and concept in practice (p. 2). The achieving of expansive learning is characterized as moving to the next level of a collective zone of proximal development (Engeström, 1987, p. 174).

The developmental potential of expansive learning relies in part on the capability of human beings to create culture. The creation of culture is a form of externalizing internal learning, which at the time is altered by the cultural surroundings through a process of internalization.

According to Engeström and Sannino (2012), Expansive Learning is a learning process that is appropriate in the radical transformation of entire activity systems (p. 53). In terms of Bateson's levels of learning (Tosey, 2006), Engeström and Sannino (2010) associate expansive learning with Learning III. While in Learning 0 there is no learning but automated responses (Tosey, 2006), Learning I implies changes in responses by corrections of errors from a set of alternatives (Engeström, 2015, p. 111). The following excerpt is a "real" situation in which Learning I can be denoted. After participating in a training course, Tosey (2006) explains:

"My course enabled me to learn a range of new skills, for example a questioning framework called 'Clean Language' (Lawley & Tompkins, 2000). Attending the course made the difference for me too between being aware of the existence of these questions (I had first come across the book some years previously) and having

sufficient understanding of them to try them out in practice. I then learnt to become more effective through correcting errors in my use of the questions (p. 7)''.

For me, this level of learning is the type of outcome achieved in current processes of professional development for ICT adoption. Then Learning II refers to changes in the set of alternatives from which the choice is made (Engeström, 2015, p. 111). To Tosey (2006), the process not only able to learn but also how to learn to learn.

The third level of learning of Bateson, which Engeström defines as being equal to expansive learning, is understood as exceeding the "self" as the core of experience (Tosey, 2006). According to Bredo (1989), the types of solutions resulting from the process of Learning III are the result of solving systematic contradictions in practice. In terms of expansive learning, the solving of inner contradictions within and between activity systems leads to a remediation and to an expansion of the activity. According to Engeström and Sannino (2010), expansion is commonly understood as positive development (p. 9).

3.3. EXPANSIVE LEARNING AS THE METHODOLOGICAL APPROACH

Mackenzie and Knipe (2006) define a methodology as the overall approach to research, which is related to the paradigm or theoretical framework. A methodology can be depicted as a systematic group of steps (Kothari, 2004) that the researchers consider appropriate for studying a research problem. Walter (2006 in Mackenzie & Knipe, 2006) highlights the importance of correspondence and influence between the research methodology and the paradigm and the theoretical framework.

Expansive learning is a collection of steps that must be interpreted as a cyclical process that explains the occurrence of specific actions of learning. In Engeström (2015), the cycle of expansive learning is presented as a methodological cycle of developmental research (p. 253) (see Figure 5). The five steps of expansive developmental research are the phenomenology and delineation of the activity, analysis of the activity, and the formation of new instruments, practical applications of new instruments, and reporting and evaluation.

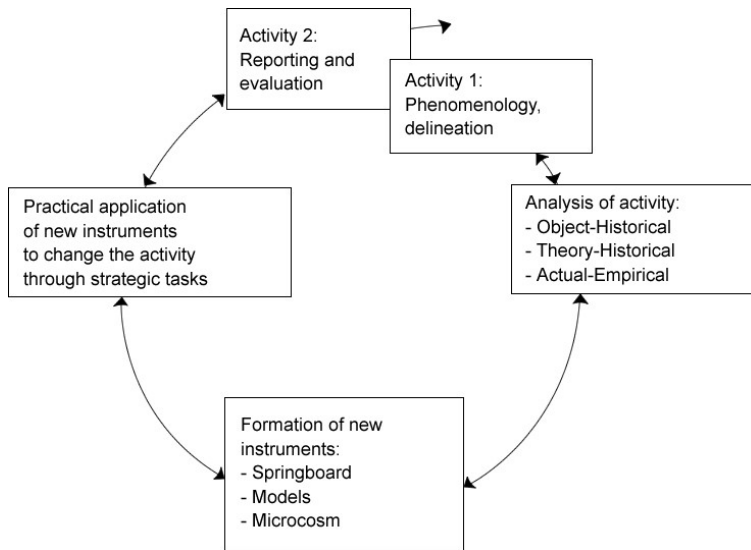


Figure 5. The methodological cycle of expansive developmental research (Engeström, 2015, p. 253).

The first step of phenomenology and delineation encompasses an initial insight into the phenomenon and a delineation of the activity system of the activity under study. This step will support the researcher's work through the realization of underlying primary contradictions. Delineation is a key task in establishing the limits of the activity.

The following step of analysis of activity is composed of three tasks: object-historical, theory-historical and actual-empirical analysis. The aims of these tasks are to define the object unit (Engeström, 2015, p. 255) for the developmental phase and a tentative model developed form of the depicted activity. A third outcome in step two is to make evident the existing inner contradictions. Moreover, of fundamental importance is leading the participants to face the secondary contradictions.

The third methodological step is the formation of instruments. Engeström (2015) identifies it as the most dramatic in terms of its importance in resolving double bind type of problems in the practice. The finding of a springboard is a significant event in which participants are involved and act as an impulse to the formation of a model and later the formation of a microcosm as the spearhead of the coming culturally advanced form of the activity system (Engeström, 2015, p. 261).

The fourth step of practical application of new instruments is applied in specific and strategic tasks (Engeström, 2015, p. 261). Such tasks are identified as potential opportunities for development. In the process of implementation or practical

application of the new instruments, new conflicts arise and participants must face them in order to accomplish practical application.

Finally, the step of reporting is the opportunity to assess the outcomes of the application of expansive developmental research. It is essential for reporting to evidence the course of the expansive transition (Engeström, 2015, p. 262). In this section, I presented an outline of expansive developmental research as the methodological approach of the study. However, in Chapter 5, I will go through further details on each methodological step with the application in practice and methodological results.

3.4. THE RESEARCH DESIGN

The design of the research study was based on the Expansive Developmental Research (EDR) methodology. In the following paragraphs, I will explain the course of actions that I applied in collection of data, analysis and intervention.

The study was organized in two phases. The first exploratory phase comprised steps 1 and 2 of EDR. The second phase of the intervention comprised methodological steps 3 and 4. Figure 6 depicts the two phases and the five steps of the research design.

As stated above, the process of reporting in expansive developmental research demands reproduction of the course of the expansive transition. In my understanding, this means that such reports must describe what actually happened in practice for every step of the methodology. Thus, it is impossible to reduce reporting to a specific section in the dissertation. In fact, every section of the dissertation reports in one way or another the results of the phases forming the research design. However, a major emphasis of reporting will be addressed in Chapter 5. It is important to mention that according to Engeström (2015), reporting in expansive developmental research does not exclude digressions in the process.

3.4.1. THE EXPLORATORY PHASE

The exploratory phase of the project encompasses steps 1 and 2 of expansive developmental research. The first step of phenomenology and delineation was carried out in the study through a process of collecting an ample set of data from the defined participants. In order to keep consistency with the results of the literature review, the initial subjects of the exploratory were faculty professors. This does not mean that they formed the individual unit of analysis. On the contrary, they were considered the subject of the activity (see Figure 3) of teaching with ICT as mediator tools aimed at the students' learning. In activity theory, the subject of the activity is the doer of the action (Oliveros, Halliday, Posada, & Bachmann, 2010).

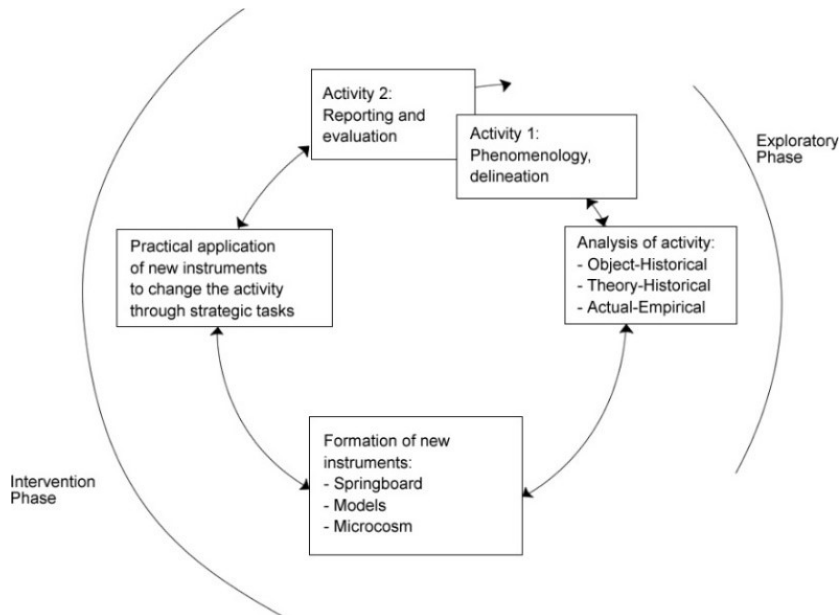


Figure 6. The five expansive learning steps and the two phases of the study (adapted from Engeström, 2015, p. 253).

The entry point subjects in the research were the faculty professors, who, according to the literature in the field of technology and education, have been identified as the most prominent actors. The central aim in step 1 was to get into dialogue with professors as a collective subject, to deeper understand their views regarding their teaching practice and on the adoption of technology. The first set of data collected from professors was then analysed, as represented in step 2 of the methodology. The analysis consisted of a comprehensive understanding of the professors' activity in terms of the activity components, such as the tools, the object, the rules and the division of labour, with special attention to the members of the community affecting their practice. A first analysis revealed the existence of multiple actors as part of the professors' community. Paper I and Paper II were the result of this preliminary analysis.

Aiming to give voice to some of the community members, the process took a step back to a new phenomenology delineation and data collection round with other actors, such as information technology (IT) staff members, faculty vice-deans, some particular middle-level departments and members of the university board. The double arrows between the steps of EDR allowed me to complete this process of moving back and forth between phenomenology delineation and analysis of the activity. After the second set of data with the members of the community, a new analysis of the activity was done using the third generation of AT. In other words, two activity systems as the minimal unit of analysis. Paper III was informed by data from this second round of

data collection and analysis. In the coming pages, I will describe in more detail the participants in the research that provided valid data and the techniques used to collect the respective data in the exploratory phase.

PARTICIPANTS AND TECHNIQUES OF DATA COLLECTION IN THE EXPLORATORY PHASE

Focus group activities with professors

The faculty professors as subjects of the activity were organized into three groups. The point of departure for selection was the classification of enthusiastic and resistant professors observed during the years of experience in my professional practice and supported by Howard & Mozejko (2015). A third type of subject participant comes from my particular interest in teacher professional development for ICT adoption. The third type of participants were professor who have participated in institutional professional development workshops and courses. The focus groups technique was used for collecting data from the faculty professors. Three types of focus groups were organized with professors according to selected profiles.

Professors enthusiastic about technology adoption formed the first focus group. The institutional department for ICT integration at UNA (UNA virtual) provided the list of potential participants. UNA Virtual maintains lists of professors that continuously develop initiatives for the adoption of technology in their teaching practice. Twenty-three faculty professors were invited to participate and 16 accepted. The 16 professors were divided into three different focus groups with enthusiastic professors. There were no participation criteria regarding age, experience, field of knowledge, faculty or level of experience in technology adoption.

A second type of focus group was organized with professors who were resistant toward technology. A list of potential participants was provided by the heads of academic departments under the assumption that they know professors' profiles in that regard. In this category of professors, 32 were invited to participate and only four accepted the invitation. As in the first case, there were no participation criteria regarding age, experience, field of knowledge, faculty or level of experience in technology adoption.

The third type of focus group was oriented toward dialogue with professors who have participated in professional development activities to adopt ICT. The institutional department of professional development (PEADP) at UNA provided the lists of participants in the last four courses related to technology in education at the time of the call. Fifty-four professors were invited, of whom four participated in the focus group. In the organization of this focus group there was no enthusiasm-resistance selection criterion. The collected data allowed me to identify other actors in the institutional dimension that in one way or other affect the professors' activity of

teaching with technology. The theoretical and methodological relevance of multi-voicedness led me to collect data from those actors. Some of the identified actors with whom it was possible to organize data collection activities were the faculty or department IT staff, faculty vice-deans, professional development department, ICT for education department, IT department and the university board.

