

Confidence in Technology Use:
The Development and Validation of a Technological,
Pedagogical, and Content Self-Efficacy
Scale for Teachers

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Abstract

This thesis is positioned at the intersection of education, technology, and motivation research fields, specifically in the context of K-12 teaching.

The purpose of this study is to investigate the relationship between teachers' self-efficacy and their technology use, and design and validate a self-efficacy measure to assess teachers' beliefs about technology use in their profession. This measure is based on the Technological, Pedagogical and Content knowledge (TPACK) framework (Mishra & Koehler, 2006) and on the standards put forth by the International Society for Technology in Education (ISTE) and by the Partnership for 21st Century Skills (P21).

In today's so-called "Information Society," technology is pervading every aspect of our life, and the education sector is no exception. On the one hand, the increased presence of technology demands teachers to be proficient in its use. On the other, a high level of technological knowledge and skills does not necessarily mean that a teacher is effective at implementing those skills in his or her classroom (or life). As Pajares pointed out, "what we know, the skills we possess, or what we have previously accomplished are not always good predictors of subsequent attainments because the beliefs we hold about our capabilities powerfully influence the ways we behave" (Madewell & Shaughnessy, 2003, p. 381). Consequently, behavior can be often better predicted by the beliefs people have about their capabilities to accomplish a particular task than by their actual capabilities (Bandura, 1977).

This thesis consists of two main parts. Part I outlines the theoretical framework that guides the research: from technology to education, describing the main features of the Knowledge Society. The self-efficacy construct from the Social Cognitive Theory perspective is also presented, and with particular relation to the use of technology (computer self-efficacy) and teaching activity (teacher self-efficacy).

Part I also presents two exploratory field case studies, the first in Brazil and the second in South Africa, which explored the hypothesis of a correlation between computer self-efficacy and teacher self-efficacy. Results from the two exploratory field case studies

were contentious. In the Brazilian study teacher self-efficacy seemed to be positively influenced by computer self-efficacy. Results from the South African study conducted in analogous conditions, indicated no correlation between the two variables examined.

The ambiguous results and the accompanying literature review from these field studies led the author to extend the research with the specific aim of providing a tool that can measure teachers' beliefs about their use of technology.

In part II of the thesis, the author designs and validates the new teacher self-efficacy scale. This is achieved through feedback from external experts, a pilot study with a small group of teachers, and a large-scale survey conducted with a sample ($n = 218$) of K-12 teachers in the United States. The survey questionnaire consisted of two main sections: the first asked teachers to provide demographical information and report their use of technology; the second included the new self-efficacy for TPACK scale and two additional measures, often used in studies of teacher self-efficacy (i.e., the Teacher Sense of Efficacy Scale, Tschannen-Moran & Woolfolk Hoy, 2001; and the Computer Self-Efficacy scale, Compeau & Higgins, 1995), which will be used to determine concurrent validity.

This thesis contributes to the literature on teacher development and motivation in using technology. Firstly, it presents a psychometrically sound instrument to assess teachers' efficacy perceptions about working with and using technology in their profession. The scale is composed of 20 items, organized in three subscales: *Technological Pedagogical Self-Efficacy* (11 items), *Technological Content Self-Efficacy* (6 items), and *Technological Pedagogical Content Self-Efficacy* (3 items). Secondly, this study illuminates the role played by years of teaching experience, professional development with technology, age, gender, ethnicity, and school level in the development of teacher self-efficacy for TPACK. On one hand, experienced teachers reported to have less confidence in technology use. On the other hand, teachers who received extensive/moderate professional development with technology reported higher levels of self-efficacy for TPACK. The role of teacher training in technology use emerged to be essential in increasing their self-efficacy for TPACK. No significant differences were

detected in self-efficacy for TPACK as function of gender, ethnicity, and school level. Finally, this research confirms the role of self-efficacy in predicting teachers' use of technology. Results indicate that self-efficacy for TPACK positively predicts teachers' technology use. These findings shed more light on the role played by teachers' self-efficacy in the technology integration process, as one of the significant indicators of teachers' technology use.

DEDICATION

To my husband Samuel

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Introduction and research overview

In today's so called *Information Society*, technology is pervading every aspect of our life, and the education sector is no exception. On the one hand, the increased presence of technology demands that teachers be proficient in its use. On the other, a high level of technological knowledge and skills does not necessarily mean that a teacher is effective in implementing those skills in his or her classroom (or life). As Pajares pointed out, "what we know, the skills we possess, or what we have previously accomplished are not always good predictors of subsequent attainments because the beliefs we hold about our capabilities powerfully influence the ways we behave" (Madewell & Shaughnessy, 2003, p. 381). Consequently, behavior can be often better predicted by self-efficacy (Bandura, 1997). This construct refers to one's capabilities to accomplish a particular task than by their actual capabilities (Bandura, 1977).

This thesis aims at investigating the relationship between teachers' efficacy beliefs and their use of technology. In conjunction with use of teacher self-efficacy measures, this work also aims to develop a psychometrically sound instrument to assess teachers' efficacy perceptions about working with technology. Accordingly, in this research the self-efficacy construct has been applied to two specific contexts: the use of technology (computer self-efficacy) and teaching activity (teacher self-efficacy). Computer self-efficacy represents "an individual perception of his or her ability to use computers in the accomplishment of a task" (Compeau & Higgins 1995, p. 192), while teacher self-efficacy can be defined as a teacher's "judgment of his or her capabilities to bring about desired outcomes of student engagement and learning, even among those students who may be difficult or unmotivated" (Tschannen-Moran & Woolfolk Hoy, 2001, p. 783).

Teacher self-efficacy and its relationship with computer self-efficacy are examined, starting from an extended literature review on studies in which these

constructs have been applied. Moreover, results from two exploratory field studies, which gave rise to the hypothesis of a correlation between them, are also reported. Specifically, in the first exploratory field study teacher self-efficacy was detected to be positively influenced by computer self-efficacy. Results from the second exploratory field study conducted in analogous conditions, instead, did not confirm the results of the previous study, showing no correlation between the two variables examined.

The literature review and the controversial results from the exploratory field studies led the author to extend the research on the relationship between teacher self-efficacy and computer self-efficacy with the specific aim of providing a tool that can measure teachers' beliefs about their use of technology. Consequently, one necessity for conducting this research was the design and the validation of a new scale for assessing teachers' beliefs about their use of technology.

The new scale is based on the Technological, Pedagogical and Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) and on the standards put forth by the International Society for Technology in Education (ISTE, 2012), and the by the Partnership for 21st Century Skills (Partnership for 21st Century Skill Framework, 2009). "TPACK attempts to define the nature of knowledge required by teachers for technology integration in their teaching, while addressing the complex, multifaceted and situated nature of teacher knowledge" (Mishra & Koehler, 2006, p. 1017). This framework suggests a path to follow in the identification of the knowledge that teachers working with technology need to master. ISTE standards have been an eminent source in defining teachers' set of skills in technology-related activities.

The scale has been validated through the feedback given by external experts, a pilot study with a small group of teachers, and finally a large-scale questionnaire distributed to a sample of K-12 teachers in the USA. The questionnaire was composed of two main sections: the first asks teachers to provide demographic information and to report their use of technology; the second part includes the

new Self-Efficacy for TPACK scale and two additional measures, often used in studies of teacher self-efficacy, namely, the Teacher Sense of Efficacy Scale (Tschannen-Moran & Woolfolk Hoy, 2001), and the Computer self-efficacy scale (Compeau & Higgins, 1995), which have been used to determine concurrent validity. Exploratory factor analysis and reliability tests have been conducted to validate the scale.

The structure of this thesis consists of two main parts. The first one (Part I) outlines the theoretical framework that guides the research and the exploratory field case studies; the first chapter (Section 1.1) illustrates the context of this research, moving from technology to education, to describe the main features of the Knowledge Society. The author then defines self-efficacy as a central construct in the Social Cognitive Theoretical perspective (Section 1.2), offering a review of literature related to teacher and computer self-efficacy. Moreover, section 2 presents two exploratory field case studies, which led the author to identify the need for a new Teacher Self-Efficacy scale that includes technological and not just pedagogical skills. The first case study (Section 2.1), the BET K-12 (Brazilian eLearning Teacher Training in K-12) project, is presented including the contextual background, methodology, and results; the same structure is kept for proposing the second case study, the MELISSA (Measuring E-Learning Impact in primary Schools in South African disadvantaged areas) project (Section 2.2). An overall analysis of the limitations of both projects is then provided (Section 2.3).

In the second part of this thesis (Part II), the resources used to design the new scale are presented (Chapter 3). Specifically, the TPACK framework (Mishra & Koehler, 2006) is illustrated in section 3.1.1, the ISTE Standards (ISTE, 2012) in section 3.1.2, and the 21st Century Skills (Partnership for 21st Century Skill Framework, 2009) in section 3.1.3. Section 3.2 presents the research questions of the study.

Chapter 4 and 5 explain respectively the methodology and the results got answering the research questions 2 (RQ2), 3 (RQ3), and 4 (RQ4). In chapter 6 results of Part II are discussed.

Accordingly to the presented parts, an overview of the research path is shown in the following table (Table I):

Table I. Overview of the Research Path

| | | | |
|----------------|------------|--|--------------------------------------|
| PART I | RQ1 | What is the relationship between teacher self-efficacy and computer self-efficacy? | |
| | | Exploratory field study I (Chap. 2) | Exploratory field study II (Chap. 2) |
| PART II | RQ2 | What are the psychometric properties of the items of a Self-Efficacy for TPACK Scale? | |
| | | K-12 teachers survey (Chap. 4 - 6) | |
| | RQ3 | Are there mean differences in teachers' self-efficacy for TPACK as a function of teachers' <ul style="list-style-type: none"> • age • gender • ethnicity • school level • years of teaching • professional development with technology? | |
| | | K-12 teachers survey (Chap. 4 - 6) | |
| | RQ4 | What is the relationship between self-efficacy for TPACK and teachers' technology use? | |
| | | K-12 teachers survey (Chap. 4 - 6) | |

Answers to these research questions are expected to contribute to the literature on teacher development and motivation in using technology in the following ways:

1. Contribute to defining the relationship between teacher self-efficacy and computer self-efficacy.
2. Provide a psychometrically sound instrument to assess teachers' efficacy perceptions about working with technology in their profession.
3. Illuminate whether teachers' technology self-efficacy differs as a function of age, gender, ethnicity, school level, years of teaching experience, and professional development with technology.
4. Explore the predictive relationship between self-efficacy and teachers' use of technology.

PART I

The Impact of Technology on Teacher Self-Efficacy

Chapter 1: Theoretical framework

This chapter provides an overview of the theoretical framework that guides this work. The first section (1.1) illustrates the context of this research, moving from technology to education, describing the main features of the Knowledge Society. The second section (1.2) presents the self-efficacy construct from the Social Cognitive Theory perspective. A literature review describes teacher and computer self-efficacy used in previous works. Section 1.3 provides evidences of relevance for the whole work of the theories and the studies reviewed in the literature.

1.1. Information and Communication Technology in educational context

In this section (1.1.1) an overview of the context in which this research is placed is proposed. Namely, (1.1.2) technology diffusion and adoption, and (1.1.3) a model to describe educational processes are presented.