Focus group with IT staff

In the case of UNA, the IT staff are located at the higher and middle level. There is an institutional IT department and individual IT staff for faculty and academic department level. At the time of the research, there were no relations of authority between them. In other words, each faculty has IT decentralized human resources to support technology-related activities of the department. The UNA Virtual department keeps lists of the IT staff in the university faculties. Eight IT staff were invited, one per faculty. Five of them participated in the focus group.

Focus group with vice-deans

The vice-dean is one of the faculty authorities at UNA. Together with the dean they lead the faculty regarding academic and administrative issues. The vice-dean is the one in charge of the academic responsibilities in the faculty. For this reason, they were invited to participate in the focus group representing the faculty authorities identified by professors as a hindrance to ICT adoption. An invitation to participate in the focus group was sent to every vice-dean of the eight faculties at UNA. Two vice-deans participated in the focus group.

Focus group with middle-level departments

The university functional structure has a variety of middle-level departments aimed at supporting academic and administrative actions. The following focus groups were organized because they were mentioned by professors as affecting ICT adoption and professional development.

Focus group with UNA Virtual department

UNA Virtual is the institutional department in charge of promoting ICT integration in the teaching and learning process. UNA Virtual has been considered part of the community, affecting professors' adoption and professional development. An invitation was sent to the UNA Virtual leader who was invited to participate in the complete group. Five persons formed the focus group.

Focus group with IT department

The information and technology department is the institutional department in charge of designing, developing and supporting everything related to technological infrastructure. It is in charge of network development, hardware, software and others. Because of its role as an important actor for professors, more than 60 persons distributed into two sub-departments form the IT department at UNA. An invitation

was sent to the general head of the IT department and to the two heads of the sub-departments. Two participated in the focus group.

Focus group with professional development department

The evaluation and professional development department (PEADP) is the institutional department in charge of developing, organizing and promoting professional development activities at UNA in different fields. The PEADP was mainly considered an actor in relation to professional development activities. An invitation was sent to the head of department who decided to invite three more department staff. In total, four persons participated in the focus group

Interviews with members of the university board

The university board is one of the highest levels of university management at UNA. At the time of the exploratory phase, it was formed by a rector, four vice-rectors and three directors of research, teaching and extension. For interviews, the board members related to academic affairs were selected, as follows: the rector, the academic vice-rector and the teaching director. All three were invited and agreed to participate in interviews.

3.4.2. THE PHASE OF INTERVENTION

The dialogue with professors during the exploratory phase gave me the opportunity to become familiar with concrete initiatives of professors and the position of academic departments regarding ICT integration. One professor in the department of mathematics participated in one of the focus groups with enthusiastic professors. In her/his comments, I denote a certain level of frustration regarding the collective dimension of using technology. As expected, as enthusiast professors toward technology the individual adoption was not an issue. For mathematic department, due to the specific characteristics of the curriculum, the integration of technology is an imperative. The case of the department of mathematics show up as a potential case for intervention because of the urgency of change. In the following paragraphs, I will present the context of the department as target of intervention. Afterwards, I describe the process of planning the intervention. The actual intervention and results are presented in Paper IV and in Chapter 5.

PARTICIPANTS AND TECHNIQUES OF DATA COLLECTION

According to Engeström (2015), the third step in expansive developmental research is aimed to formulating models as solutions of double bind situations. Since the literature review it was clear the necessity of research in practice and to provoke changes in professors through some form of professional development. The change laboratory method was selected as a facilitator method guiding professors to the theoretical-ideal construction of springboards, models and microcosm (Engeström, 2015, p. 261). The change laboratory method is framed into the tradition of Cultural-Historical Activity Theory. Moreover, it is aimed at developing the type of learning

envisioned as expansive (Engeström, 2015). As a formative type of intervention (Engeström, 2011) the change laboratory method is adequate for the formation of instruments to the extent that is not predetermined in terms of goals and expected outcomes. Moreover, it advocates the participants' development of agency in the construction of concepts and development of solutions.

A formative intervention is a type of experiment that differs from design laboratories from the design to the outcomes. In line with the activity theory perspective, it applies the method of double stimulation of Vygotsky (Engeström, 2015). The main differences pointed out by Engeström between formative interventions and design experiments are (Engeström, 2011, p. 606):

The starting point: In linear interventions, the contents and goals of the intervention are known ahead of time by the researchers, and the intervention itself is commonly detached from vital life activities of the participants. In formative interventions, the participants (whether children or adult practitioners, or both) face a problematic and contradictory object, embedded in their vital life activity, which they analyse and expand by constructing a novel concept, the contents of which are not known ahead of time to the researchers.

The process: In linear interventions, the participants, typically teachers and students in school, are expected to execute the intervention without resistance. Difficulties of execution are interpreted as weaknesses in the design that are to be corrected by refining the design. In formative interventions, the contents and course of the intervention are subject to negotiation and the shape of the intervention is eventually up to the participants. Double stimulation as the core mechanism implies that the participants gain agency and take charge of the process.

The outcome: In linear interventions, the aim is to complete a standardized solution module, typically a new learning environment that will reliably generate the same desired outcomes when transferred and implemented in new settings. In formative interventions, the aim is to generate new concepts that may be used in other settings as frames for the design of locally appropriate new solutions. A key outcome of formative interventions is agency among the participants.

The role of the researcher: In linear interventions, the researcher aims to control all of the variables. In formative interventions, the researcher aims to provoke and sustain an expansive transformation process led and owned by the practitioners.

CHANGE LABORATORY AS A METHOD OF INTERVENTION

In the study, the use of change laboratory can be seen as a nested expansive methodological application. While the whole study follows the steps of the cycle of expansive developmental research, also in the steps 3 and 4 the change laboratory method was in concrete carried out.

The change laboratory method follows a process of six phases (see Figure 7) aimed to achieve expansive learning actions of the expansive learning cycle (see Figure 4).

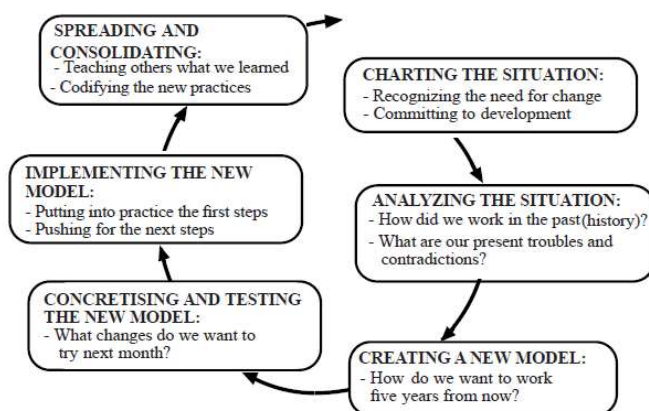


Figure 7. Phases of the change laboratory process (Virkkunen & Newnham, 2013, p. 17).

The change laboratory activities are founded on the principles of double stimulation and of ascending from the abstract to the concrete (Sannino, 2011). According to Sannino, Engeström, & Lemos (2016), the principle of double stimulation underlies to formative interventions. Formative interventions are studies in which a task is not exclusively designed by the researcher, but are interpreted and reconstructed by the subject and not strictly controlled from outside (p. 603). In the principle of double stimulation, the first stimulus is the problem itself and the second stimulus is the use of artefacts and signs with significant meaning (Sannino, 2011) to transform the activity.

On the other hand, in ascending from the abstract to the concrete a reconceptualization of the object is targeted (Sannino et al., 2016). The basic practical experimentation (Sannino et al., 2016, p. 605) in formative interventions, such as change laboratory, is fundamental to accomplishing the formation of springboards, models and a microcosm in step 3 of expansive developmental research.

The change laboratory method has developed instruments and processes to provoke expansive learning actions. The method must be carried out in a pilot unit of an

activity that is in need of major transformation (Virkkunen & Newnham, 2013, p. 15). Thus, one of the important outcomes of the expansive developmental research is the definition of the unit that is object in the developmental phase.

In practice, CL uses a set of tools for the double stimulation of participants, for the representation of the activity in past, present and future time, and to register the proposal of ideas and tools that lead to the creation of new models. A basic setting for a change laboratory intervention is depicted in Figure 8.

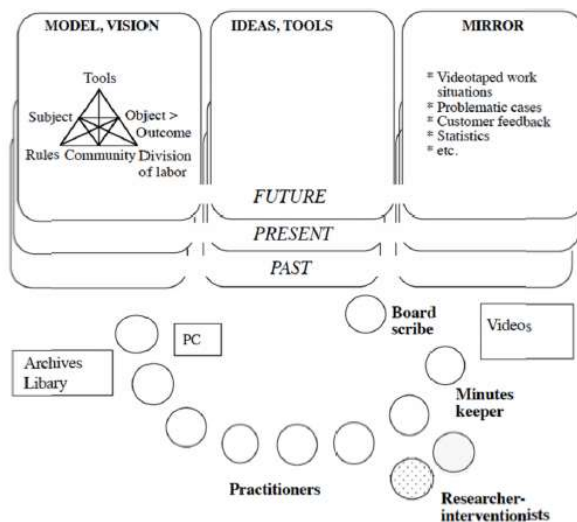


Figure 8. Change laboratory basic configuration (Virkkunen & Newnham, 2013, p. 16).

THE CONTEXT OF THE DEPARTMENT OF MATHEMATICS

The department of mathematics belongs to the Faculty of Natural and Exact Sciences at the Universidad Nacional, Costa Rica. It has two academic programmes: the bachelor degree in teaching mathematics (ToM) and service courses of mathematics (SC). The former is the main programme and is oriented toward the education of professors of mathematics for teaching in secondary education. The latter refers to teaching mathematics for other university programmes, such as chemistry and informatics, which require mathematics in their curriculum.

In the case of ToM, the use of technology is essential not only as a tool for teaching but also and most important, as content part of the curriculum. The curriculum in ToM is aimed to preparing mathematics teachers at secondary level. The Ministry of Public Education, as the regulator of secondary education, has recognized the importance of using technologies for teaching mathematics at primary and secondary levels.

According to Calderón (2017) the intelligent use of digital technologies is one of the five disciplinary axes across the curriculum. The use of technology is conceptualized as computational resources for contents development using GeoGebra in the field of Geometry (Calderón, 2017, p. 220). The importance of including technology in the university curriculum for teaching mathematics is not exclusively related to the development of technical skill, but also to the development of pedagogical skills required for teaching with ICT at secondary level. Moreover, the ability to facilitate secondary students' learning.

The necessity of transformation and the consequent challenge are evident for the department authorities and for some professors. However, the lack of action affects the department's development toward the accomplishment of the national curriculum requirements. The department of mathematics has about 60 professors plus administrative staff and authorities. The professors can teach in both academic programmes as required by the administration.

PLANNING THE INTERVENTION

According to Virkkunen and Newnham (2013), planning a CL intervention begins with dialogue between the researcher-interventionist and the leaders of the organization to delineate an initial object and unit of intervention.

In January 2016, the researcher and the head of the mathematics department had an initial Skype meeting. The plan to intervene was presented to the head of department. Moreover, the head of department shared the state of the situation in the department regarding ICT integration. Through dialogue it was evident the gap among professors regarding the interest in the use and level of adoption of technology for teaching and learning. The head of department described a large group of professors as being "resistant to change". Some possible reasons were outlined for such resistance. As stated by Virkkunen and Newnham (2013), the collection of data starts from this initial stage. In the meeting, the head of the department declared their interest and intention of making important changes regarding the limited integration of technology, primarily but not exclusively, in the ToM programme. After the dialogue, the head of department approved the intervention.

A second Skype meeting took place in February 2016. In this meeting, the group of participants was discussed and agreed. The group consisted of 14 professors from both academic programmes, ToM and CS. A balance was sought between professors willing and less willing toward adoption of ICT.

The participation of professors was not voluntary. They were called to participate because, according to the head of the department, an open and voluntary participation would not be succeed. The professors were offered with the external motivation of obtain a certificate. The certificate granted points that accumulated, helping professors to grow in the academic development institutional system at the time.