1.1.1. Education in the Knowledge Society

Among all human activities, it is education that is most closely connected to communication (Cantoni et al., 2007). Communication is an activity made to create a habit change in our interlocutor (Peirce, 1907); a successful communication, indeed, is the one through which we promote a change in the person we are talking to. In the same way, in teaching activities there is an exchange of knowledge aiming at making the learner grow up or improve own knowledge, attitude or skill about a specific topic. Moreover, from a communication perspective, the educational process is focused on the people who are involved in the educational activity: learner and teacher are the main actors and the process is established and defined according to their needs (Cantoni & Tardini, 2006).

Information and Communication Technologies (ICT) can provide learners' and teachers' with higher quality level of learning experience – e.g. distance learning for people living in isolate or unprivileged areas – and in more suitable ways – e.g. on demand online courses for managers who need time flexibility for study. eLearning, in fact, is defined by the European Union as “the use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration” (CEC, 2001, p. 2).

Nowadays, ICT are permeating every aspect of our life and certainly also the educational sector. This advent asks for an effective ability in using them. Not being able to manage ICT means not being fully integrated in the society. That is

why the advent of a new technology causes some inevitable changes also in the educational field. Digital technologies, in fact, are considered as new tools/strategies to improve the teaching and learning experience, but also as content of educational activities. Therefore, on one hand, ICT let the educational process improve its possibilities (Unwin, 2009), and design new scenarios for teaching and learning activities; on the other hand, as for other contexts, the introduction of new tools requires new ways of thinking about the educational process itself (Cuban, 2001; 2004).

All innovations that are introduced in society, and in particular in the educational context, face critics and proponents. The discovery of writing, for example, happened in a context where memory was the main tool to keep information. It brought several advantages, like a wider range of diffusion of information, and, with the alphabet's invention (1300 b. c.), a system to keep and support knowledge. In Phaedrus, one of Plato's dialogues (370 b. c.) the innovation of writing is presented as a threat to the use of memory, and a way to make people trust in external and unverifiable information. Currently, the debate about the introduction of ICT in educational context is open and heated, and requires further exploration.

Media Education is a research field investigating communication and education practices that can foster and promote the adoption of media in given contexts. It can be defined as a pedagogical method to deal with the role of media in human educational processes. Rivoltella (2005) highlights three main goals of Media Education:

1. Educating *to* the media, i.e. helping the audience of a message delivered through a medium to de-construct it and discover its (implicit) contents. The goal is to raise the awareness of learners – in particular of young students – about the role played by the medium in the delivery of a message;
2. Educating *with* the media, i.e. integrating the use of new media into current training practices as an educational strategy for delivering;

3. Educating *through* the media; in this perspective learners are required to produce educational contents and present them by means of a specific medium, thus experiencing in first person the production processes that lie behind that specific medium.

In the first perspective, media are considered as a subject of study. Educating to media basically means educating on how to use the media, either in a production perspective (becoming able to master specific ICT/media) or in a usage perspective (becoming more aware of messages mediated by ICT/media). In the second and third perspectives, media education largely overlaps with eLearning. ICT/media are considered as an educational strategy to deliver content and, even more, to provide learners with a direct experience of ICT. Moreover, ICT exposure helps them become more active and conscious players in the so called Knowledge Society, “a society where the most valuable asset is investment in intangible, human and social capital and where key factors are knowledge and creativity” (Cantoni & Tardini, 2006, p. 35).

Several authors in the field of Media Education research (e.g. Bauerlein, 2008; Bullen et al., 2009; Howe & Strauss, 1991; Oblinger & Oblinger, 2005; Prensky, 2001) argue that digital technology not only enhanced the range of possibility of educational activities – positively and negatively, but also changed learners’ needs and competencies. Specifically, Prensky (2001) proposed a distinction between *digital immigrants*, who grew up before computer and Internet diffusion and who have to adapt and integrate digital technology into their life, and *digital natives*, who were born in a context where computer, Internet, videogames and mobile phones were already in place. Rapetti and Cantoni (2012) highlight that the distinction proposed by Prensky (2001) has been studied as theory in several works, but few have been provide an empirical confirmation of it. A great contribution has been made by the New Millennium Learners research project run by OECD (OECD-CERI, 2010). Results from these studies suggested that *digital natives* are not technology addicts but, in educational contexts, they are

able to organize their learning environments by choosing digital media and non-digital media according to their needs (Rapetti & Cantoni, 2012).

Nevertheless, Prensky's (2001) distinction suggests that the process of technology adoption plays a relevant role in understanding the eLearning process itself. Diffusion theories are the research field where the processes and patterns of adoption of technologies are being studied.

1.1.2. Diffusion and adoption of technology

According to UNESCO (2008), to live, learn, and work successfully in an increasingly complex, information-rich and knowledge-based society, students and teachers must utilize technology effectively. All *technologies of the word* (Ong, 1982) adopted by the human society have to be learned and integrated into daily life. According to Fidler (2000), in fact, when a new technology enters society, it does not replace the previous ones, but there is a reorganization of the context. In the educational field this means that teaching and learning processes inevitably undertake a change, showing new possibilities. In this process, which Fidler (2000) called *Mediamorphosis* it is possible to recognize six principles, which can also be applied to the educational context (Cantoni et al., 2007): (1) co-existence and co-evolution of media forms: new educational practices co-exist with the old ones; (2) gradual metamorphosis of new media forms from old ones: eLearning develops from pre-existent educational practices; (3) propagation of dominant traits in media forms: eLearning expands previous educational activities' traits; (4) survival of media forms and enterprises in a changing environment: educational activities that are not ICT related evolve and adapt in order to survive in the new context; (5) merits and needs for adopting new media: eLearning develops in order to answer new needs given by the new context; and (5) delays from proof of concept to widespread adoption of new media: eLearning integration and adoption require time.

According to Rogers (2003), the adoption of an innovation, like the use of ICT in the educational context, is strictly related to the perception of the adopter about the innovation. Specifically, Rogers underlined five perceived attributes that an innovation should show to be easily accepted. The first one is the *relative advantage*, defined as the added value that the innovation should bring in the context it is used or practiced. A second factor is the *compatibility*, which the innovation should have to be integrated in the context in which it will be part. *Complexity* is the third factor: the innovation should have a low level of complexity to be easily mastered and consequently adopted. *Trialability* and *observability* are the last two factors identified by Rogers: the innovation should offer the possibility of being tested in a safe context before being adopted. The more you can observe positive results with the innovation, the better you adopt it. The attributes proposed by Rogers are fundamental to understanding why some technologies are widely adopted or rejected in the educational context, as in every other context.

In *Diffusion Theories*, Rogers (2003) analyzes also the role that people play in a new technology adoption's process. He recognizes five types of innovation adopters, which should be taken into account in understanding new educational technology enhanced-contexts: the first are the *innovators*: estimated as 2.5% of the population, they accept and start using the innovation just because it is a novelty. They do not necessarily recognize the utility of the innovation, but are attracted by everything new. The second portion of adopters, 13.5% of the population, is defined as *early adopters*: they usually act as opinion leaders, spreading the added value of owning the innovation. The third part is called *early majority*, composed by 34% of the population: they accept the innovation slower than the previous types of adopters, but at the same time they are not the last in doing that. The fourth segment is composed by the *late majority*, 34% of the population who accept the novelty once it has been widely accepted and used by more than half of the population. The curve of adoption is closed by the

laggards: they are the 16% of the population who adopt an innovation when it is no more an innovation.

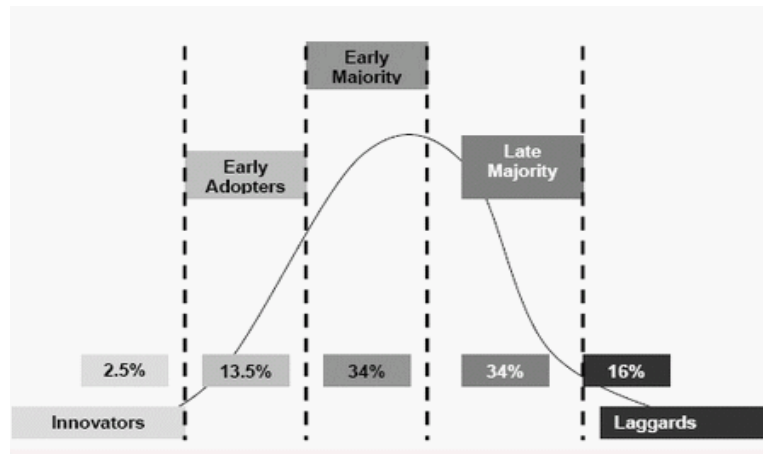


Figure 1.1 Curve of Adoption (Rogers, 2003)

Moreover, Rogers (2003) identifies five stages in the process of adoption of an innovation, which an adopter, both an individual and an institution, has to pass through. *Knowledge* is the first one: in this stage the potential adopter is exposed to the innovation, but she or he is not aware of the potentiality of it. In the *persuasion* stage, the adopter is fascinated by the innovation and searches for more information about it, be it is a new tool or a new process. *Decision* is the stage during which the adopter decides about the adoption, evaluating the added value of the innovation. In the *implementation* stage the adopter uses or applies the innovation, trying the actual advantage compared against the old tool or process. The last stage is named *confirmation*: the adopter confirms (or not) the decision of adoption, exploiting all the potentiality of the innovation.

An interesting contribution to this topic in learning-related contexts is offered by Succi and Cantoni (2008). To deepen the comprehension of the issue of innovation and eLearning acceptance, they propose a *Map of eLearning Acceptance*. The map illustrates the variables (*eLearner*, *organizational context*,

and *asset*), the phases (*preparation*, *start*, and *persistence*), and the components (*knowledge* and *commitment*) involved in the process of eLearning acceptance.

The adoption of an innovation is a complex process that requires time and can be quickened or delayed in accordance with the context, the adopters, and the characteristics of the innovations themselves. To better understand how eLearning adoption occurs, the following section presents a model showing the main elements of an educational context technology-enhanced.

1.1.3. Information and Communication Technology in educational contexts: a model

To better understand new possibilities of educational settings and activities with ICT, the *Triangle Model* (Cantoni et al., 2007) will be presented below. This model summarizes the main elements of an ICT-enhanced learning scenario and it is composed by three main items.