The second phase of the Change Laboratory intervention is the intervention itself. First, a set of preparatory data was collected to obtain a better understanding of the current situation, to be used as mirror data during the intervention and for planning the first session.

Preliminary data were collected through one focus group with the professor participants. Moreover, one focus group was carried out with students of the bachelor programme in the teaching of mathematics. Four students participated in the focus group. They were selected voluntarily from different courses in the ToM programme. Furthermore, two separate interviews took place with two graduate students of the ToM bachelor programme that were already working as higher education professors. Finally, a meeting with the head and assistant head of the department took place before the beginning of the CL sessions.

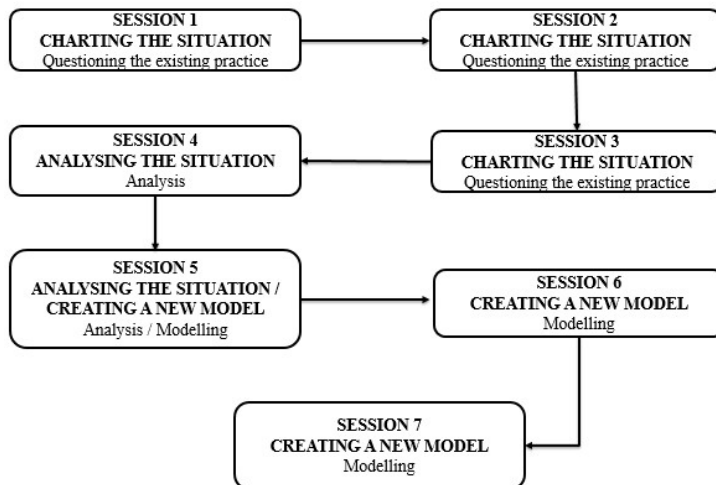


Figure 9. Relation between the CL sessions and the corresponding change laboratory phase.

Afterwards, seven sessions of two hours each were carried out during the spring of 2016. A description of the sessions will be reported in the next section. Finally, one follow-up session was scheduled but not executed due to time limitations. According to Virkkunen and Newnham (2013), only the first session can be planned in advance based on previous data. The following sessions were planned based on the previous participant's agreements. Figure 9 depicts the seven sessions carried out in the department of mathematics at UNA and the corresponding phase of the change laboratory process achieved.

CHAPTER 4. A PATH OF QUESTIONS, ANSWERS AND FURTHER QUESTIONS

After an explanation of the research design and phases of the study, in this chapter, I report in detail the actions carried out in every phase and step of the research design, how the data were collected and analysed and the corresponding findings. Following the expansive transition of actions of EDR, I first present the phase of the study and then the corresponding step within every phase. For each step, the findings will refer to one or more of the articles forming the dissertation. The full papers can be reviewed in a separate publication. However, here I include subsections with reflections on the main findings of every article, in order to propose answers to the research questions. I also add complementary reflections beyond the papers, not reported due to space limitations and to paper goals. Afterwards, I raise further questions or challenges arising from the reflections in every step of the methodology that were important to consider further in the study or in further research.

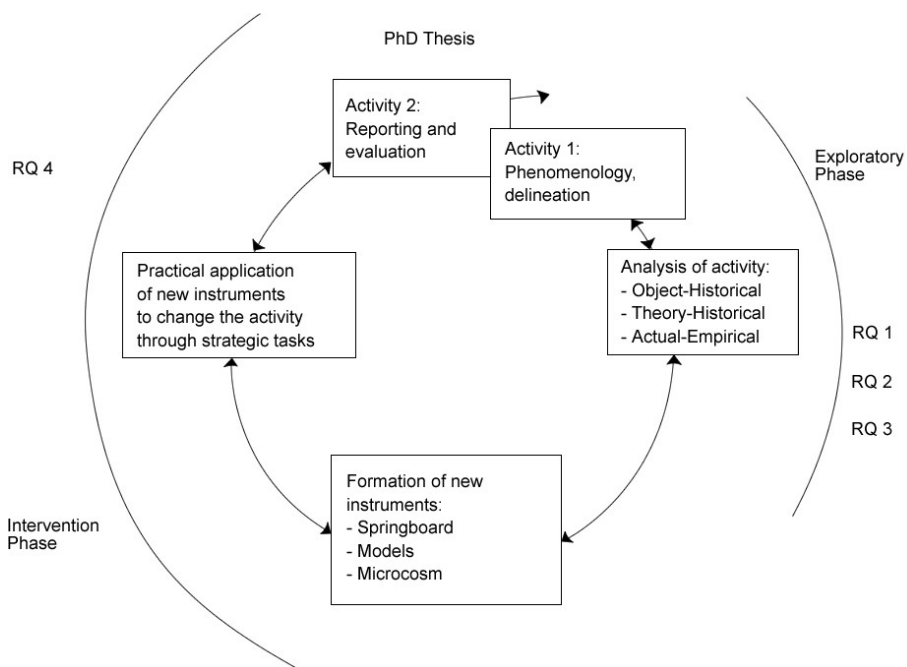


Figure 10. The two phases of the research, the steps of expansive developmental research and the research questions.

The data and analysis carried out in the exploratory phase were the basis for answering the first, second and third secondary research questions. The data collected and analysed resulting from the phase of intervention were the backbone for structuring the answer to the fourth secondary research question (see Figure 10). In this chapter, I mainly cover step 5 of reporting in expansive developmental research. The report will go through the phases, zooming in to describe every phase and zooming out to move between phases.

4.1. THE PATH OF EXPLORATORY PHASE

As shown in Figure 6, the first phase of the research comprises the steps of phenomenology and delineation, and analysis of the activity. Both are complementary and interact with each other in order to develop a better and more profound understanding of the phenomenon.

4.1.1. PHENOMENOLOGY AND DELINEATION

The first step of the exploratory phase was phenomenology and delineation. The phenomenological insights (Engeström, 2015, p. 253) were gained through the data collection techniques of focus groups and semi-structured interviews (Qu & Dumay, 2011). The focus group with professors was the point of departure as they were the primary subject in the research. The dialogue with professors who were “enthusiastic and resistant” to technology was primarily based on their experience regarding the use of technology in practice. The data were collected to delineate a basic configuration of professors’ activity system of teaching with technology. A special emphasis was placed on what professors identified, explicitly or implicitly, as their goal or object of their activity, as well as some expected outcomes and related motives of teachers when they adopt technology. Some parts of the dialogue were oriented to reflect on professional development for ICT adoption. The data collected allowed me to identify rules, members of the community and division of labour, which are all part of the professors’ activity of teaching with technology in daily life at UNA.

According to Engeström (1990 in Murphy & Rodríguez-Manzanares, 2014), the subject in the activity system is the individual or group whose viewpoint is adopted in the analysis. The configuration of the groups was previously discussed in this dissertation in section 4.2.2. The three types of focus groups conducted included enthusiastic and resistant professors and professors that participated in professional development activities aimed at ICT adoption.

During the configuration of the groups, I noticed that the focus groups with professors who were enthusiastic about technology were rapidly filled out. On the other hand, with resistant professors was not simple and only four of the 32 invited agreed to participate in the focus groups. With regard to the third type of focus group with

professor participants in professional development in ICT, 54 professors were invited and four finally participated.

The participation in focus groups to some extent was as expected. It is expected that an enthusiastic professor will show more interest in participation than a resistant one. However, the question of the underlying reasons causing the differences between participants came into reflection. Moreover, how do these underlying reasons influence professors' behaviour in relation to participating in activities related to ICT adoption? These questions and the first secondary research question supported my interest to understand the barriers of faculty professors, enthusiastic or resistant, regarding the integration of technology.

Phenomenology and delineation are not separate tasks. Conversely, delineation starts from the first contact of the researcher with the sources of data. The identification of the boundaries of the activity (Engeström, 2015) is not a static and one-time task, as long as its constitutive components may change. According to Murphy and Rodríguez-Manzanares (2014), the objects may change the activity and are susceptible to change. Delineating the activity was, for me, an essential exercise in order to understand the subjects' surrounding reality for further analysis and decisions in the study.

The first iteration of delineation contributed with three types of activity systems according to the subject participating in the focus groups. As mentioned before, enthusiastic professors, resistant professors and professors that had participated in TPD activities. The first two activity systems indicate the configuration of the activity of teaching, with technology as a tool, for enthusiastic and resistant teachers. The third activity delineates the activity of professors' professional development for ICT adoption.

The configuration of the activity of teaching for enthusiastic professors

For enthusiastic professors, the object that gives direction to their activity is the students' learning. The main object of professors when introducing technology as a mediator tool remains the same. In other words, the professors consider technology as a support to improve the students' learning. However, the object is not fixed or unique for the collective subject of teachers. Rather, other objects arise as secondary objects that coexist with the primary one or become the primary object when using technology. For one of the participants, one of the reasons for using the virtual room is because it is possible to design the course once and reutilize it in the next semester. In other cases, it is difficult for professors to determine which object is primary. For some professors, when technology is introduced as a mediator tool, the object is not necessarily the improvement of students' learning, but rather improving their teaching and becoming a better teacher. The differences in the goal can affect professors' decisions on what technologies to use and how to use them. However, the differences in objects do not affect enthusiastic professors' decision regarding the use of

technologies. Rather, aspects such as rules, community or division of labour have more impact on enthusiastic professors' adoption of technology. In the study, enthusiastic professors identified a significant number of rules and community members limiting adoption and integration. Figure 11 depicts a basic configuration of the activity system for enthusiastic professors using technology for students' learning as the central object.

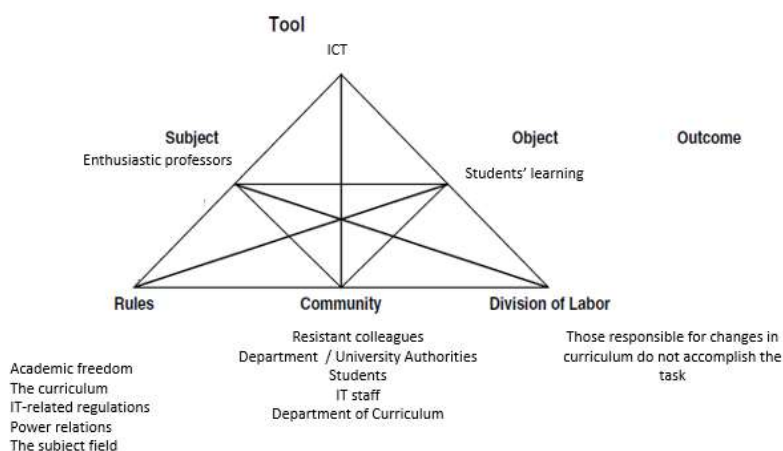


Figure 11. The basic activity system for enthusiastic professors at UNA (adapted from Engeström, 2015, p. 63).

The configuration of the activity of teaching for resistant professors

For resistant professors, the goal of the activity is not very different from that of enthusiasts. The main object of their activity of teaching is also the students' learning. However, they do not see technologies as a relevant tool to mediate it and to achieve the expected outcomes. They prioritize the use of traditional tools. The rules, the community and the division of labour are also causes of total or partial resistance toward the adoption of technology. Figure 12 depicts a basic configuration of resistant professors to technology.

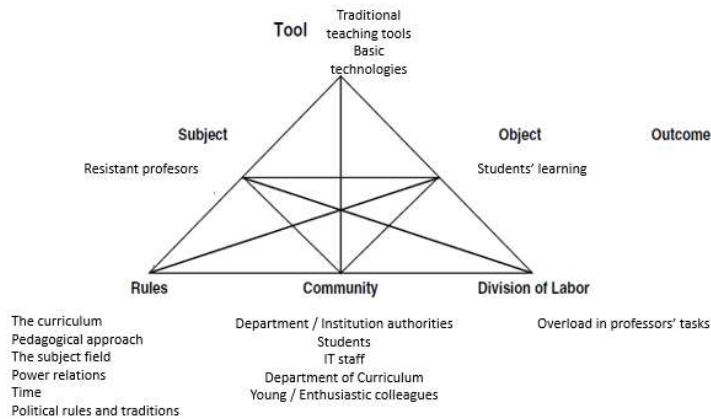


Figure 12. A basic activity system for resistant professors at UNA (adapted from Engeström, 2015, p. 63).