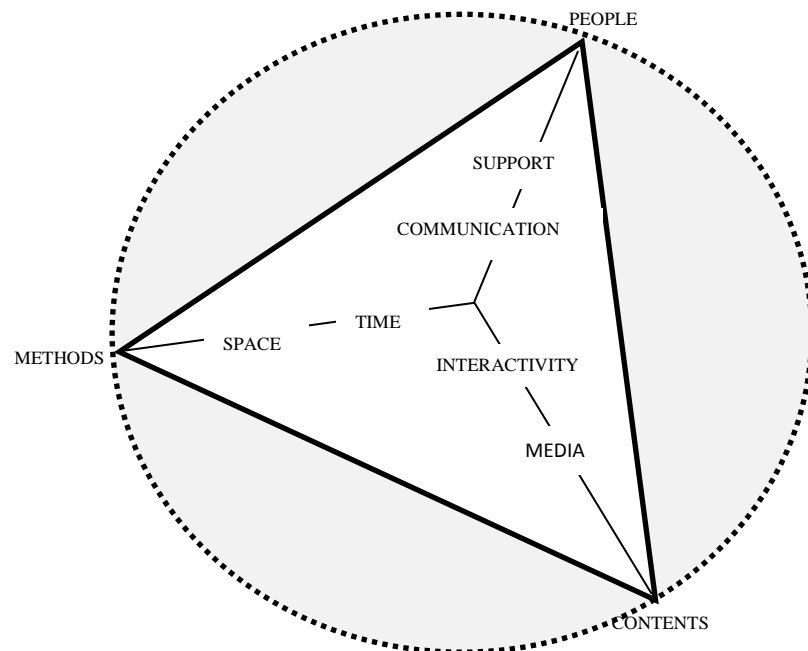


Figure 1.2 Triangle Model (Cantoni et al., 2007)

- *People:* An educational activity is firstly a communication process, and the people involved are the key components. ICT can increase the possibility of communications with new tools and modalities. Communication could be synchronous or asynchronous, related to the time dimension, and syntopic or asyntopic according to the space dimension. An important aspect related to this item is the support. Considering that the integration of ICT brings several changes in the educational scenario, it is fundamental to pay attention to the learners in their new condition of eLearner. Specifically, support can be related to the content of the educational process: students have the possibility to solve their problems or doubts about a specific subject. Support can be also related to the methods of teaching and learning: the support in this case helps the students focusing on the main topics or processes, and organizing their learning activities. Technological support refers to all the facilitations provided to the students in order to face technological problems that ICT-enhanced settings can bring. Choices of support are made according to the ICT level of the educational activity, and to the availability of the budget.
- *Methods* represent the educational activities that the learner is supposed to carry out. ICT can broaden the offer of educational activities which can be differently characterized by space and time dimension. Regarding space dimension, it is possible to have activities in the same space (syntopical activities) or in different spaces (asyntopical activities). The same happens within the time dimension: learners can attend an activity at the same time it is delivered by the teacher (synchronous activities) or in a different time (asynchronous activities). The variety of activities that ICT can provide under a variety of learning contexts is one of the main reasons for introducing eLearning.
- *Contents:* This item includes all materials employed during the educational activity. In particular, the model underlines two main aspects: the variety of the media and the interactivity aspect. ICT let the teacher and the learner use

different formats – e.g. images, audio, video, etc. – at the same time; interactivity is defined as the situation in which one receives appropriate feedback in response to an action. Because of ICT, it is possible to design interactive applications that are usually appealing for the learners, such as simulations. However, interactivity does not ensure successful learning.

The Triangle Model shows how the learning scenario may become more complex and rich with the integration of ICT. In fact, ICT do affect all elements of the model: technologies can modify the context, but also the strategies of learning and teaching (Cantoni et al., 2007). The new conditions of eLearner and eTeacher need to be taken into account for an effective learning activity to take place (Cuban, 2001).

This thesis focuses on teachers working in ICT-enriched contexts, and, in particular, aims at addressing how teachers' beliefs about technology influence their use at school and outside of school. The next section (1.2) proposes a theoretical framework through which examine this issue. Specifically, points to the need to understand teachers' beliefs about their knowledge as beliefs have been shown to be good predictors of behavior (Bandura, 1986).

1.2. The importance of beliefs

This section gives (1.2.1) a brief overview of the Social Cognitive Theory (Bandura, 1995), where the concept of self-efficacy plays a dominant role. This theory provides a framework that guides the reader to a better understanding of self-efficacy in human functioning. Moreover, this section shows (1.2.2) the key aspects of self-efficacy, presenting the main processes that self-efficacy control, and the four sources that are hypothesized to generate and alter self-efficacy. Finally, (1.2.3) self-efficacy are placed within the educational context, applied to the teaching context, and related to technology use. Computer self-efficacy

construct is then introduced and supported by a comprehensive literature review of measurement scales.

1.2.1. Social Cognitive Theory

A high level of knowledge and skills does not necessarily mean that an individual is actually using that knowledge or skill in her/his life. In fact, “what we know, the skills we possess, or what we have previously accomplished are not always good predictors of subsequent attainments because the beliefs we hold about our capabilities powerfully influence the ways we behave” (Pajares as quoted in Madewell and Shaughnessy, 2003, p. 381).

In 1977, Albert Bandura introduced the concept of self-efficacy with the publication of *Self-Efficacy: Toward a Unifying Theory of Behavioral Change*. Bandura defined self-efficacy as “people’s judgment of their capabilities to organize and execute courses of action required to attain designated types of performances” (Bandura, 1995, p. 391). This concept mainly contributed to Bandura’s research path to a definition of a new theory about human functioning, the Social Cognitive Theory. In 1986, with *Social Foundation of Thought and Action: a Social Cognitive Theory*, Bandura presented human functioning as a dynamic interplay of personal, behavioral, and environmental influences. How people interpret the results of their own behavior informs and alters their environments and personal factors, which, in turn inform and alter subsequent behavior. This is the foundation of Bandura’s (1986) conception of reciprocal determinism, the view that (a) personal factors in the form of cognition, affect, and biological events, (b) behavior, and (c) environmental influences create interactions that result in a process of triadic reciprocity.

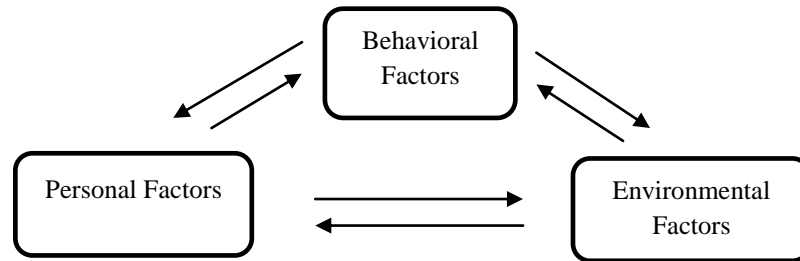


Figure 1.3 Bandura's Model of Triadic Reciprocity (1986)

Social cognitive theory provides an agentic view of human behavior in which individuals, through their own self-referent thoughts and feelings, can in part determine the course of actions they take. “Persons are neither autonomous agents nor simply mechanical conveyers of animating environmental influences. Rather, they make causal contribution to their own motivation and action within a system of triadic reciprocal causation” (Bandura, 1989, p. 1175). Individuals are active players in the environments in which they live, and they can change the development of the events.

1.2.2. Self-efficacy

Beliefs about individual's capabilities are considered a decisive factor in human functioning, specifically because “what people think, believe, and feel affects how they behave” (Bandura, 1986, p. 25). Consequently, people's behavior can often be better predicted by the beliefs people have about their capabilities to accomplish a particular task than their real capabilities. It is not unusual that a person with a high level of capability is unable to accomplish a task with desirable results or differs from other people with the same skills. Self-efficacy affects the results of people's actions and motivation to action, in part defining their behavior. In fact, people with low self-efficacy have low level of aspirations and stay away from complex tasks (Bandura, 1994; Schunk & Pajares, 2002).

They tend to avoid difficult situations, and when they have to face them, they focus on troubles and possible bad results instead of concentrating on how to perform successfully (Bandura, 1994). On the contrary, people with high level of self-efficacy face difficult situations as challenges, and increasing confidence about their capability to control what happens to them. They attribute failures to lack of skills or knowledge that they can acquire (Bandura, 1994; Schunk & Pajares, 2002).

Self-efficacy influences how people feel, think, motivate themselves and behave (Schunk & Pajares, 2002), and specifically it affects several human processes, such as selection, motivation, cognitive and affective processes. First of all, self-efficacy influences choices people make. A person usually selects tasks and activities s/he judges s/he can do according to her/his competencies and capabilities. On the contrary, a person tends to avoid tasks that s/he does not feel confident to accomplish. Positive perceptions about individuals' competencies can give the person an incentive in the completion of the task. Moreover, self-efficacy affects the effort that a person will spend in activities; specifically it influences perseverance and resilience in facing difficult situations. A high level of self-efficacy enables high level of persistence and resilience. Self-efficacy also controls the level of stress and anxiety. In fact, low level of self-efficacy can interfere in the perception of a situation people have to face, creating a sense of anxiety instead of serenity. Self-efficacy plays an important role in individuals' thought patterns and emotional reactions (Schunk & Pajares, 2002).

There are several factors that can influence the relationship between self-efficacy and human behavior. Bandura (1986) underlines the importance of correctly measuring the level of self-efficacy: it is fundamental to clarify which are the skills required to accomplish an activity in order to measure self-efficacy truly affecting that activity. Consequently, when competences required by a specific task are not clear, self-efficacy can wrongly affect the success of the task (Schunk & Pajares, 2002).

Self-efficacy can be confused with outcome expectations, which refer to people's judgments of the results of their own actions. Bandura (1977) defines outcome expectations as "a person's estimate that a given behavior will lead to certain outcomes" (p. 193). Self-efficacy, instead, is the judgment that a person gives to her/his capabilities required to reach those outcomes. Often these two judgments are closely aligned, but not always. For example, a student believes s/he can do well in Math, but her/his teacher does not like her/him. In this case the student has high level of self-efficacy and low outcome expectations, because the situation is out of her/his control.

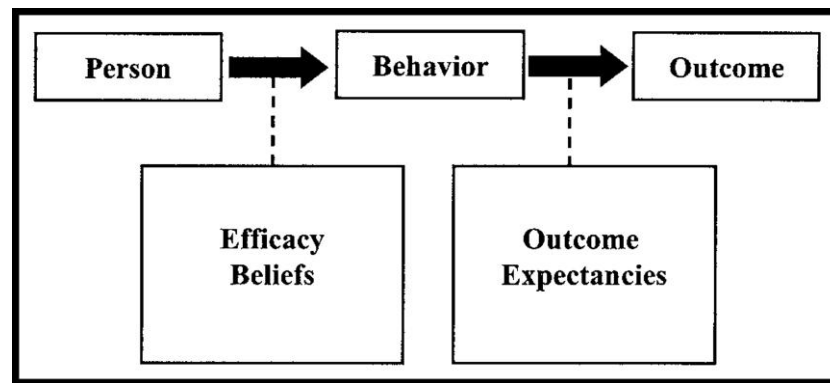


Figure 1.4 Efficacy beliefs and Outcome Expectations (Bandura, 1977)

Another frequent misunderstanding is the use of self-efficacy and self-esteem interchangeably. In fact, as highlighted by Bandura (1997), they are two different constructs. The first refers to judgments about one's capability, while the second concerns judgments about self-worth. These two constructs do not have a defined relationship. People can judge themselves as more or less efficacious in performing a specific activity without changing their judgments of self-worth.

Bandura (1977) hypothesized four main sources of influence on self-efficacy, namely mastery experiences, vicarious experiences, social persuasion, and emotional and psychological states.

- *Mastery experiences* are the most effective means of creating a sense of self-efficacy. These in fact represent the memories of past successful experiences that individuals may revert to while facing current or future situations. Positive mastery experiences reinforce self-efficacy, while negative mastery experiences weaken it.
- *Vicarious experiences* emanate from the observation of peers or “models”: a process of comparing oneself to other individuals. Seeing these models succeed may increase the observer’s self-efficacy, while seeing them fail may weaken self-efficacy. This process is intensified the more the observer regards him/herself as similar to the model.
- *Social persuasion* represents verbal judgment that others provide. It is possible that one’s self-efficacy may increase if one is encouraged or positively evaluated by others. Likewise, negative persuasion can weaken one’s self-efficacy.
- *Emotional and psychological states* represent one more source of self-efficacy. Individuals often consider that their skills are related to the way they feel in a particular moment (e.g., mood, anxiety, stress), which can positively or negatively influence self-efficacy (Bandura, 1997).

1.2.3. Teacher self-efficacy and its measures

Due to its relevance in predicting human behavior, self-efficacy has been widely studied in several contexts (e.g. health, sport, business, media). Education is certainly one of the most explored. Specifically, teacher self-efficacy (TSE) is considered one of the most decisive self-beliefs that can predict teachers’ professional behaviors (Coladarci, 1992; Gibson & Dembo, 1984; Guskey, 1984; Klassen et al., 2011; Skaalvik & Skaalvik, 2007; Tshannen-Moran & Woolfolk-Hoy, 2001). Teachers with a high level of self-efficacy believe that they can

teach difficult students with extra effort and suitable strategies, and consider family support as an important added value in the effectiveness of their teaching activities (Bandura, 1997). On the contrary, teachers who do not consider themselves efficacious in their teaching activities believe that they can do little to motivate difficult students, and they usually consider family unsupportive for the development of the students (Bandura, 1997).

Since the 1970s, this construct has been studied and measured, firstly by the RAND (*Research AND Development*) organization (Armor et al., 1976) who created two specific items that were part of a broader questionnaire, to evaluate teachers' beliefs about the extent to which they believe that they can control their teaching practice. RAND's researchers worked on teacher self-efficacy having Rotter's locus of control (1966) as theoretical framework. Locus of control is defined by Rotter as the extent to which individuals believe that they can control events that affect their life; it can be internally or externally controlled. RAND's researchers suggested that TSE as well can be internally or externally controlled. According to the two items, they recognized respectively two types of TSE, namely general teacher efficacy (GTE), and personal teacher efficacy (PTE): the first related to what a teacher can do to face external factors, and the second related more to teacher's individual experiences.

Guskey, in 1981, created a 30-items scale measuring Responsibility for Student Achievement (RSA). Specifically, RSA measures the extent to which teachers feel themselves responsible for students' outcomes, and comprises two subscales associated with students' success and failure. In the same year, Rose and Medway created the Teacher Locus of Control scale comprising 28 items aiming at measuring teachers' responsibility for students' success or failure, internally or externally controlled. This scale has never been widely accepted by researchers due to weak scores in the relationship with the RAND scale (α from 0.11 to 0.41). The same path has been followed by the Webb scale (Ashton et al., 1982),

structured with a forced-choice format: teachers have to choose between couples of statements about their professional behaviors.

Bandura (1977) contributed to a deeper understanding of TSE. He suggested an alternative to Ritter's locus of control to study teacher's professional behaviors. Bandura highlighted the context specificity of TSE. Ashton, Buhr, and Crocker, (1984) proposed a series of vignettes describing scenarios: teachers were asked to judge their confidence in managing a particular situation. In the same year, Gibson and Dembo (1984) developed a new scale having the RAND's structure, but applying Bandura's conceptual foundation. Through factor analysis, they recognized two factors tracing back to Bandura's self-efficacy and outcome expectancy. These factors are known as Personal Teaching Efficacy ($\alpha = 0.75$) and Teaching Efficacy ($\alpha = 0.79$). This scale has been applied to several specific contexts, such as science teaching (STEBI scale by Riggs & Enochs, 1990), classroom management (Emmer, 1990), and special education (Coladarci & Breton, 1997). Though widely used, some statistical and conceptual issues remain (Tschannen-Moran & Woolfolk-Hoy, 2001).

In response to the increasing number of scales measuring TSE, Bandura (1997) created a scale which included different levels of task demands and measured a variety of teachers' activities (Tschannen-Moran, Woolfolk-Hoy, & Hoy, 1998). Bandura's scale was composed of 30 items, with seven subscales related to different types of teaching tasks: efficacy to influence decision making, efficacy to influence school resources, instructional efficacy, disciplinary efficacy, efficacy to enlist parental involvement, efficacy to enlist community involvement, and efficacy to create a positive school climate. Information about validity and reliability of this scale has not been published.

Tschannen-Moran, Woolfolk-Hoy and Hoy (1998) provided a review of the main studies about TSE from 1986 to 1997, highlighting in particular: a lack of qualitative studies, a need for longitudinal studies to assess development and stability of TSE (Henson, 2001; Klassen et al. 2011), a lack of studies about

sources of TSE (Henson, 2001), and collective TSE (Goddard, Hoy, & Woolfolk-Hoy, 2004).

Tschannen-Moran and Woolfolk-Hoy (2001) proposed a new model of TSE analyzing previous TSE studies with the aim of bringing together the two main TSE research paths – Bandura and Rotter’s point of view on TSE. The Ohio State Teacher Efficacy scale (OSTES), later named Teachers’ Sense of Teacher Efficacy scale, was tested in long form (24 items) and short form (12 items). It was composed of three factors: efficacy for instructional strategies, efficacy for classroom management, and efficacy for student engagement. With three factors, OSTES addressed some limitations of previous scales by assessing a broader range of teaching tasks. Tschannen-Moran and Woolfolk-Hoy (2001) tested the scale with pre-service and in-service teachers, claiming their scale was “reasonably valid and reliable”.

Klassen and colleagues (2011) classified 218 articles from 1998 to 2009, analyzing some characteristics of the studies, such as methodology, domain specificity, internationalization, collective efficacy, sources of TSE, and teacher’s grade level. Results suggest researchers started answering to the need for qualitative studies highlighted by Tschannen-Moran, Woolfolk-Hoy and Hoy (1998): qualitative and mixed methods studies increased (e.g. Cantrell & Callaway, 2008; Cheung, 2008), as well as longitudinal studies (e.g. Brouwers & Tomic, 2000; Henson, 2001; Woolfolk-Hoy & Spero, 2005). Collective efficacy and sources of TSE need to be explored more. Klassen and colleagues (2011) noticed that invalid measurements are currently in use; scales focus more on teacher’s control of students’ outcomes instead of teachers’ capabilities to teach students.

A selected literature review on Teacher Self-Efficacy measurement scales is proposed in Table 1.1. This literature review has been conducted on PsycINFO, Web of Science, and Behavioral Science Collection as databases, using as keywords *Self-Efficacy* and *Teacher*, and *Teacher Self-Efficacy*. The aim of this

literature review was to look at the Teacher Self-Efficacy measurement scales applied by researchers, and the main results they observed. The focus was set on journal articles, which provided empirical studies, conducted with quantitative or mixed methodology, not addressing job satisfaction or sources of teacher self-efficacy as main focus of the study. Fifty four articles out of the initial 102 were analyzed, and 22 of them (studies with $N > 200$) are reported in table (Table 1.1). The table provides the authors and the year of publication, the sample of the study, the instruments used with the scale's items number and reliability (Cronbach's alpha); the main results of the each study are also reported.

Table 1.1 Selected Literature Review of Teacher Self-Efficacy Studies

| Authors | Participants | Instruments | Main Findings |
|--|--------------------------|---|---|
| Brouwers & Tomic (2001) | 832 in-service teachers | <ul style="list-style-type: none"> Teacher interpersonal self-efficacy scale (29 items; $\alpha = .91$) | It was hypothesized that the three Teacher Interpersonal Self-Efficacy subscales comprised three different activities linked to teacher self-efficacy (classroom management, elicit support from colleagues, and elicit support from principals). The three-factor model fits the data better than either a two-factor or one-factor alternate model. |
| Caprara, Barbaranelli, Borgogni & Steca (2003) | 2688 in-service teachers | <ul style="list-style-type: none"> Perceived self-efficacy (12 items; $\alpha = .74$) Perceived collective efficacy (9 items; $\alpha = .82$) Perceptions of the behavior of various constituencies in the school community (29 items; $\alpha = .80$) Job satisfaction (4 items; $\alpha = .82$) | The perceptions that teachers have of other constituencies' behavior largely mediated the links between self and collective-efficacy beliefs. Collective-efficacy beliefs, in turn, partially mediated the influence that teachers' perceptions of other school constituencies' behavior exerts on their own job satisfaction. |

| Authors | Participants | Instruments | Main Findings |
|---------------|--|--|---|
| Çayci (2011) | 366 pre-service teachers | <ul style="list-style-type: none"> Teacher efficacy scale (Gibson & Dembo, 1984); Turkish version; 16 items; $\alpha = .71$ Attitude scale regarding teaching profession (Özgür, 1994); 33 items; $\alpha = .75$ | According to the results there is a positive and meaningful relationship between the elementary teacher candidates' teacher efficacy and their attitudes towards the profession of teaching. |
| Chan (2008) | 188 pre-service / 88 in service teachers | <ul style="list-style-type: none"> General self-efficacy scale (Schwarzer et al., 1999); 10 items; $\alpha = .82$ Collective self-efficacy scale (Schwarzer et al., 1999); 12 items; $\alpha = .92$ Seven domain-specific sets of teacher self-efficacy beliefs (Schwarzer et al., 1999); 18 items; $\alpha = .91$ | The experienced teachers reported the highest level of global and domain-specific teacher self-efficacy, suggesting that there could be a trend of rising teacher self-efficacy as a teacher went through preparation and teaching practice to becoming a novice and then a more experienced teacher. |
| Cheung (2008) | 725 Hong Kong / 575 Shanghai in service teachers | <ul style="list-style-type: none"> Teachers' sense of efficacy scale (Tschannen-Moran & Woolfolk Hoy, 2001); Hong Kong and Shanghai version; 12 items; $\alpha = .70$ | Hong Kong in-service teachers had lower efficacy scores than the Shanghai counterparts. |

| Authors | Participants | Instruments | Main Findings |
|-----------------------------------|--|--|---|
| Coladarci (1992) | 364 in-service teachers | <ul style="list-style-type: none"> • Commitment to teaching, 1 item • Teacher efficacy scale (Gibson & Dembo, 1984); 8 items; $\alpha = .75$ • School climate, 30 items; $\alpha = \text{NA}$ | Greater teaching commitment tended to be expressed by those teachers who were higher in teacher self-efficacy; who taught in schools with fewer students per teacher; who worked under a principal regarded positively in the area of instructional leadership, school advocacy, decision making, and relation with students and staff. |
| Cruz & Arias (2007) | 211 in-service teachers / 188 pre-service teachers | <ul style="list-style-type: none"> • Teacher efficacy scale (Gibson & Dembo, 1984); Spanish version; 26 items; $\alpha = .79$ | Factor analysis showed three principal factors: classroom management/discipline efficacy, personal teaching efficacy and general teaching efficacy. Analyses which compared efficacy expectancies showed significant differences in the management/discipline dimension in favor of the group of in service teachers. Differences in management/discipline dimension in terms of the number of years' experience in the group of in-service teachers emerged. |
| Denzine, Cooney & McKenzie (2005) | 387 pre-service teachers | <ul style="list-style-type: none"> • Prospective teachers' sense of efficacy scale (Woolfolk Hoy, 1990); 22 items; $\alpha = .72$ | The proposed two- and three-factor models of Teachers' Sense of Efficacy Scale for prospective teachers were rejected. A re-specified three-factor model of the Teachers' Sense of Efficacy Scale was then derived from theoretical and empirical considerations. The re-specified model hypothesized three dimensions: self-efficacy beliefs, outcome expectations, and external locus-of-causality. |