The activity of professional development from professors' perspective

A third activity system delineated is the activity of professional development from the professors' point of view (see Figure 13).

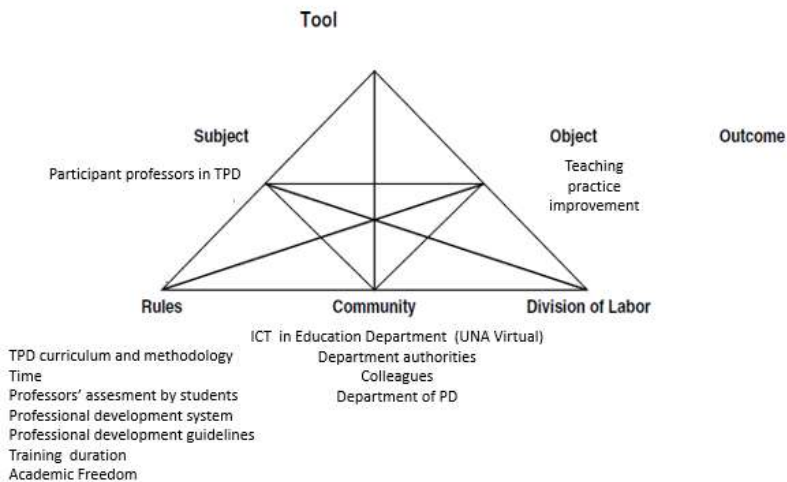


Figure 13. A basic activity system of the activity of professional development for ICT adoption at UNA (adapted from Engeström, 2015, p. 63).

The task of delineation of the activities facilitated the emergence of further reflection and questioning. For instance, having defined the components of the activity that influence professors' adoption or not of technology, it became essential to obtain a deeper understanding of how the rules, community and division of labour affect enthusiastic and resistant professors' adoption of technology in teaching activity. The

three previous representations of professors' activities regarding ICT adoption and professional development for ICT adoption are central to the coming methodological step of analysis of activity, to answering the research questions and to taking major decisions in the research process. The process and findings in phenomenology and delineation are the raw material for Paper I: *An activity theory approach to study barriers of faculty regarding technology integration in higher education*.

Further reflections on Paper I

Activity theory in its second generation is the approach used to study the barriers of faculty professors to technology integration. The paper aimed to explore mainly the barriers faced by enthusiastic professors to using technology. The paper first characterizes the enthusiastic professor in terms of their attitudes using the ABC model of attitudes (Jain, 2014); second, it delineates the potential factors affecting enthusiastic professors in their adoption of technology; and third, it describes some of the problems that these types of professors face in the adoption process.

According to Blackwell et al. (2014), the positive beliefs of professors regarding the use of technology are a predictor of positive adoption. It can be acknowledged that the so-called enthusiastic teachers do not experience second-order-type barriers or they can easily take actions to overcome them. For instance, one of the most important second-order barriers in the literature to adopting technology is the professors' lack of confidence (Al-Senaïdi, Lin, & Poirot, 2009; Bingimlas, 2009). The findings in Paper I showed that the affective dimension of enthusiasts of technology indicates that they have feelings of dominance and superiority over technology. Moreover, they are not afraid of using technology or trying new technologies. Something similar occurs with the lack of motivation (Almekhlafi & Almeqdadi, 2010; Goktas et al., 2009). The analysis in Paper 1 describes the use of technology as a passion that motivates professors' practice. Table 5 shows how the attitudes found in enthusiastic professors evidence that second-order barriers are not significant for them in ICT adoption.

Second-order barrier	Enthusiasts' attitudes in the affective dimension
Lack of motivation	Passionate toward technology
Attitudes and beliefs do not support ICT adoption	Openness to learning
Second-order barrier	Enthusiasts' attitudes in the behaviour dimension
Teachers' lack of interest	Problem-solving oriented, participatory, explorers, curious

Lack of ICT competences/skills	Permanent participants in professional development activities
Second-order barrier	Enthusiasts' attitudes in the cognitive dimension
Lack of relevance to the professor's discipline	Intention to expand the integration in their field
Resistance to change	ICT as essential for teaching

Table 5. Second-order barriers and the corresponding manifestation of enthusiastic professors' attitudes

As shown, a professor called enthusiast, shows positive attitudes toward technology, and as a result, they do not experience intrinsic barriers to technology.

Recent literature has shown that the relation between positive beliefs and frequency of use is not always positive (Hue & Jalil, 2013). Similarly, it has shown that even professors with positive beliefs face limitations in ICT adoption. This is more evident when the enthusiastic professors attempt to innovate by surpassing the individual level. The presence of other actors at the same level or at higher levels affects their practice of teaching with technology. When internal barriers are mostly solved, the main types of problems that affect enthusiastic professors are external to them. These findings are similar to those in Ertmer et al. (2012) showing that among professors where second-order barriers were not primary, first-order barriers were more relevant.

Paper I explains, from an activity theory perspective, why this occurs. As previously mentioned, the barriers to enthusiasm are closely related to first-order barriers described in the literature, such as a lack of equipment, lack of time, lack or low quality of training, lack of policy and lack of support (Bingimlas, 2009; Buabeng-Andoh, 2012; Goktas et al., 2013; Panda & Mishra, 2007). Although the limitations are external, they have an internal impact on the affective behaviour and cognitive dimensions of professors' attitudes. A third-party individual or department in the institution has normally solved first-order barriers. Enthusiastic professors in the study experienced negative feelings toward technology adoption when success depended on third-party individuals or groups. Paper 1 showed that the levels of enthusiasm decreased after some time struggling with problems caused by others. Feelings such as loneliness or disappointment can even lead professors to affect their actions of adoption. Some professors decide to reject using technologies because external problems are not solved. In the best case scenario they remain at the same level of adoption without intending any change or innovation. Repeated negative experiences may influence professors' beliefs regarding the adoption of technology. In the article, enthusiastic professors referred to technology as a demanding activity. Based on the results of the study, I started to question the suitability of labelling professors with

regard to technology adoption. It cannot be asserted that professors who are enthusiastic about technology will always be enthusiasts. On the contrary, there is a possibility that enthusiasm will be reduced. In sum, enthusiastic professors are not free from experiencing second-order barriers. This finding has implications for institutional policies and strategies for ICT adoption, in the development of professors' standards regarding ICT and in teachers' professional development models.

Enthusiastic professors experience changes in attitudes when other actors participate in their activity. Even in the classroom, at the lower level of professors' practice others affect the activity of teaching. However, at the classroom level the professor has control over most of the variables.

Activity theory as an analytical tool allowed me to identify the members of a community that influence in different ways professors' activity of teaching with technology. According to enthusiastic professors, resistant colleagues significantly influence their activity of teaching with technology. Moreover, in the case of UNA, they felt that the IT institutional department and the university authorities at the middle and higher levels introduced limitations to their practice. Other departments at the middle level of university management also affect technology adoption even though they are not primarily related to teaching or technology. The identification of others affecting professors is intimately related to the division of responsibilities in the activity and the institutional rules emitted by community members. Paper 1 led me to realize the complexity in the configuration of professors' activity of teaching with technology and the need to study the phenomenon from a more comprehensive perspective and the development of potential solutions.

Finally, the paper introduced the possibility of studying the limitations in the adoption of technology for enthusiastic professors through the manifestation of tensions and contradictions. Engeström (2015) introduces four types of contradictions. A first level of contradictions is evident within each component in the activity – in other words, dilemmas or conflicts arising in the internal reflection of the subject on their own practice. In the study, enthusiastic professors showed critical reflections on their own work in terms of the quality of ICT adoption, how the pedagogy has changed or how significant technologies are in terms of students' learning. According to Russell, (1996), professors move through different levels in learning to use technology from awareness to creative application in new contexts. A first level of limitation in enthusiasts emerges in the intention of professors to progress through the levels of adoption. The first form of tension in potential contradictions emerges then in the form of the technology use value and exchange value – in other words, the use of technology for students' learning against the use of technology as a commodity.

However, a second type of tension, dilemma or conflict between the enthusiastic professor and "the others" affects the progression through levels of adoption. As

mentioned before, those others are the members of professors' community. The complexity of the enthusiasts' activity of teaching with technology lies not only in the identification of their community but in the relation and mutual affection toward each other.

It is evident enough that the professor has no control over the members of their community, or the rules or the problems in the division of labour. Hence, the dilemmas or conflicts with other resistant colleagues or with the university board can be classified as external or first-order barriers. The limitations provoked by resistant colleagues are not acknowledged in the reviewed literature on first-order barriers. Furthermore, according to Ertmer (1999), first-order barriers are easy to measure and relatively easy to eliminate once money is allocated (p. 50). However, the barriers resulting from the effect of resistant professors cannot be solved by allocating money. This finding shows that a complex configuration of professors' activity of teaching with technology also supposes a complex interaction among the constitutive activity components and the barriers resulting from such interaction.

Reflections beyond Paper I

Other findings were not addressed in Paper I because of space limitations. Paper I was oriented toward understanding in more detail the enthusiastic professors' characterizations, the activity system configuration and barriers. However, the focus groups with resistant professors also showed results regarding their characteristics and attitudes to technology. Similarly to enthusiasts, the so-called resistant professors must not be labelled as such without an extensive understanding of the reasons limiting their adoption of technology. Using the case of a resistant professor, I placed special attention on the underlying reasons for such an attitude of resistance toward technology. According to the analysis, resistant professors are not necessarily responsible for the lack of adoption. Briefly, in Paper I, I point out that resistant professors express signals of conflict among emotions, behaviours and beliefs regarding the adoption of technology. The attitudes are not in all cases radically negative and they can change in certain conditions. In the dialogue with the professor, she/he identified himself/herself as being resistant to technology. However, the resistance in this case was not historically rooted:

T12: I am one of the oldest professors, relatively old. I started working here in year 2000. I have been a professor since 1995 when the technology was the overhead projector of transparency films to project on the blackboard or on the wall. Here I took a course about how to use the transparency film and how to improve it and techniques with paper.

The professor in the excerpt was not fully resistant to technology in the past but he felt he was lagging because of the accelerated advance of technologies. Other factors that aggravate the lack of adoption in this case were the professor's pedagogical beliefs (Ertmer, 2005) and the lack of readiness in the curriculum for ICT.

Nevertheless, resistance is not necessarily rooted in professors' beliefs. In the case referenced in the excerpt, the professor showed an interest in learning to use technologies. However, some external reasons impeded the action to learn, such as a lack of time for professional development. In resistant professors, there exists a combination of first-order and second-order barriers limiting adoption. This is in contrast to findings in research pointing at internal barriers or beliefs as the fundamental target to foster technology adoption (Ertmer, 2005). I support the notion that resistance is not uniquely caused by professors' internal beliefs. On the contrary, it can be nuanced with a combination of internal and external factors. In some cases, professors can be considered to be resistant when they have a lower level of adoption. In one of the focus groups, the professor of the case realized that they were not as resistant as they thought. In several sections of dialogues, they evoked situations in which they used technology:

T12: Well now that you mention it. Within this psychodrama programme, we have a spontaneous theatre group, and now that you say it, we have a Facebook group and WhatsApp, and in fact, I do not know how I would live without that type of communication. Now I realize that I do unconscious things. I am applying technology but otherwise, to agree

Similarly to enthusiasts, the resistant professors in the study showed major congruence among their feelings, conduct and beliefs toward technology adoption. However, the attitudes can change in both directions and resistant professors can become users and enthusiasts can become passive. These initial findings were a primary approach to the nature of professors' barriers to ICT adoption. It has implications not only for further studies of barriers but for the design of professional development taking into account the types of participants at whom TPD is aimed.

4.1.2. THE ANALYSIS OF ACTIVITY

Engeström (2015) suggests dividing the analysis of activity into three: object-historical analysis, theory-historical analysis and actual-empirical analysis. Because the exploratory approach of the first phase in the study was aimed at gaining knowledge, primarily about the current activity, I focused on the actual-empirical analysis. The empirical analysis worked as an analytical tool to depict the current relations among the components found in the previous step of delineation. The focus on actual-empirical analysis does not exclude the fact that some historical and theoretical elements emerged to complement, support or better explain findings. For research purposes, the analysis of activity is oriented toward revealing potential tensions within and between the activity system components. This means that in this phase both the units of analysis of the second and third generation of activity theory were used.