| Authors | Participants | Instruments | Main Findings |
|--|---|---|--|
| Shireeen-De Souza, Boone & Yilmaz (2004) | 300 in-service teachers | <ul style="list-style-type: none"> Science efficacy instrument- STEBI (Riggs & Enochs, 1990); 23 items; $\alpha = .89$ | Parametric tests suggested that self-efficacy and outcome expectancy measures correlated highly for middle school teachers, for those that did not have a science degree and a written science curriculum. Significant predictors of self-efficacy are: minutes per week science is taught, educational level, number of days in the school year, holding of a science degree, and the presence of a science curriculum. |
| Erdem & Demirel (2007) | 346 pre-service teachers | <ul style="list-style-type: none"> Student-teachers' self-efficacy beliefs toward teaching (28 items; $\alpha = .92$) | The results of the study were strongly supported by the validity and reliability of the survey. Cronbach's alpha was calculated and the reliability coefficient was 0.92. A single-factor model was specified for the structure of the survey as anticipated. |
| Fives & Buehl (2010) | 102 in-service / 270 pre-service teachers | <ul style="list-style-type: none"> Teacher's sense of efficacy scale (Tschannen-Moran & Woolfolk Hoy, 2001); 24 items; $\alpha = .95$ | Teachers with 10 or more years of teaching experience and those teaching at the elementary level reported higher levels of efficacy than did pre-service teachers or those teaching at the middle or high school levels, respectively. |

| Authors | Participants | Instruments | Main Findings |
|------------------------------------|----------------------------------|---|--|
| Gencer & Cakiroglu (2007) | 584 pre-service science teachers | <ul style="list-style-type: none"> Science teaching efficacy belief instrument - STEBI Turkish version (Tekkaya et al.,2004); 23 items; $\alpha = .79$ Attitudes and beliefs on classroom control - ABCC (26 items; $\alpha = .73$) | Data analysis indicated that pre-service science teachers generally expressed positive efficacy beliefs regarding science teaching. In addition, results revealed that participants were interventionist on the instructional management dimension, whereas they favored non-interventionist style on the people management dimension of the ABCC inventory. |
| Goddard & Skrla (2006) | 1981 in-service teachers | <ul style="list-style-type: none"> Collective efficacy beliefs scale (21 items; $\alpha = .94$) | The results of two-level hierarchical linear models indicated that a school's past academic achievement, rate of special program placement for gifted children, and faculty ethnic composition explained 46% of the variation among schools in perceived collective efficacy. The article also reports a much smaller but statistically significant relationship between collective efficacy beliefs and teacher race and experience. Teachers of color and those with more than 10 years experience reported slightly higher levels of perceived collective efficacy. |
| Goddard, Hoy & Woolfolk Hoy (2002) | 452 in-service teachers | <ul style="list-style-type: none"> Collective teacher efficacy (21 items; $\alpha = .94$) | Collective teacher self-efficacy was positively associated with differences between schools in student-level achievement in both reading and mathematics. |

| Authors | Participants | Instruments | Main Findings |
|---|--|---|--|
| Guksey & Passaro (1994) | 59 pre-service 283 in-service teachers | <ul style="list-style-type: none"> Teacher efficacy scale (Gibson & Dembo, 1984); 8 items; $\alpha = .75$ | Two-factor solution that accounted for 32 % of the variance in scale scores. Contrary to previous research, these factors corresponded not to a personal versus teaching efficacy distinction, but instead to a simpler internal versus external distinction, similar to locus-of-control measures of causal attribution. |
| Klassen, Bong, Usher, Chong, Huan, Wong & Georgiou (2009) | 1211 in-service teachers | <ul style="list-style-type: none"> Teachers' sense of efficacy scale (Tschannen-Moran & Woolfolk Hoy, 2001); 24 items; $\alpha = .95$ Job satisfaction (Caprara et al., 2003); 1 item | Teacher sense of efficacy scale showed convincing evidence of reliability and measurement invariance across the five countries (Canada, Cyprus, Korea, Singapore, and the United States), and the relationship between the Teacher sense of efficacy scale and job satisfaction was similar across settings. |
| Klassen & Ming Chiu (2010) | 1430 in-service teachers | <ul style="list-style-type: none"> Teachers' sense of efficacy scale (Tschannen-Moran & Woolfolk Hoy, 2001); 24 items; $\alpha = .95$ Job stress (Chaplain, 2008); 1 item Job satisfaction (Caprara et al., 2003); 1 item | Teachers' years of experience showed nonlinear relationships with all three self-efficacy factors, increasing from early career to mid-career and then falling afterwards. Female teachers had greater workload stress, greater classroom stress from student behaviors, and lower classroom management self-efficacy. Teachers with greater workload stress had greater classroom management self-efficacy, whereas teachers with greater classroom stress had lower self-efficacy and lower job satisfaction. Teachers with greater classroom management self-efficacy or greater instructional strategies self-efficacy had greater job satisfaction. |

| Authors | Participants | Instruments | Main Findings |
|---------------------------------------|---------------------------|--|--|
| Lin & Gorrell (2001) | 714 pre-service teachers | <ul style="list-style-type: none"> Teacher efficacy scale (Gibson & Dembo, 1984); 8 items; $\alpha = .75$ | Taiwan pre-service teachers' efficacy beliefs are influenced by cultural and/or social backgrounds, by the respective programs, by the context of their studies, and by their increasing experience. |
| Skaalvik & Skaalvik (2007) | 244 in-service teachers | <ul style="list-style-type: none"> Teacher self-efficacy (24 items; $\alpha = .90$) Perceived collective teacher efficacy (6 items; $\alpha = .79$) External control (5 items; $\alpha = .79$) Teacher burnout (Maslach et al., 1996); 22 items $\alpha = .89$ | They found strong support for 6 separate but correlated dimensions of teacher self-efficacy, which were included in the following subscales: instruction, adapting education to individual students' needs, motivating students, keeping discipline, cooperating with colleagues and parents, and coping with changes and challenges. Teacher self-efficacy was conceptually distinguished from perceived collective teacher efficacy and external control. Teacher self-efficacy was strongly related to collective teacher efficacy and teacher burnout. |
| Tariq-Ahsan, Sharma & Deppeler (2012) | 1623 pre-service teachers | <ul style="list-style-type: none"> Teacher efficacy for inclusive practice scale - TEIP (Sharma, Loreman & Forlin, 2011); 18 items; $\alpha = .89$ Sentiments, attitudes, concerns regarding inclusive education scale – SACIE (Loreman, Earle, Sharma & Forlin, 2007); 15 items; $\alpha = .63$ | It was found that variables such as length of training, gender, interaction with persons with disabilities, knowledge about local legislation, and level of training involved had significant relationship with participants' perceived teaching-efficacy, attitudes and concerns. In addition, it was also found that pre-service teachers' perceived teaching efficacy is correlated to their attitudes towards inclusive education. |

| Authors | Participants | Instruments | Main Findings |
|---------------------------------------|---|---|--|
| Tschannen-Moran & Woolfolk Hoy (2001) | 1 st study: 224, 2 nd study: 217, 3 rd study: 410 teachers | <ul style="list-style-type: none"> Teachers' sense of efficacy scale (Tschannen-Moran & Woolfolk Hoy, 2001); 24 items; $\alpha = .95$ | The scale validation process suggested three factors: instruction strategy (.86), classroom management (.86), and student engagement (.81). |
| Tschannen-Moran & Woolfolk Hoy (2007) | 255 in service teachers | <ul style="list-style-type: none"> Teachers' sense of efficacy scale (Tschannen-Moran & Woolfolk Hoy, 2001); 24 items; $\alpha = .95$ | Contextual factors such as the teaching resources and interpersonal support available were found to be much more salient in the self-efficacy beliefs of novice teachers. Among experienced teachers, for whom an abundance of mastery experiences were available, contextual factors played far less important a role in their self-efficacy beliefs. |

Focusing on the main results of the studies proposed in Table 1.1, it is possible to group the articles according to some key topics. Chan (2008) explored differences in teacher self-efficacy between experienced and novice teachers. Experienced teachers reported the highest level of self-efficacy. Fives and Buehl (2010) also investigated this topic, confirming Chan's findings. Cheung (2008) compared teachers from two different locations customizing the teacher self-efficacy scales to its research context. Denzine, Cooney, and McKenzie (2005) focused on pre-service teachers validating a teacher self-efficacy scale for pre-service teachers. Also Lin and Gorrell (2001) focused on pre-service teachers, confirming that teaching experience was a factor effecting teacher self-efficacy.

Goddard, Hoy and Woolfolk Hoy (2002) explored collective teacher self-efficacy related to student achievement. Moreover, Goddard and Skria (2006) investigated collective teacher self-efficacy as a function of race and teaching experience. Skaalvik and Skaalvik (2007) found a strong relationship between teacher self-efficacy and collective teacher self-efficacy. Caprara and colleagues (2003) investigated the relationship between teacher self-efficacy, collective self-efficacy, and job satisfaction.

Çayci (2011) reported a positive relationship between teacher self-efficacy and teachers' attitudes to their job. Furthermore, Coladarci (1992) observed that teachers who were higher in teacher self-efficacy reported higher levels of teaching commitment. Klassen, and colleagues (2009) explored the relationship between teacher self-efficacy and job satisfaction among different settings, reporting no relevant variations.

Brouwers and Tomic (2001), Cruz and Arias (2007), and Tschannen-Moran and Woolfolk Hoy (2001; 2007) focused on teacher self-efficacy measurements. They validated new scales studying their dimensions and factors.

Concerning the instruments used, Table 1.1 presents a variety of teacher self-efficacy scales. However, the most recurring instrument (31%) is the Teacher

Sense of Efficacy Scale proposed by Tschannen-Moran and Woolfolk-Hoy (2001). Researchers tested this instrument in different contexts confirming its validity and reliability.

1.2.4. Computer self-efficacy and its measures

Self-efficacy is a key factor in predicting behavior (Bandura, 1977). It was studied in computer based activities as Computer self-efficacy (CSE), and defined by Compeau and Higgins (1995) as “a judgment of one’s capability to use a computer” (p. 192). Research about CSE started in mid-1980s, with Hill, Smith and Mann (1986; 1987), who created a scale measuring self-efficacy regarding usage of computers within undergraduate students. “Beliefs of efficacy regarding computers exert an influence on the decision to use computers that is independent of people beliefs about the instrumental value of doing so” (Hill, Smith & Mann, 1987, p. 307). Miura (1987) explored gender differences in CSE related to course enrollment at college level. According to her study, men rated themselves higher in CSE than women did. Concerning gender issues, Murphy, Coover and Oven (1989) validated a Computer Self-Efficacy Scale composed of 32 items. With a sample of 414 individuals engaged in a computer-based course, differences in male and female judgment of their capabilities in using computer were established. Gist, Schwoerer, and Rosen (1989) proposed a CSE scale composed of five items assessing efficacy on specific aspects of computer utilization over six levels of difficulty. CSE was positively related to performance.