Expansive developmental research is not a linear process. On the contrary, it allows the researcher to step back as required by the inquiry. The delineation of the activity

required the phenomenology step to be expanded to include the voices of professors' members of community that from their perspective affect their activity of teaching with technology as well as the activity of professional development for ICT adoption. It was possible to collect data from members of the university board, the IT institutional department, IT department staff, the professional development institutional department, the ICT for education institutional department (UNA Virtual) and faculty vice-deans. More details about the configuration and techniques used with these subjects are described in Section 4.4.2. The data sets were selected and analysed in order to answer the research questions. Moreover, to gain further insights to delineate the next steps in the research design.

In the previous step of phenomenology and delineation, the activity system of both "enthusiastic and resistant" professors caught my attention. According to Engeström (2005), the object, in AT, carries or embodies the true motive of the activity. In the case of "enthusiastic and resistant" teachers, the data showed that the main object of activity is students' learning. A fundamental difference between them regards the tools they use to mediate that learning. The enthusiastic professors identify information and communication technologies as fundamental resources to facilitate learning. Resistant professors dispense with ICT as a tool to mediate students' learning. However, both see their practice altered by formal or cultural guidelines, other individuals or groups in the institution and the distribution of tasks among them. According to the step of delineation, rules and community members affect both enthusiastic and resistant professors. The former are affected in their intention to adopt technology and the latter are affected in their intention to avoid the adoption of technology.

The main concern turns into what the barriers are affecting not only resistant professors, but also enthusiastic professors in relation to the organizational rules, community and division of labour. As shown in Paper I, enthusiastic professors are not free of limitations. However, their limitations are not internal or individual. On the contrary, limitations arise when the activity of adoption becomes collective. Barriers or limitations will be approached through the concepts of tensions and contradictions within the tradition of activity theory. Paper II, From professors' barriers to organizational conditions in ICT integration in higher education, aims to focus on the tensions emerging among subjects and other constitutive components of the activity such as rules and community.

Further reflections on Paper II

Paper I stated that external barriers of professors to adopting technology influence, at a certain level, professors' beliefs regarding technology adoption. The results suggest that the absence of second-order barriers in professors is not sufficient to take the adoption for granted. The findings in Paper I showed that the existence of institutional individuals or group actors, rules and organization of work limited their processes of adoption. However, the nature of such limitations was not addressed.

Paper II aims to deepen the manifestations of external barriers as obstacles in willing professors to the process of adopting technology for teaching and learning purposes. The delineation of the activity system for willing professors (see Figure 10) is taken as a basis to explore professors' limitations. The limitations were analysed using the concept of secondary contradictions of activity theory that occurs between the components of the activity (Engeström, 2015).

Paper II shows that professors willing to adopt technology are affected by members of their community. Thus, professors do not act in isolation (Blin 2005 in Murphy & Rodríguez-Manzanares, 2014). In other words, there exist persons or groups that share some of the same effort in relation to the object (Liaw, Huang, & Chen, 2007). As regards the adoption of technology, the article stresses professors' colleagues, the students, the institutional department of information technology, the university authorities and other middle-level administrative departments as sources of barriers. Barriers related to members of the community can be categorized as external to professors to the extent that they are not related to their underlying beliefs on teaching and learning (Ertmer, 1999). A non-exhaustive list of external barriers includes: the lack of technological resources, ICT not fitting in curricula, a lack of time and insufficient training, as well as technical faults, a lack of faculty rewards. Moreover, the lack of technical support, the lack of institutional support, the lack of leadership, crowded classrooms, the lack of technology plans or policy and the lack of sharing best practices (Almekhlafi & Almeqdadi, 2010; Al-Senaidi et al., 2009; Goktas et al., 2013, 2009; Groff & Mouza, 2008; Panda & Mishra, 2007; Pelgrum, 2001; Schoepp, 2005; Wood et al., 2005).

Not much literature has approached individuals or groups of members of professors' community as sources of limitations or as limitations in themselves. However, institutional characteristics or culture, and student-level issues have been mentioned but not studied in depth (Buabeng-Andoh, 2012; Groff & Mouza, 2008). Professors unwilling to use technology have not been studied as a barrier for willing ones. The unwillingness of some professors toward technology inhibits the adoption in willing professors as well as at the department level. According to Toledo's (2005) five-stage model for computer technology integration into the teacher education curriculum, the fifth stage of system-wide integration requires increases in faculty and students' enthusiasm for integration. Moreover, the willing vs unwilling tension is an inhibitor of development in levels of adoption and integration of technology.

The tension that arises between willing professors and members of the community is in two opposite directions. In the case of willing professors, they aim to integrate technology, and unwilling professors aim not to integrate when the integration affects their status. The complexity of the activity of using technology for willing professors can be depicted as complex, in the sense that it receives opposition from several members of the community from different levels of the university (see Figure 14).

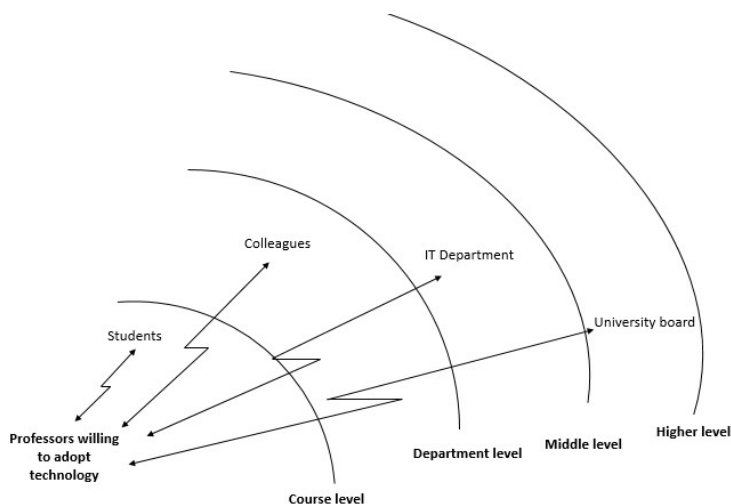


Figure 14. Existing tensions between professors and the community across university levels.

A second topic addressed in the article is the role of rules in limiting professors' adoption of technology. Rules in CHAT are explicit and implicit norms, conventions and social relations within a community (Kuutti, 1991). The relation between the subject, the community and rules is evident in the adoption of technology. Paper II indicates that some individuals or groups in the community are responsible of issuing the rules that limits adoption. The issuing of rules also surpasses the institutional levels. Rules, explicit or non-explicit, are not a detached means or mechanism that intends to affect adoption on purpose. On the contrary, explicit rules respond to the historical moment in which they were created as tools to mediate an activity. Non-explicit rules are also historically delineated through the cultural formation of groups. Potential limitations or tensions exist as secondary contradictions between the professors and the community and professors with rules. However, according to the article, a third-party tension was observed. For instance, technology regulations affect professors' adoption of technology in practice. The IT institutional department issues technology regulations. Rather than observing two different tensions against rules and the community, the tension is formed by the participation of three actors: willing professors, the IT department as a member of the community and the rule itself. As a community, members and rules can differ from department to department, from faculty to faculty and from university to university, and the study of limitations should be conducted in context. Many other rules and community members can be added to the activity system or systems. As activity systems are dialectic and multi-voiced in principle, the study of barriers to ICT adoption will be better understood if both principles are acknowledged and addressed. In traditional approaches to barriers such as an internal-external approach, the latter are not deeply addressed regarding their causes and effects. The contemporary challenges to overcome in ICT adoption and

integration are collective rather than individual. Instead of focusing on the individual limitations, they should be understood and addressed in their relations and mutual affections. In terms of barriers to ICT adoption, the lack of policies is an important external barrier. As an external barrier, and according to theory, it is expected that the professors do not participate in solving the barrier. It is expected that the management level of the organization is responsible for emitting policies. However, as the paper has shown, the separation in the goals of management level and professors' practice result in non-appropriated rules. Furthermore, if the approach is individual, a misleading division of labour can affect the whole activity.

Reflections beyond Paper II

Of essential importance to me was realizing the significant influence of others in professors' activity. However, Paper 2 collected the professors' perception of others and not the perception of others of the activity. The activity in CHAT traditions is dialectical and a driver of change (Roth, 2004). Furthermore, a better understanding of the complexity of adoption and integration of technology and the barriers that limit them must not be circumscribed to professors' perception. Here was of relevance to me, more than before, the verse credited to Ramón de Campo Amor that says:

“... nothing is true, nothing is falsehood:

All is according to the colour

of the crystal one looks through.”

Further data were collected from members of the professors' community to see the problem from the others' crystals. Activity theory has the mechanisms to facilitate the exploration and promote changes in a multi-voiced and complex reality. Expansive learning as a third generation of activity theory introduces the interaction between two activity systems as the minimal unit of analysis (see Figure 15). It recognizes not only the complexity of a central activity but also the complexity of other components of internal activity systems and the complexity of the interaction between them.

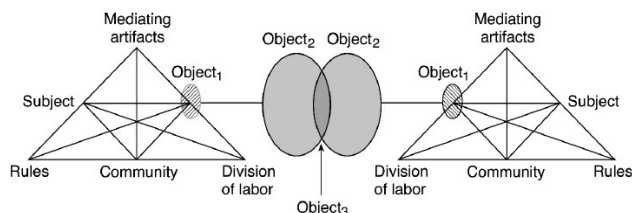


Figure 15. Two interacting activity systems. The minimal unit of analysis in expansive learning (Engeström, 2001, p. 136).

The expansive learning unit of analysis allowed me to put in a common place the different views on ICT adoption and integration from the perspective of those involved in the process. As shown in Papers I and II, professors are not the only actors in the activity. Rather, other individuals and groups influence their practice. Hitherto the limitations have been approached from teachers' perspective in relation to themselves and others. However, it is important to acknowledge a higher level of complexity in the interaction of two activity systems and allow the subjects to enter into dialogue.

Further questions

The presence of other actors influencing teachers' activity led me to question why external barriers such as, for instance, a lack of technical support exist in literature and are still a contemporary barrier affecting professors. Why, as an external barrier is not solved by the simple act of hiring more IT staff? Is the simple act of hiring IT staff the solution for overcoming such a barrier?

Paper III, Contemporary Challenges of Professional Development for ICT Integration at Universidad Nacional, Costa Rica, explores in depth the nature of the relationship between professors' activity of adoption of technology and other actors in the community. Furthermore, it also provides some ideas on how professional development can address the complex configuration of barriers to adopting and integrating technology. Paper III is the result of the step of analysis of activity in the methodological cycle of expansive developmental research (see Figure 5).

Further reflections on Paper III

With the members of the community identified by professors and delineated in step 1 of phenomenology and delineation (see Figures 11, 12, and 13), Paper III resembles a dialogue between professors and the members of the community. The three types of professors, willing, not willing and participants in TPD, took part in the dialogue. The paper aimed to show the opposite positions that occur between actors of human activity regarding a shared or partially shared object.

The relation between professors willing and unwilling to adopt technology particularly attracted my attention. As found in Paper I, willing professors must not be labelled as willing permanently and unwilling professors do not intend to be unwilling for ever. In Paper II, a mutual affection between both was suggested. Paper III makes evident the contrary direction of actions between both regarding the integration of technology. A basic minimal interaction between willing and unwilling professors' activity systems was built upon the collected data in the exploratory phase and is depicted in Figure 16.