Tarkzade and Koufteros (1994) validated a 30-items CSE scale, measuring the relationship between computer training and CSE within undergraduate students. Results suggested that both male students and female students increased CSE while attending computer training. An important contribution to CSE was established by Compeau and Higgins (1995). Using a survey with manager and

professional, they validated a 10-item task-oriented CSE scale. Marakas and colleagues (1998) argued “results obtained to date have, in some cases, been either equivocal or contradictory” (p. 126). They provided a literature review of studies about CSE, shedding light on weaknesses and strengths of each study. Moreover, they made a distinction in CSE according to generalization category (e.g. Compeau and Higgins, 1995) defining Task Specific Computer Self-Efficacy (CSE) as “an individual perception of efficacy in performing specific computer-related tasks within the domain of general computing” (p.128). Furthermore, they defined General Computer Self-Efficacy (GCSE) as “an individual's judgment of efficacy across multiple computer application domains” (p. 128).

Cassidy and Eachus (2002) created the Computer User Self-Efficacy scale, and validated it with academic and administrative people from university level. The aim of their study was to investigate the relationship between CSE, gender and experience in computer usage. A positive correlation between experience and CSE was reported. Men rated themselves higher in CSE than women. Moss and Azevedo (2009) provided an important literature review of CSE, specifically related to Computer-Based Learning Environments (CBLE). They organized the literature review according to three main research questions (a) what factors are related to the development of Computer Self-Efficacy? (b) What is the relationship between self-efficacy and learning outcomes with CBLEs? and (c) What is the relationship between self-efficacy and learning processes with CBLEs? Results suggested that “both behavioral and psychological factors are related to computer self-efficacy” (p. 591). Moreover, it emerged that “computer self-efficacy is related to learning outcomes with CBLEs” (p. 591).

This section proposed a brief review of some of the main studies about computer self-efficacy. It showed that several researchers studied computer self-efficacy in different fields, and education appears to be one of the most explored.

1.3. Relevance of the reviewed literature

This section is devoted to shed light on the significance of theories and previous studies reported in the review of the literature for this thesis. The theoretical framework of this work is diverse and refers to different research areas, from educational technology to Social Cognitive Theory (Bandura, 1977).

The first part of the theoretical background (1.1) is related to the introduction of ICT in the educational context. Specifically, the Media Education framework was presented as a guide for better understand the role of ICT in the educational context. Roger's Diffusion Theory (2003) contributed to this thesis showing the processes of adoption and integration of ICT. Moreover, the Triangle Model was an inspiration in defining the role played by the people involved in the educational process, inter alia the teachers. The first part of the chapter framed the issue addressed in this thesis that is teacher's integration of ICT in schools.

The second part of the theoretical framework (1.2) let the author do a further step in defining the topic of this work. Efficacy beliefs in the framework of Social Cognitive Theory (Bandura, 1977) were presented and adopted as main focus of this thesis. Specifically, teacher self-efficacy and computer self-efficacy were defined and studied as efficacy beliefs related to teaching activities and technology use. The author then proposed a review of articles mentioning measurement scales about teacher self-efficacy and computer self-efficacy. All the articles presented in these reviews have been studied and considered to address the first research question (RQ1) – What is the relationship between teacher self-efficacy and computer self-efficacy?

Chapter 2: Exploratory field case studies

In addition to the literature review, exploratory field case studies were conducted in Brazil and South Africa to investigate the relationship between teachers' self-efficacy and their use of technology. This chapter illustrates the milestones of these studies in which teacher's beliefs about their use of technology were analyzed. In this chapter, the first research question (RQ1) is addressed. Specifically, it provides (2.1) the outline of the BET K-12 (Brazilian eLearning Teacher Training in K-12) project, and (2.2) the description of the MELISSA (Measuring E-Learning Impact in primary Schools in South African disadvantaged areas) project. Finally, this chapter offers (2.3) an overview of the limitations and the outlook of the projects.

Parts of this chapter have been already published in the following articles/book chapters:

Fanni, F., Rega, I., & Cantoni, L., (2013). Using self-efficacy to measure primary school teachers' perception of ICT: Results from two studies. *International Journal of Education and Development using Information and Communication Technology*, 9(1), 100-111.

Rega, I. & Fanni, F. (2012). Measuring primary schools teacher's perception of ICT through self-efficacy: A case study. *Journal of Universal Computer Science*, 18(3), 410-428.

Cantoni, L., Fanni, F., Rega, I., & Tardini, S. (2009). Fostering digital literacy of primary teachers in community schools: The BET K-12 experience in Salvador de Bahia. In S. Marshall, W. Kinuthia & W. Taylor (Eds.), *Bridging the Knowledge Divide. Educational Technology for Development* (pp. 415-433). Charlotte, NC: Information Age.

2.1. BET K-12 project

In the following sections the BET K-12 project is outlined. In particular, (2.1.1) context, (2.1.2) methodology, and (2.1.3) main results of the project are described.

2.1.1. Context

In Brazil, the Federal Government's law n. 4019/2004 requested teachers to obtain a university degree in order to keep on teaching. Even if the first foreseen deadline – year 2012 – has been postponed, this law has promoted an important and positive mobilization among teachers, which resulted in a significant growth in the demand of updating-courses, especially for in-service teachers who did not possess the required university degree. Even if the goal of the government's decision is to improve of teacher preparation and, as a consequence, of the quality of Brazilian school system, it could cause negative side effects, such as the closure of disadvantaged schools for a lack of graduate teachers. For this reason the training of teachers, particularly of those who live in disadvantaged areas, is still a crucial issue for the Brazilian school system.

In this context, in 2005 started the three-year project named BET K-12 – Brazilian eLearning Teacher Training in K-12. It was run by the New Media in Education Laboratory (NewMinE Lab) housed at the Università della Svizzera italiana (Switzerland), in partnership with a Brazilian NGO (CEAP – Centro de Estudo e Assessoria Pedagógica) active in the teacher training field, and the Universidade Federal de Bahia. BET K-12 project was funded by the Swiss National Science Foundation and the Swiss Agency for Development and Cooperation. The aim of the project was to help primary school teachers in community schools in a disadvantaged area of Salvador (State of Bahia, Brazil) to obtain the university degree by training them in the use of ICT and in the implementation of ICT in their teaching activities. Specifically, the NewMinE

Lab designed and developed two blended learning courses to be introduced into the CEAP curriculum:

- *ICT in Educational Contexts*: twenty-hour course approaching three main topics, namely website qualitative assessment, strategies to learn online and strategies to teach online;
- *Communication Theory*: sixty-hour course addressing three main issues, namely principles of logics, principles of linguistics and text production.

Moreover, a basic face-to-face twenty-hour course on *Computer Literacy* was added to the CEAP curriculum to provide teachers with the necessary technical skills and knowledge to become eLearners.

2.1.2. Participants and methods

The study oversaw two rounds of data gathering designed in two different research settings: the first one, named *First round*, semi-experimental, and the second one, named *Second round*, experimental.

Participants in this study were primary school teachers ($n = 109$) working in disadvantaged areas in the Salvador the Bahia. Forty-four of them took part in the *First round*, and 65 teachers were part of the *Second round*, 35 randomly assigned as experimental group and 30 randomly assigned as control group. BET K-12 sample has been selected according to the following criteria:

- can access computers and network facilities, in order to be trained and to access the online part of the curriculum;
- show a great motivation in the learning experience;
- lack prior computer skill;

- be part of the BET K-12 network, and agreed with project research and educational statement.

BET K-12 teachers were all Brazilian, and their average age was 34 ($SD = 8.34$). The majority was female, except for 2 men. On average they have been teaching for 9 years ($SD = 5.23$).

In order to measure the impact of ICT on teacher practices, a questionnaire was designed evaluating computer and teacher self-efficacy and their changes (if any) along both rounds (pre-post test). Computer self-efficacy (CSE) questions were based on the questionnaire validated by Compeau and Higgins (1995). This contains 10 items that refer to the use of software in a given educational context; for each item a Likert scale from 1 to 10 was provided, where 1 stands for “not at all confident” and 10 stands for “totally confident”. These 10 items were repeated for all the technologies presented in the curriculum. For teacher self-efficacy (TSE), the Teacher’s Sense of Efficacy Scale validated by Tschannen-Moran and Woolfolk Hoy (2001) was adopted. In this scale, 12 items - divided into 3 categories: *student engagement*, *instructional strategies* and *classroom management* - refer to different aspects of the teaching activity; for each question a Likert scale from 1 to 9 was provided, where 1 stands for “nothing” and 9 stands for “a great deal”. Teachers were asked to answer these questions indicating how they would consider themselves capable of accomplishing each given teaching activity. A section of demographic information was also added to the questionnaire, in order to describe the sample and investigate teachers’ use and exposure to technology.

Data were gathered through paper questionnaires in four occasions both in *First round* and *Second round*. Descriptive statistical analysis was performed using MS Excel. F-Test and regression analysis were computed using SPSS software.

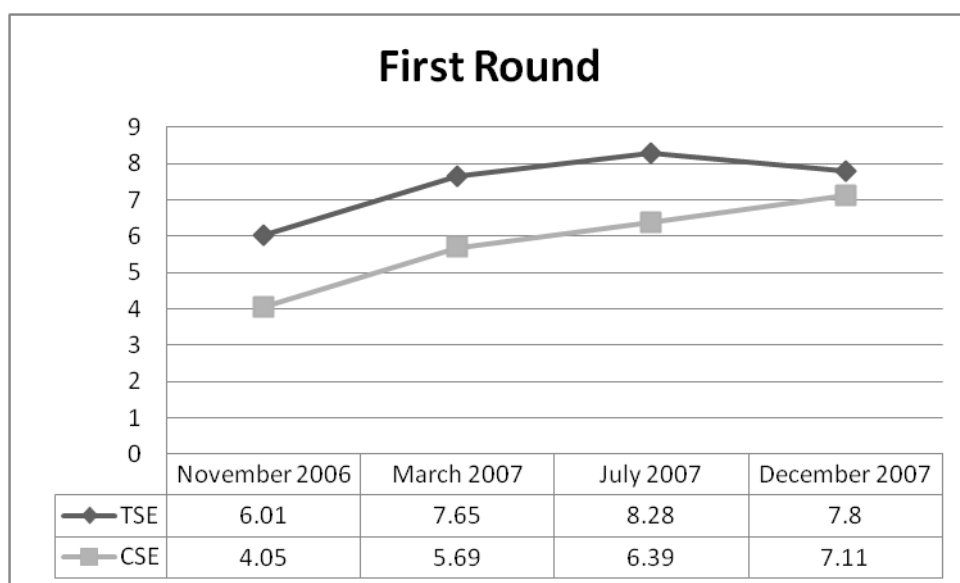
The research hypotheses that were tested through the aforementioned methodology are:

- H1: the increase of technological skills promoted by the attendance to the proposed curriculum causes an increase in CSE;
- H2: the increase of CSE influences an increase in TSE.

2.1.3. Results

In the *First round*, BET K-12 researchers delivered the teacher training curriculum from November 2006 to July 2007 to a group of 44 teachers ($n = 44$). TSE and CSE were measured in a semi-experimental context in four specific moment of the curriculum delivery: beginning of the course (November 2006), middle of the course (March 2007), end of the course (July 2007), and a follow-up (December 2007).

Figure 1 shows that CSE mean values significantly increased throughout the project (Positive F-Test in all four data collections, $p < .05$); TSE grew within the first three data collections, but decreased in the last collection (Positive F-Test in all four data collections, $p < .05$).

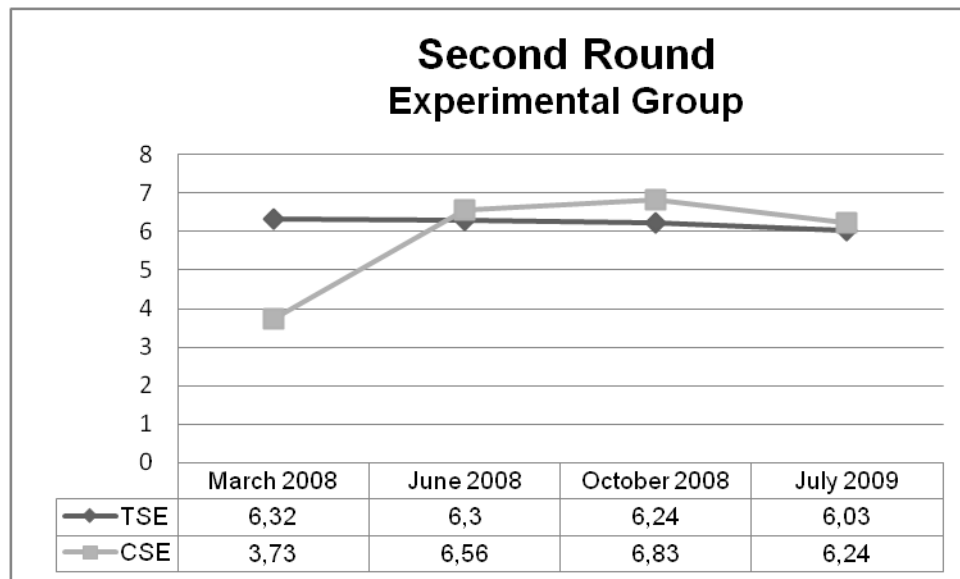


Note. TSE = Teacher self-efficacy. CSE = Computer self-efficacy.
 Data are normalized to a 10 grade scale.
 N = 44.

Figure 2.1 Teacher and Computer Self-Efficacy During the Project Time Span – First Round

The regression analysis shows that in November 2006 β value was 0.19** ($R^2 = 0.16$), in March 2007 $\beta = 0.23^*$ ($R^2 = 0.11$), in July 2007 $\beta = 0.28^{**}$ ($R^2 = 0.26$), and $\beta = 0.31^{**}$ ($R^2 = 0.11$) in the last data collection. Results supported both hypotheses (H1) and (H2).

BET K-12 researchers decided to adopt an experimental setting with an experimental group composed of 35 teachers attending the project's curriculum and a control group composed of 30 teachers. TSE and CSE were measured in four specific moments of the curriculum delivery: beginning of the course (March 2008), middle of the course (June 2008), end of the course (October 2008), and a follow-up (July 2009). In this case the first hypothesis (H1) was verified, while the second one (H2) was not, as Figure 2 shows. CSE mean values significantly increased along the project (Positive F-Test in all four data collections, $p < .05$); TSE remained statistically the same (Negative F-Test in all four data collections).



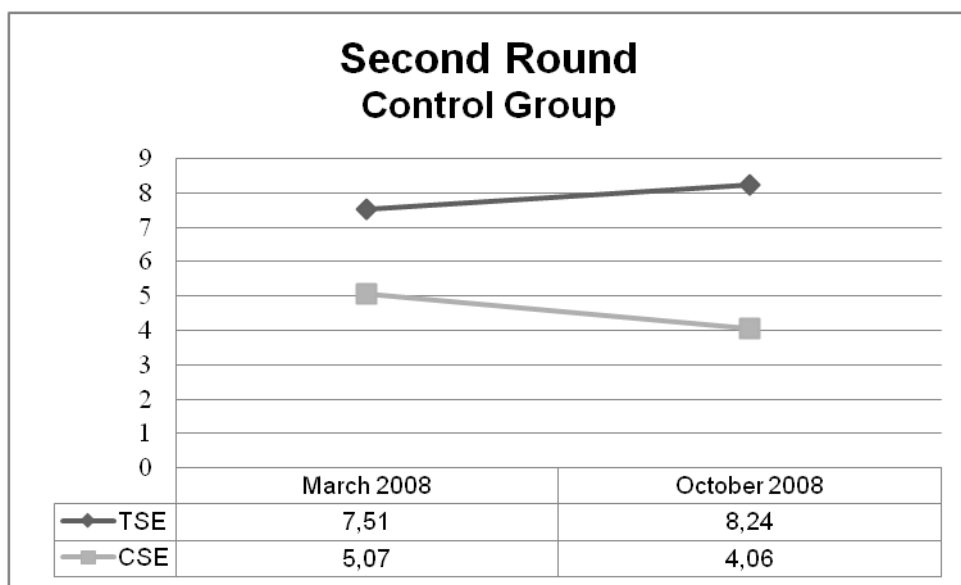
Note. TSE = Teacher self-efficacy. CSE = Computer self-efficacy.
Data are normalized to a 10 grade scale.
 $N = 35$. July 2009 $N = 7$.

*Figure 2.2 Teacher and Computer Self-Efficacy During the Project Time Span –
Experimental Group Second Round*

CSE mean values significantly increased throughout the project (Positive F-Test in all four data collections, $p < .05$); Even though CSE decreased in the last measurement, (H1) was confirmed. This may be explained by the fact that once a teacher learns how to use a new tool, after nine months the novelty wears off. It is also important to consider that in the last data collection only 7 questionnaires were completed (July 2009), which represents a bias in the comparison of the results and reduces significance. TSE remained statistically unvaried along the project (Negative F-Test in all four data collections). (H2) was refused, because no significant regression between the two variables had been detected in the four measurements.

Furthermore, control group data gathered at the beginning of the course (March 2008) and at the end of the course (October 2008), highlights that (H1) was confirmed: as shown in Figure 3, the attendance of ICT course is a factor that increases the CSE of teachers (Positive F-Test in both data collections, $p < .05$).

On the other hand, the growth of TSE values was not caused only by the increase of CSE, but also by other external factors, since it increased during the course time span, even if those teachers did not attend the course (Positive F-Test in both data collections, $p < .05$). The analysis of the regression coefficients was not significant at any data collection for the control group.



Note. TSE = Teacher self-efficacy. CSE = Computer self-efficacy.
Data are normalized to a 10 grade scale
 $N = 30$.

*Figure 2.3 Teacher and Computer Self-Efficacy During the Project Time Span –
Control Group Second Round*

In the next section (2.2), a second exploratory field study is presented. In fact, researchers taking part in the BET K-12 project decided to further investigate the matter in a similar context to properly understand if:

- Self-efficacy is a construct that can be adopted to explain changes in teachers' attitudes towards technologies.

- ICT-based courses can affect teachers' perception of being good teachers (Fanni et al. 2010).

2.2. MELISSA project

In the following sections the MELISSA project has been outlined. In particular, (2.2.1) context, (2.2.2) methodology, and (2.2.3) main results of the project are described.

2.2.1. Context

In recent years, the South African Department of Education (DoE) has outlined ICT as an integral part of modern education, especially in terms of computer-assisted teaching (Fanni et al. 2010). This has spawned a renewed interest in distance education and technological learning in the national degree programme, stipulated as part of the National Policy Framework for Teacher Education and Development. Furthermore, it has become pertinent for the DoE to introduce technological infrastructures within under-resourced schools. One of these DoE's initiatives is taking action in the Western Cape Province, under the name of *Khanya* project. *Khanya* project was initiated by the Western Cape Department of Education in 2001 as a programme to equip schools in the Province with ICT infrastructure. The goal of *Khanya* was to empower educators in every school of the Province to use appropriate and available technology to deliver curriculum to all learners in the province by 2012 (Khanya 2012).

In this framework ran the MELISSA – Measuring E-Learning Impact in primary Schools in South African disadvantaged areas – project. It is a joint research initiative funded by SER – Swiss Secretariat for Education and Research – involving the Università della Svizzera italiana in Switzerland, and the University of Cape Town and the Cape Peninsula University of Technology in

South Africa. The aim of this three-year project (2009-2012) was to measure the impact of ICT teacher training modules on primary school teachers working in disadvantaged areas in the Western Cape, South Africa. For this purpose, a training program was designed, upon the curriculum developed within the BET K-12 project, to introduce educators to ICT practices, exploring the incorporation of ICT in their teaching activities. The course was delivered twice during the three years of the project; the first round from July 2009 to May 2010, and the second from July 2010 to June 2011.

2.2.2. Participants and methods

One hundred and ten primary school teachers were selected from 6 disadvantaged primary schools that received fully kitted computer laboratories, as they took part in the *Khanya* initiative. Moreover, they have been selected according to the following criteria:

- Ability to access computers and network facilities, in order to be trained and to access the online part of the curriculum.
- Show great motivation in the learning experience.
- Lack prior computer skill.
- Be part of the MELISSA network and agree with project research and educational statement.

MELISSA research was developed in an experimental setting: among the 110 primary school teachers selected as sample of the project, 42 teachers were randomly assigned to an experimental group, and received training (referred to throughout as *Group A*); whilst 68 teachers were assigned to a control group, which initially did not receive training (referred to throughout as *Group B*).

The sample of 110 teachers was composed of 78% women with an average of 40 years ($SD = 10.2$). They have been teaching for an average of 17 years ($SD = 11.4$).

Questionnaires were created following the BET K-12 protocol (2.1.2). Data were gathered through an online questionnaire designed with Survey Monkey. Descriptive statistical analysis was performed using MS Excel. The F-Test and the regression analysis were computed using SPSS software.

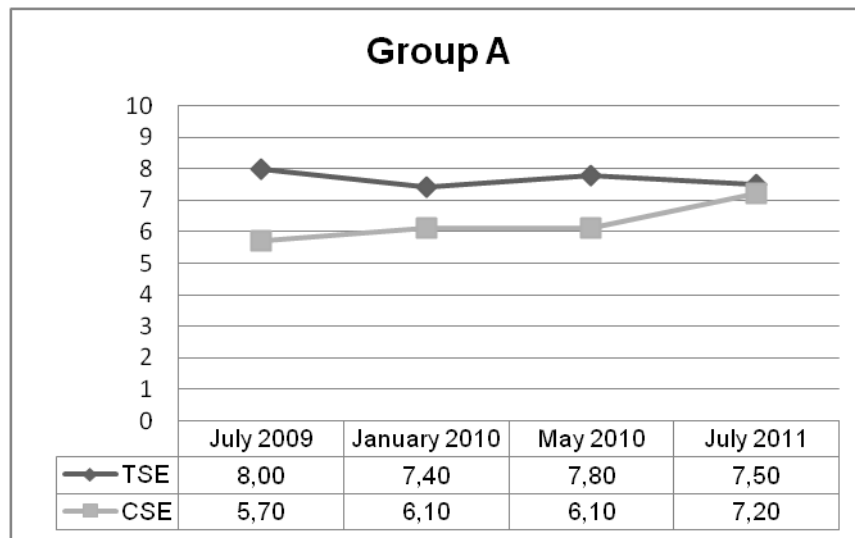
Questionnaires were conducted with *Group A* on four occasions: beginning of their course (July 2009), middle of their course (January 2010), end of their course (May 2010), and a follow-up (July 2011); and four times with *Group B*: July 2009 and January 2010 (they participated as the control group), January 2011 (middle of their course), and July 2011 (end of their course). Due to organizational problems, data concerning the beginning of the second course delivery were not available. Moreover, data collection during 2010 has been severely constrained by an extensive public sector strike, which closed schools for several weeks.