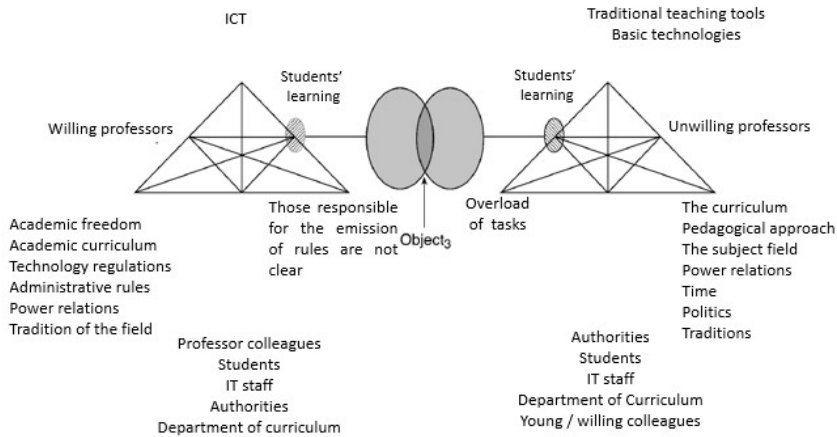


Figure 16. Willing and not willing professors' interacting activity systems (adapted from Engeström, 2001, p. 136).

An essential finding in the study is that both willing and unwilling professors share the students' learning as their object of activity. However, what is different for them is the types of tools that they use to mediate the students' learning. According to Castro (2016), the expected attitude of a willing professor to technology is a combination of positive feelings, behaviours and beliefs toward it. Thus, the decision on how, or what tool or instruments are used, to mediate learning is different from one to another. Moreover, the decision of using or not using technology is not whimsical but influenced by the subject's system of activity. The direction of willing professors can be depicted as from a to b and the direction of unwilling professors as from c to b (see Figure 17).

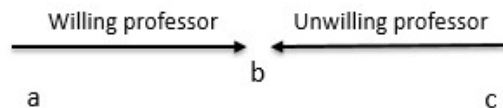


Figure 17. Opposite directions of professors willing and unwilling to adopt technology.

In some cases both forces can be increased by the same rules and members of the community but the impulse can be in different forms. For instance, whether the academic curriculum does not include ICT at any level becomes a limitation for the professors interested in adoption. Conversely, whether the curriculum integrates technology to some degree affects the unwilling professor in their direction of not adopting technology. The two types of professor coexist in an academic department and the tension is clearly a limitation in the department's capacity to integrate technology. The lack of an adequate curriculum for ICT integration is a barrier in the

literature (Goktas et al., 2009). However, as demonstrated, opposite forces can affect essential rules that are enablers for integration.

Similar dialogues exist between willing professors and members of the community such as the university board and IT staff. However, the difference relies on the common object between actors. Opposite forces and the resultant tensions between the central activity of willing professors and their neighbours' activities can be the sources of quaternary contradictions between actors. Quaternary contradictions can exist between actors at the same institutional level as professors or with members of the community at higher organizational levels.

Reflections beyond Paper III

Teachers' professional development for ICT

Teachers' professional development for the adoption of ICT is one of the three parts forming my research foci (see Figure 1). To contribute to answering the primary research question on professional development to overcome barriers to the integration of information and communication technologies it was of fundamental importance not only to enlarge the knowledge on barriers but also to identify the contemporary challenges of professional development to overcoming those barriers. Activity theory provided novelty in the study of barriers through the single introduction of the object-oriented, collective activity system as the unit of analysis, and the expansion of the unit of analysis to consider at least two interacting activity systems as the minimal unit of analysis. The conceptualization of TPD challenges in Paper III was based on a radically different conceptualization of barriers. However, further data not used in the paper but analysed in the study showed limitations in the process of TPD as conducted at UNA.

Figure 13 depicts the basic activity system of professional development resulting from the collected data. The main goal of professors participating in TPD is learning how to adopt technology to improve their teaching. Their participation is primarily motivated by the intention of improving the students' learning. However, one of the problems in TPD initiatives is the diversity of participants' goals. For some professors the aim in participating is to improve their qualification in semester evaluation. Other professors prioritize the diploma as a way to demonstrate knowledge or as an instrument to increase salary. This finding is consistent with findings in Giavrimis et al. (2011) on the reasons of teachers to participate in TPD.

Together with the diversity of goals as a source of problems in TPD-ICT, the influence of others is also a factor with a negative impact on training. Among the members of the community that influence TPD-ICT are the ICT unit (Cifuentes, 2016), the institutional department of PD, authorities of the academic department and other colleagues. Moreover, there are rules that also affect the activity such as the course curricula, academic assessment and institutional PD policies, among others. In some cases, the rules are connected to some members of the community. For instance, the

barrier of a lack of quality in professional development (Wood et al., 2005) is caused by inappropriate training methodologies. The ICT unit at UNA is in charge of training professors for ICT adoption. In the study, the professors blame the ICT unit for weaknesses in the training methodology:

(T1) At the end, the courses were very linear. Courses of opinion, or more often on how to press buttons and nothing beyond than that. Maybe, the creation of a virtual classroom. However, you are not able to do anything out of it.

On the other hand, the voice of the ICT unit says that the weaknesses in methodology are not its responsibility. Rather, the decision on the methodological approach is an institutional guideline standard across all the initiatives of professional development:

(UVI) They [institutional guidelines] induce us, not to say impose on us a model. The model refers to three moments of the participatory methodology. I think several elements converge here. With that model, you had a big group of teachers of various disciplines. In some cases it works, but in others, nothing happens; in some people it causes a desire for motivation, in others not so much.

The previous data extract evidences the existence of a complex level of problems in the activity of professional development that in order to be solved requires the participation in the process of several actors. Some of the problems that the professors mentioned regarding the activity of TPD-ICT are: the lack of clarity in the objective of the course, the lack of integration in an oriented system of training, the lack of profound reflection, the lack of significance to the practice, the lack of continuity in training and deficiencies in the pedagogical background of trainers.

Further questions

Accomplishing higher levels of integration of technology requires adequate approaches on the part of professional development to the types of problems found. However, the question of what is adequate is crucial. What do these adequate approaches look like or under what perspective and theory of learning must they be developed? Does there exist a suitable professional development approach in the current literature?

The following phase is guided by previous questioning and will describe the intervention part of the research and the process of selecting an adequate approach for intervention. It also explains the actual process of intervention, the findings and limitations.

4.2. THE PHASE OF INTERVENTION

4.2.1. FORMATION OF NEW INSTRUMENTS

One of my initial contacts with activity theory as a research framework was using the activity system as an analytical tool (Yamagata-Lynch, 2010) to represent activities with the aim of exploring and better understanding problems. However, as I went into it in depth, I saw the potential of activity theory as an approach for knowledge construction (Engeström, 2000), as a methodology of research (Engeström, 2015, p. 249) and as a method for development and change (Engeström, 2005; Engeström, 2011). The framework equipped me as researcher with an all-in-one toolbox to approach and understand the research problem at the same time as acting to promote changes to it.

The basic aim of the research is to change the practice. As mentioned in Chapter 2, my practice-based experience in the training of professors and the limited results observed encouraged me to find a way to do things differently. The development of practices implies the formation of new instruments in the activity.

Step 3 of expansive developmental research (see Figure 5) aims to formulate qualitative new models as alternatives to resolving the double bind. The double bind comes as an outcome of the analysis of activity and is typically a situation that cannot be resolved by an individual alone (Engeström & Sannino, 2011). The analysis of activity evidenced the collective dimension of the problems in the activities of ICT adoption and of professional development. The reviewed literature indicated the existence of primarily individual approaches to ICT adoption, in the study of barriers and in the TPD initiatives to overcome barriers. The knowledge accumulated from the three papers made me realize the impossibility of solving the problem of ICT integration from an individual perspective. This insight was essential in deciding on the method of intervention.

In my understanding, both the field of ICT in education and professional development for ICT face double bind types of problems. My argument is based on Engeström and Sannino's (2011) conceptualization of double bind as processes in which actors repeatedly face pressing and equally unacceptable alternatives in their activity system with seemingly no way out (p. 374). The historical tension between investments in technology and training and the limited results seems to me like the "no way out". Furthermore, to solve a double bind situation, collective actions are required toward practical transformation (Engeström & Sannino, 2011, p. 375).

In the formation of new instruments, expansive research interventions aim to assist participants with "a language" (Engeström, 2015, p. 258) or a tool to work on as a springboard to the first task in the formation of new instruments. My task as a researcher was to provide "the language" to be used by participants to approach the

formation of instruments. The change laboratory method is the selected tool for the intervention. Change laboratory became the springboard to me in order to propose a solution to the problem of overcoming barriers and the challenges of professional development for ICT integration found in previous steps and manifest in Paper III. Change laboratory is the tool provided to the professor participants in the intervention phase. It plays a double role as a methodology of intervention and as a professional development intervention to overcome barriers to ICT adoption and integration. Change laboratory's theoretical underpinnings and practical concepts are explained in Section 4.4.2.

One of the expected outcomes in step 2 of the analysis of activity in expansive developmental research is the definition of the object unit in the developmental phase of the activity under investigation (Engeström, 2015, p. 255). In this step, the object unit takes the form of the potential unit of intervention. As explained above, the department of mathematics was selected as the unit of intervention. Further details regarding the planning of the intervention can be found in Section 4.4.2.

4.2.2. PRACTICAL APPLICATION OF NEW INSTRUMENTS

Carrying out a change laboratory as a professional development intervention is the way of accomplishing step 4 of my design research. The actual intervention is the practical application of new instruments. Change laboratory is a new instrument introduced as a transformative professional development intervention. According to Engeström (2015), introducing a new instrument brings the participants into a tertiary form of contradiction between the old and new ways of doing and thinking (p. 261). A potential tertiary contradiction was evident between the initial expectations of professors coming to professional development activity and the actual activities carried out in the sessions. The contradiction was more evident in the second session when the professors complained about the methodological form of the “workshop”. I will explore the contradiction in depth in a later section. Paper IV, namely A Change Laboratory formative intervention approach to motivate university professors to identify and overcome barriers to ICT integration, describes the results of the change laboratory intervention with a special focus on the concept of agency.

Reflections on Paper IV

In Paper IV, I describe in more detail the process of intervention. I summarize the methodological process of the sessions and how the sessions match the process of expansive learning. The paper pays special attention to the concept of agency as a condition to change activities within the AT conceptual tradition. An accurate definition of agency is through its expression in practices such as breaking away from a given frame of actions and taking the initiative to transform it (Virkkunen, 2006, p. 49).

The primary research question in the study is related to the motivation of professors to overcome barriers. However, as stated in the review of literature, some of those barriers have been classified as external to teachers. Moreover, attempts have been made to solve internal barriers from teacher-centred and skills development-oriented approaches of professional development.

According to Ryan & Deci (2000), motivation is concerned with energy, direction, persistence and equifinality. In Cultural-Historical Activity Theory, the motive of an activity is not detached from the object. According to Leontyev (1978), there is no activity without a motive. In this regard, AT is supportive of the practitioners' realization of the goal of the activity and in the clarification of what the motives should be focused on. However, transformative agency must not be reduced to the individual plane of motivation. But seen as collective production and maintenance (Haapasaaari, Engeström, & Kerosuo, 2014) of actions in practice. In that sense, transformative agency is the concept through which I approached professors' motivation to overcome barriers. The results reported in Paper IV are related to potential forms of agency of professors to overcome the arising barriers in the mathematics department.

Reflections beyond Paper IV

In this section I highlighted some of the relevant findings of the intervention in relation to the process of expansive learning as a theory of learning; that is, the accomplishments of learning actions during the seven intervention sessions. The aim is to reflect on change laboratory not only as a method for research but also as an alternative method of professional development to ICT adoption and integration. Thus, I will go through a description of relevant findings per session and their connections with the theoretical expansive learning actions.

A seven-session change laboratory intervention was conducted with professors of the department of mathematics aimed at identifying and changing practices in the adoption and integration of ICT in teaching mathematics. Further details on the context and problem can be found in Section 4.4.2. According to Virkkunen and Newnham (2013), the intention in a change laboratory intervention is to collaboratively carry out a cycle of expansive learning actions and to take a major step forward from the current phase of activity (p. 74). Methodologically speaking, CL does not follow a previous structured design of sessions and contents. Rather, it is based on the participants' agency and interests. Only the first session is previously planned based on the previous data collected (see page 60 of this dissertation). Therefore, sessions 1, 2 and 3 in the intervention remain in the expansive action of questioning. According to Engeström & Sannino (2010), questioning is about criticizing or rejecting some aspects of the accepted practice (p. 7). In the case of intervention with professors in the department of mathematics, the students were from the beginning the predominant target of critics. For professors in the department the students are both a source of joy and frustration.

The selected mirror data to facilitate the questioning were from students referring to professors' uses of technology in the classroom. At this point, the critics were oriented toward students, and external limitations such as the nature of the curriculum, the lack of resources and the lack of university guidelines. However, some professors indicated the possibility of internal responsibility for the lack of adoption of technology.

The reflection also provoked the formation of groups in relation to the form in which ICT must be adopted in the department, whether it must be an individual decision or a guideline of the department. The process of questioning was not at all linear, organized or script-based. On the contrary, it moved from one point to another in a messy way. In the third session, the process of questioning naturally overlapped into the expansive learning of analysis. This overlapping is common and there was no clear boundary between actions. The action of analysis embraced session 4 and part of session 5. According to Engeström & Sannino (2010), the analysis refers to the why type of questions and explanations. The analysis was essential for a clearer and more systematic depiction of the problems or tensions limiting the adoption and integration of ICT. Moreover, the historical analysis guided the professors to realize the historical contradictions limiting their practice. Later, the historical contradictions took the form of structural barriers as a priority to overcome.

In the fifth, sixth and seventh session the participants developed the expansive learning action of modelling. The action of modelling is not exclusive or isolated. Rather, a back and forth process between the analysis, questioning and modelling nourishes it. In other words, to model a solution the participants take previous reflections and ideas for solutions and turn them into concrete tensions and contradictions to propose a more mature solution model. In session 6, the participants agreed on the lack of willingness to adopt technology as the structural barrier to adopting and integrating ICT in the department. As an alternative to overcome the barrier, they proposed creating spaces for sharing previous experiences of colleagues.. A similar idea of sharing was proposed in previous sessions but in the form of semester reports. In session 7, the professors delineated a more developed form of the idea and named it "round tables". Later they delineated some of the rules and characteristics for the concept of round table. The process here described and presented in Figure 18 resembles the creation and development of the germ cell as an expected outcome in learning action three of modelling (Virkkunen & Newnham, 2013, p. 50).

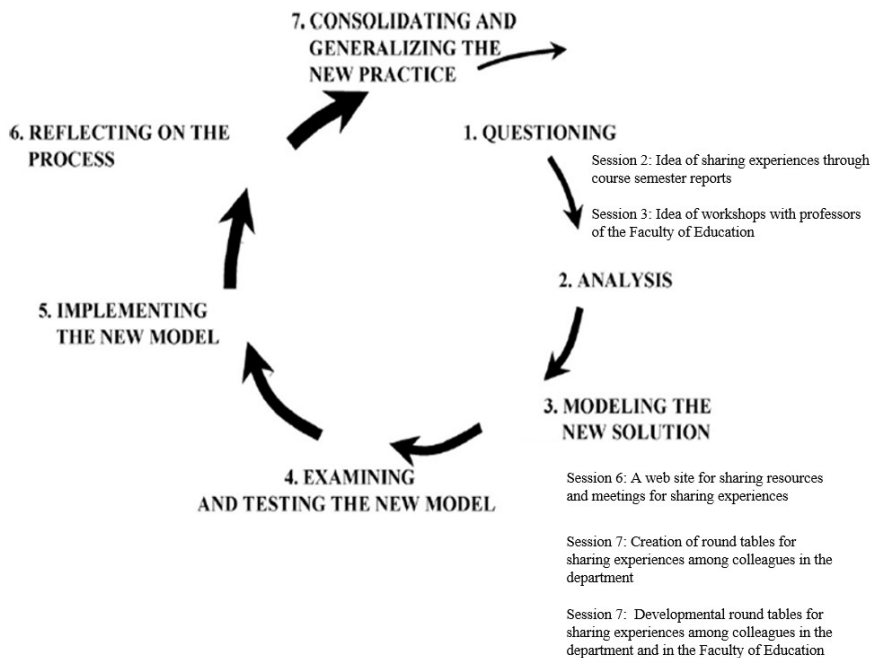


Figure 18. The expansive learning actions and the development of a germ cell as a potential solution in practice (adapted from Virkkunen & Newnham, 2013, p. 51).

The process depicted in Figure 18 can be conceptualized as the initial steps of the fundamental principle of the change laboratory method as a formative intervention of ascending from the abstract to the concrete. The process involves identifying structural barriers and the formulation of a model. Yet, in this case, the model remains theoretical or abstract due to time limitations preventing moving forward to the next learning actions. Nevertheless, the professors were motivated to reflect on the practice, to identify systemic tensions and contradictions, to propose solutions and, as stated in Paper IV, some level of agency to implement it in practice. Moreover, another important finding is the potential of expansive learning to expand the scope of development. In the case of the mathematics department, on several occasions the professors realized the need for other actors to participate in the intervention. For them, the construction and implementation of solutions, and their effectiveness, are only possible if leaders and other professors participate in change laboratory. The following excerpts exemplify the potential intention toward socio-spatial (Who else should be included?) and moral-ideological (Who is responsible and who decides?) dimensions (Engeström, 2015, p. xvii) of object expansions:

T9: "So, if we decide on the teaching mathematics programme the professors of that programme might be participating"

T1: "I would say that, as was mentioned before, that's because the persons in charge of taking decisions are not here in this discussion space. We do not take concrete actions."

At the end of session 5, one professor suggested inviting the head of department to participate in the coming sessions. Although they were invited, they declined because of time limitations. The situation demonstrated the challenge in integrating participants from other institutional levels into a formative type of professional development and the need to understand the inner tensions and contradictions in the head of department's system of activity.

The aim in this section was to reflect on change laboratory as a potential professional development intervention to overcome barriers to ICT adoption and integration. As mentioned above, a complete cycle of expansive learning consists of seven learning actions, which are intended to be achieved through a change laboratory intervention. However, as was acknowledged in Paper IV, and as I do so again here, in my case I could not complete a full cycle of expansive learning. The reasons are related to the tension between the autonomy promoted by change laboratory and formative interventions and the need to collect data and change practices to accomplish the research objectives. As a researcher, I decided to prioritize the former. Yet, the collected data helped me to answer the stated research questions. I agree with the words of Engeström when he says, regarding the practical application of new instruments in expansive developmental research (the intervention in my case):

"This step of expansive research is the most difficult and the most rewarding one" (Engeström, 2015, p. 262).

Later he says:

"The reward awaits in the careful analysis of such data. The researchers face the fact that all their skilful efforts to make the participants acquire and apply the culturally more advanced models according to a plan have been partially futile. A genuine expansive learning cycle inevitably produces not only civilization but also an ingredient of wilderness. To gain a theoretical grasp of wilderness, to find and understand something unexpected as a piece of the history of the future is the reward" (Engeström, 2015, p. 262).

4.2.3. REPORTING AND EVALUATION

Reporting and evaluation is the final step in a methodological cycle of expansive developmental research. As depicted in Figure 10, I went through a complete cycle of the methodology. However, a form of reporting has been followed throughout this

dissertation document and in the research papers. As a summary of reporting, I present the names and stated publication of the written papers.

Paper I: An activity theory approach to study barriers of faculty regarding technology integration in higher education.

Castro, W. (2016). An Activity Theory Approach To Study Barriers of Faculty Regarding Technology Integration in Higher Education (April), 7232–7241.

This paper was published during the 10th annual International Technology, Education and Development Conference. It became my first experience of research communication. The main implications of the paper are related to the field of ICT adoption and further study of barriers. Other findings are related to the complex relation between internal and external barriers among professors, and the existence of an external world beyond the internal one in professors that affects both adoption and integration was the linkage with Paper II.

Paper II: From professors' barriers to organizational conditions in ICT integration in higher education.

Castro, W. & Nyvang, T. (20XX). From professors' barriers to organizational conditions in ICT integration in higher education. Manuscript submitted for publication.

Paper number II was written in collaboration with Tom Nyvang. The paper is closely related to Paper I in the sense that it relies on the second generation of activity theory as the theoretical approach and as an analytical tool. Paper I was helpful for describing the complexity in teaching activity with technology and showed the existence of rules and members of community potentially affecting the professors' practice. Paper II aims to deepen that complexity to understand the potential tensions between professors and rules and between professors and the members of community to understand the underlying causes of barriers in literature or to find new barriers.

Paper II was essential to reflect the fact that current challenges or barriers to ICT adoption and integration will also mean challenges to professional development in order to adequately attend to the required institutional conditions for ICT integration. The potential challenges of professional development are addressed in Paper III.

Paper III: Challenges of Professional Development for ICT Integration in Higher Education

Castro, W. (20XX). Challenges of Professional Development for ICT Integration in Higher Education. Manuscript submitted for publication.

Paper III was the first formal reflection on professional development as a tool to overcome barriers to ICT adoption. Papers I and II were fundamental pillars to primarily understand the barriers from the perspective of activity theory and to understand what problems professional development should attend to. The paper approached the problem from the viewpoint of the third generation of activity theory.

To conclude, the paper proposes a model of organizational-oriented development of ICT integration and adoption as an alternative to address the contemporary challenges of teacher professional development

Paper IV: A Change Laboratory professional development intervention to motivate university professors to identify and overcome barriers to the integration of ICT.

Castro, W. (2017). A Change Laboratory professional development intervention to motivate university professors to identify and overcome barriers to the integration of ICT. Manuscript submitted for publication.

Paper IV responds to the process of intervention in the department of mathematics at UNA. It describes the intervention sessions, and the main contributions of the method as a professional development option to overcome the barriers to ICT integration in higher education.

The paper places special attention on the concept of agency as a collective manifestation of motive within the Cultural-Historical Activity Theory tradition.

The papers are printed in volume II of the thesis dissertation.

CHAPTER 5. A FINAL SUMMARY OF CONTRIBUTIONS

5.1. RESPONDING TO THE RESEARCH QUESTIONS

As mentioned in Section 3.4.1, the secondary research questions are connected to each other and are the empirical foundations to answer the primary research questions. To answer the main questions on how professional development helps professors to overcome the existing barriers in the integration of information and communication technologies for teaching and learning, and how this can be theoretically understood, an understanding of the main constructs from an activity theory perspective was necessary.

The first secondary question regarding the barriers of higher education faculties started from the division between first-order or external and second-order or internal barriers of professors to adopting technologies in teaching and learning. The study showed that professors both willing and unwilling to use technology face both internal and external barriers. Moreover, it is not possible to associate one type of barrier with a specific category of professor. For instance, professors willing to use technology are supposed to not experience internal barriers. However, they face limitations in terms of adoption mainly related to the actions taken by others that affect their practice. Similarly, professors reluctant to use technology face both internal and external limitations.

To be specific, the faculty professors do not experience barriers in a separate form. Neither is the appearance of barriers a sequential phenomenon. On the contrary, the coexistence of barriers and the influence of others in the emergence of these barriers are fundamental findings in understanding the contemporary challenges of teachers in adopting information and communication technologies.

The presence of a non-linear or deterministic framework of barriers is the foundation to understanding the contemporary challenges of professors in adopting ICT. The existence of a diverse range of limitations does not reside exclusively in professors. On the contrary, the acknowledgment of the adoption of technology as a human activity and the perspective of human activity as collective turns the traditional approach of professors' barriers into an organizational conditions approach to successful integration in education. Even considering professors as the main collective subject in technology adoption, the individuals forming the subject are different in many senses. Furthermore, the existence of rules, a community and a division of labour affecting the activity of teaching and learning makes integration a more complex challenge. Even more, the particularity of contexts within educational

institutions means that the rules and the ways in which the community and division of labour affect ICT integration are particular and potentially different. The non-explicit rule of the relations of power in educational contexts is in itself a major topic to study. In sum, the phenomenon of ICT integration in education cannot be seen going forward as an individual obligation of professors neglecting the key participation and influence of other actors in the institutional context for a successful integration. The challenge of a collective approach to ICT integration must also influence how professional development for ICT integration must be understood and accomplished.

The third secondary research question aims to connect the findings and answer of the second secondary research question in the field of professional development for ICT integration. The shift in the understanding of barriers and the challenge of organizational conditions to facilitate integration supposes different forms and challenges to professional development approaches. Such approaches must consider challenges as a collective and cross-level development. The cross-level development implies the contrasting of objects, motives and goals of the institutional actors in ICT integration. Moreover, it implies perhaps the creation or expansion of common objects in order to identify not the barriers, but the historical contradictions affecting ICT integration. Recognizing contradictions, in the CHAT tradition, is basically for the development of institutional solutions. The institutional solutions must be not only for overcoming limitations but aimed at achieving the cultural appropriation of the technological tools and the transformation of the common object. It is proposed that the contemporary challenges of TPD-ICT should be addressed through an organizational-oriented professional development model for ICT integration in education (see Paper III).

The fourth secondary research question aims to execute the specific method of change laboratory as an alternative to attend not only to the contemporary challenges in the integration of ICT but also the contemporary challenges of professional development for ICT integration. The answer to the fourth secondary research question is closer to the answer to the first primary question. It is an accumulation of the answers to the previous three secondary questions.

A first initial consideration on how professional development helps professors to overcome barriers to ICT integration is through recognizing and attending to the complex challenges of ICT integration and the professional development itself. As explained in the corresponding section, the change laboratory method is very congruent with the theoretical and methodological approach of the study. In this sense, according to the results of the empirical intervention, explained in more detail in Paper IV, the selected type of intervention helped the professors to overcome barriers through the development of human agency (Haapasaari, Engeström, & Kerosuo, 2014). The development of agency is not the result of whatever intervention. Rather it is a central aim in formative interventions such as change laboratory. The formation of agency is the intentional collective motivation to act to solve problems, in this case

the overcoming of barriers. The change laboratory intervention generates the conditions to hear multiple voices participating in the activity, to confront such voices, to realize the tensions and contradictions affecting the activity and to develop collective solutions in a collective agreement according to the institutional context and culture. The results of the intervention showed, within the limitations of time framing the study, initial signals of development of agency in the participants to the extent that there was a concrete proposal of a solution to the structural barrier in the place of intervention.

The second main research question challenged me to approach to a theoretical understanding of the findings. The process of understanding a phenomenon from a theoretical perspective is perhaps the more difficult endeavor. Even though the process of theorizing is clear for the researcher, the craftwork requires making it as clearly as possible for the reader. As stated by Swedberg (2012), theory is substantially different to the originator to those who did not create it (p. 15). Moreover, the link between the process of theorizing for the creator is alive, for the latter cold written language (Swedberg, 2012). However, an attempt to theoretically understanding what happened during the three years of research study is crucial to contribute with knowledge to the field of educational technology. I will focus on two basic issues to theoretically discuss the research findings: the barriers of ICT integration and the professors' labels in their relation to technology, and the professional development models to ICT integration.

5.1.1. A DIFFERENT UNDERSTANDING OF THE CONCEPT OF BARRIER IN ICT INTEGRATION

The approach of extrinsic and intrinsic barriers in ICT adoption in education (Ertmer, 1999) is related to first and second order barriers to change (Brickner, 1995). While first-order changes resulting from overcoming first-order barriers are not understood as profound, the second-order changes result of overcoming second-order barriers in the extent they confront fundamental beliefs of current practice (Ertmer, 1999, p. 48). According to theory, second-order barriers are expected to be closer to the possibility of transformation of education with ICT.

The achievement of changes or transformation in education with technologies has been teacher focused. As a result, the study of barriers has been linked to teachers' actions within the classroom. Thus, the extrinsic barriers are understood as extrinsic to teachers and the intrinsic, intrinsic to teachers. Although Dexter, Anderson, and Becker (1999) recognizes the influence of culture and context in the creation of norms affecting teaching practices, Ertmer (1999) considers that teachers have the flexibility of decision within contextual norms.

However, the influence of context and culture is more than thought regarding in teachers' decisions and possibilities of adoption of technology. The teachers' flexibility of choice is not that flexible because the existence of norms, the influence of others, and the lack of clarity in the assignment of responsibilities. Professors are hindered to move to higher levels of adoption or simply desist if using technologies.

Although the presence of positive beliefs toward technology is a predictor of adoption, it is not a guarantee of durable or innovative integration. Even the so-called enthusiastic professors' experience decreases in their levels of adoption. The influence of context and culture is crucial in limiting adoption. Its influence cannot be diminished as a first-order barrier. On the contrary, it is a complex combination of first and second order barriers. Culture in traditional approaches of barriers is considered as an extrinsic barrier to professors. However, from a broader understanding of human activity as collective, culture, for instance, must be understood as an intrinsic barrier to the organization. Thus, the dichotomy between external and internal barriers must be overcome to make way for a complex interaction between current and historical accumulated tensions across and among institutional levels.

5.1.2. ORGANIZATIONAL PROFESSIONAL DEVELOPMENT FOR ICT INTEGRATION IN EDUCATION

The change in how the problems of ICT integration are understood should provoke changes in how to attend and overcome the limitations. Professional development is one of the most important strategies to overcome barriers and promote adoption in traditional understanding. However, teachers professional development has been also criticized because the lack of incidence and low quality.

The traditional understanding of barriers as extrinsic and intrinsic allowed the focus of TPD in overcoming second order barriers of professors. Thus, TPD has been mostly focused on teachers' development of skills and beliefs. The latter indirectly through the development of the former. Professional development has not aimed to overcome first-order barriers because they have been identified as external to teachers, as the responsibility of someone else, and that there is nothing that teacher can do to solve. However, the professional development approach used in the study demonstrate how professors are able and capable to find and implement solutions to overcome tensions as a whole independently of their nature.

A professional development approach must consider not only professors, but also those members of professors' community that affect integration. Both, integration and professional development are not isolated activities. On the contrary, they are collective, culturally affected and contextually delineated. It means that the solutions to overcome barriers are not standard solutions fitting all institutions. Rather, professional development must guide to realize the adequate solution but specially develop participants' agency to understand problems and find solutions.

A professional development approach is not to develop one single level development. Rather it must include different actors even when they have opposite positions. Moreover, discrepancies are the fundamental triggers to find solutions. Especially when actors are across institutional levels. This is similar to Balanskat et al. (2006) description of barriers in terms of micro, meso, and macro levels. However, no previous studies introduces theoretical and methodological approaches to understand the interaction of limitations among levels.

Cross level professional development or organizational development to ICT integration must facilitate the interplay of opposite forces, facilitating process of internalization and externalization as key for cultural appropriation and the root of changes. This aim is coincident with Cuban, Kirkpatrick, and Peck (2001) call to fundamental organizational changes and teachers' preparation to improve the adoption.

5.2. SUMMARIZING CONTRIBUTIONS OF DISSERTATION TO

5.2.1. ICT INTEGRATION IN EDUCATION

- The final goal of transforming education with the use of technology for teaching and learning must be understood as, and achieved through, a process of collective organizational integration rather than a process of individual professor adoption.
- Professors, as part of the collective organization, are not enthusiastic or resistant through their own decision or forever. Their levels of adoption of technology are influenced by tensions or historical contradictions due to the interaction between the self and the external world.

5.2.2. BARRIERS OF ICT ADOPTION IN HIGHER EDUCATION

- In connection with the previous, the barriers or limitations in ICT adoption and integration are not a professor-exclusive responsibility. The study of barriers from a professors' perception must be surpassed by the collective study of institutional conditions for ICT integration.
- The overcoming of barriers to ICT adoption and integration in education is not binary in the sense that overcoming barriers is a guarantee of adoption. On the contrary, after overcoming barriers, further barriers can appear. The current concept of overcoming barriers must be rather understood as a process of developing the activity of teaching through attending to collective tensions or historical contradictions.
- The study of barriers must surpass the separation between first-order and second-order barriers. They must be approached and overcome within their interactions and mutual affections.

- The study of barriers to ICT adoption and integration in education must be acknowledged as a complex relation among humans, artefacts, context and culture. In other words, the study of barriers must not intend to identify, list and overcome standard barriers. On the contrary, the barriers are context-dependent and culturally delineated. In other words, which may constitute a barrier in a specific context, they could not be identified as such in a different context.
- The overcoming of contextual limitations requires contextual solutions that must be created collectively through the horizontal departments and crossing the vertical levels of the organization.

5.2.3. CONTRIBUTIONS TO PROFESSIONAL DEVELOPMENT FOR ICT ADOPTION IN HIGHER EDUCATION

- The challenges of professional development are closely related to the studies of the limitations that hinder the adoption and integration of technology.
- Professional development in itself must be an activity in permanent development and must not offer standard solutions to professors or the managerial level. Instead, professional development must create spaces to collectively develop the required contextual solutions to problems.
- Professional development must be oriented toward developing the practice of teaching with technologies as a mediator tool, rather than seeking the individual development of a professor. The development of the practice can imply the learning of development of the participants.
- The professional development toward ICT integration must be understood as organizational development including not only professors but also other organizational actors in the horizontal and vertical dimensions.
- Organizational development for ICT integration must attempt to develop and foster the common goals of the participants. Common goals are a cornerstone to achieve the dreamed transformation of education with ICT.
- Change laboratory as a theoretically based professional development intervention demonstrates the potential to contribute to supporting the current limitations of ICT integration and some of the challenges of professional development toward ICT integration. It allows participants to surpass the separation between the so-called internal and external barriers.
- Change laboratory helps to reduce the gap between research and practice in the integration of ICT in education.
- Change laboratory and the theory of expansive learning are a potential framework to support organizational professional development and motivate professors and other actors toward an in-practice identification and solving of limitations of ICT integration.

5.3. METHODOLOGICAL CONTRIBUTIONS

Although the review of literature in this dissertation was focused on the areas comprising the research foci of the study, I had also reviewed a relevant amount of literature regarding activity theory and expansive learning as theoretical and methodological approaches of the study. The continuous cyclical revision of literature facilitated by the hermeneutic framework for literature review allowed me to acknowledge that with very few exceptions (Laferrière et al., 2013) there are no studies directly using activity theory and expansive learning to study and encourage the overcoming of barriers to ICT adoption and integration in higher education. The initial point of departure of the activity system as a unit of analysis was fundamental for the findings along the study. The wide perspective facilitated not only the possibility of contributing to the study of the areas in the research foci but also the approach to the role of the researcher as part of the problem.

As I mentioned in the initial chapters, my research interests lie mainly in the practice. My intention as a researcher was to promote a change in practice through research, which inevitably at some point would influence the study. One of the main methodological findings for me is that in using activity theory as a kind of backbone during the study from the world view to the method of intervention, my position as a researcher was considered part of the study. My voice as a researcher must be understood as one of the voices in the process, as one of the members of the professors' community potentially affecting their practice. Moreover, the voice of the researcher is a source of direction that can be potentially in an opposite direction to others actors' voices, causing tensions and contradictions, but also as a participant in the construction of solutions. This methodological realization is key in reducing the gap between research and practice, between the researcher's aims and practitioners' aims, and, as in my case, to acknowledge the researchers as part of the practice.

5.4. FINAL THOUGHTS AND CONCLUSION

As I explained in Chapter 2, my initial approach to the problem was from the viewpoint of professors as those almost exclusively responsible for ICT adoption. In that regard, my view was closely related to the current literature regarding considering the second-order barriers as the focus of study and development in professors, particularly motivation. Consequently, the initial aim was to develop a professional development approach to foster professors' motivation toward ICT adoption.

However, the process of research was enlightening in changing my views and acknowledging the participation of a variety of factors and actors affecting professors' willingness and practices of adoption and in showing that overcoming second-order barriers is not a guarantee of success in adoption.

On the other hand, professional development is a fundamental tool for promoting ICT integration and adoption. However, I realize that professional development must not be only oriented primarily toward professors' learning or individual development. Rather it should be aimed at the development of practice in collaboration with those actors with some level of participation in the practice.

To conclude, I am sure that these three years of research have changed how I will see my practice in the future. I have cleansed the crystal from which I used to see the problems. I realized that professors are not alone in the world of transforming education with technologies, and that the mere act of developing policies, investments, professional development and any new solution can be unfruitful if it is imposed unilaterally – any new technology, any new pedagogical approach to adopting technology, any new professional development initiative. In sum, any new tool, in the broadest sense of the word, aimed at contributing to the transformation of education must be collectively developed.

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