The research hypotheses that have been tested through the aforementioned methodology were the same that led BET K-12 research, i.e.:

- H1: the increase of technological skills promoted by the attendance to the proposed curriculum causes an increase in CSE;
- H2: the increase of CSE influences an increase in TSE.

2.2.3. Results

The graphs below show the results of all the measurements conducted during the project, Figure 4 for *Group A* and Figure 5 for *Group B*. Mean values of CSE and TSE of the teachers involved in the project are shown in the graphs.

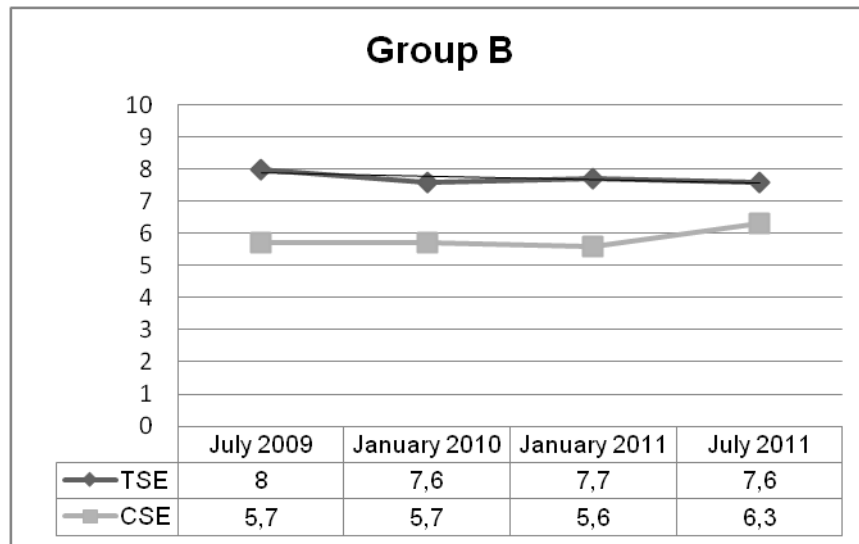


Note. TSE = Teacher self-efficacy. CSE = Computer self-efficacy.
 Data are normalized to a 10 grade scale
 N = 42.

Figure 2.4 Teacher and Computer Self-Efficacy During the Project Time Span – Group A

The first questionnaire (July 2009), reveals a CSE rate of 5.7 out of 10, and a TSE level of 8 out of 10. In this first survey, no significant regression between the two variables had been detected ($\beta = 0.13^{**}$, $R^2 = 0.04$). During the training, in January 2010, the trend of the two variables remains statically the same (CSE = 6.1, TSE = 7.4, both with positive F-Test, $p < .05$). No significant regression between the two variables had been detected ($\beta = 0.30^{*}$, $R^2 = 0.20$). At the end of the training, in May 2010, the CSE rate increases to 6.1 out of 10 (negative F-Test); TSE rate, instead, remains statistically unchanged (7.8 out of 10, positive F-Test, $p < .05$). Also in May 2010, no significant regression between the two variables had been detected ($\beta = 0.16^{*}$, $R^2 = 0.97$). A follow up survey (July 2011) let the MELISSA researchers confirm changes in CSE and TSE values along the course: comparing mean values in July 2009 and July 2011, CSE increased from 5.7 to 7.2 out of 10, while TSE decreased from 8 to 7.5 out of 10 (positive F-Test, $p < .05$). No significant regression has been detected between

CSE and TSE mean values along the course time, not even in July 2011 ($\beta = 0.37^*$, $R^2 = 0.003$).



Note. TSE = Teacher self-efficacy. CSE = Computer self-efficacy.

Data are normalized to a 10 grade scale.

$N = 68$.

Figure 2.5 Teacher and Computer Self-Efficacy During the Project Time Span - Group B

Similarly, analyzing *Group B* data through the same procedure, CSE mean values slightly increased along the project time span; from the beginning to the end of the project CSE mean value statistically grew from 5.7 to 6.3 out of 10 (negative F-Test). TSE mean values, on the other hand, decreased from 8.0 (July 2009) to 7.6 (July 2011) out of 10 (negative F-Test). A significant regression has been detected only in July 2011 ($\beta = 0.58^{**}$).

On the whole, results from the statistical analysis show that CSE increased as the training progressed both in *Group A* and *Group B*, validating the first research hypothesis (H1); while TSE decreased. No regression between the two variables can be detected, except for *Group B* in July 2011. Considering that a positive regression between the two variables occurred with no specific pattern just once

along the four surveys completed by both *Group A* and *Group B*, the second research hypothesis (H2) was not confirmed by statistical analysis.

2.3. Limitation of the studies and outlook

The previous sections (2.1 and 2.2) presented results from two field exploratory case studies where Teachers Sense of Self-Efficacy Scale (Tschannen-Moran & Woolfolk Hoy 2001) has been applied, together with Computer Self-Efficacy Scale (Compeau & Higgins 1995) as tools to measure teacher's perception of ICT use. Specifically, studying the relationship between TSE and CSE, the hypothesis that (H1) an ICT teacher training course can improve CSE, and that (H2) the increase of CSE can positively influence TSE were tested.

While the first project confirmed both hypotheses in the first round, its second round, instead, confirmed only the first one (H1), but refused the second one (H2). BET K-12 researchers tested the same hypotheses in a similar context through the second project - MELISSA project, validating the first hypothesis (H1), but refusing the second one (H2): CSE slightly increased during the project period; conversely, teachers' perception of being good educators decreased along the project time span. Furthermore, CSE was not significantly correlated to TSE, suggesting that MELISSA teachers, even though they felt themselves more capable of using ICT, did not perceive themselves as being better teachers.

It is worth noting that due to organizational priorities both projects presented some limitations. Teachers in the sample were divided in groups – experimental and control, according to their school provenience, creating groups populated by different number of teachers. Moreover, no measures to control for bias and representativeness between the different schools and groups were adopted.

On the whole, despite CSE level in teachers did improve, TSE has not been positively affected as expected. Nevertheless, the author considers the use of ICT

as one of the main skills, which a teacher has to master in the so-called *Knowledge Society* (Rivoltella, 2008); as a matter of fact, teachers have to be able not only to teach through ICT, but also to teach how to properly use them (Bates & Sangrà, 2011). Nowadays, in fact, ICT are permeating our life, affecting also the teaching and learning experience (Rapetti & Cantoni 2012, OECD 2012); in this context, CSE of teachers should be somehow interpreted within TSE as an integral part of it.

In conclusion, both projects' results suggest exploring new research paths regarding the methodology applied. On one hand, they confirm the relevance of self-efficacy construct as theoretical framework to describe teachers' perception of ICT use; on the other hand, they reveal a need for a more suitable tool to better measure the role of ICT in teacher experiences.

Encouraged by these results, in the following part of this work (Part II), the author explores the option to integrate computer and teacher self-efficacy, designing and validating a new scale measuring self-efficacy of teachers working in the *Knowledge Society*.

PART II

Towards a New Teacher Self-Efficacy Scale

Chapter 3: Theoretical underpinnings of the scale and research questions

Part 1 of the thesis posed the bases for the development of the new teacher self-efficacy scale, which considers technology integrated in teaching activities. It addressed the first research question of the study (RQ1) - What is the relationship between teacher self-efficacy and computer self-efficacy? - through the literature review offered in chapter 1, and two exploratory field case studies proposed in chapter 2.

The review of the literature provided a picture of the *knowledge society* in which technology is pervading every aspect of our life, and education context is likewise not excluded from this process. It also described the two variables - teacher self-efficacy and computer self-efficacy studied through the first research question (RQ1). Moreover, it proposed a selection of the main studies in which the two variables were measured. This helped the author identifying strengths and weaknesses of the measurement scales used in each study. This evaluation was accomplished through the analysis of the methodology and the results of each reviewed article. The Teacher Sense of Efficacy Scale (Tschannen-Moran and Woolfolk Hoy, 2001) and the Computer Self-efficacy Questionnaire (Compeau & Higgins, 1995) were selected due to their recurring applications that confirmed their validity and reliability in different contexts.

In the second chapter, the author applied the chosen measurement scales - The Teacher Sense of Efficacy Scale (Tschannen-Moran and Woolfolk Hoy, 2001) and Computer Self-efficacy Questionnaire (Compeau & Higgins, 1995) - in two field exploratory case studies to validate the first research question (RQ1). Due to research constraints, the author developed the studies in a specific context: disadvantaged areas in Brazil and South Africa. Two projects were carried out – BET K-12 in Brazil and MELISSA in South Africa, measuring the impact of technology training on computer and teacher self-efficacy. Results from both

projects were controversial. The relationship between computer and teacher self-efficacy was not comprehensively studied through the exploratory field case studies. This may be due to project limitations as explained in chapter 2. Nevertheless, results from the exploratory field studies - and the literature review - confirmed the relevance of self-efficacy construct as theoretical framework to describe teachers' perception of ICT use. Teachers' beliefs about their use of technology may be a good predictor of their actual use (Bandura, 1997). Results from Part 1 also suggested the need for a new teacher self-efficacy scale, which considers technology as part of teachers' body of knowledge and skills. In fact, the review of the literature showed that the use of ICT is one of the main skills, which a teacher has to master in the so-called *Knowledge Society* (Rivoltella, 2008).

Part II of this thesis is dedicated to the design and validation of a new teacher self-efficacy scale that can measure teachers' efficacy beliefs about their use of technology in school and outside of school. This chapter provides (3.1) a review of articles in which technological competences are integrated in teacher self-efficacy scales and (3.2) the framework adopted and the resources used as reference to develop the new teacher self-efficacy scale. The research questions that are addressed in the second part of this thesis are presented in section 3.3.

3.1. Self-efficacy of K-12 teachers using technology

Bandura (1997) advised that “teachers’ beliefs in their efficacy affect their receptivity to, an adoption of, educational technologies” (p. 241). Several studies about self-efficacy of teachers using ICT are present in literature, examining various aspects of teaching activities in different context. In the following table (Table 3.1), a selected literature review of studies concerning self-efficacy of teachers using ICT is reported. The review has been conducted on PsycINFO, Web of Science, and Behavioral Science Collection as databases, using the following keywords: *Self-Efficacy* and *Teacher* and *Technology*; *Self-Efficacy* and *Teacher* and *Computer*; *Teacher Self-Efficacy* and *Technology*; and *Teacher Self-Efficacy* and *Computer*. The aim of this literature review was to explore studies about Self-efficacy for K-12 teachers using technology and the main results they observed. The focus was set on journal articles, which provided empirical studies, conducted with quantitative or mixed methodology. For each article, Table 3.1 provides the authors and the year of publication, the sample of the study, the instruments used with the scale’s items number and reliability (Cronbach’s alpha); the main results of the each study are also reported.

Table 3.1 Selected Literature Review of Studies About Self-efficacy of K-12 Teachers Using Technology

| Authors | Participants | Instruments | Main Findings |
|-----------------------------|--------------------------|---|--|
| Abbitt & Klett (2007) | 108 pre-service teachers | <ul style="list-style-type: none"> Attitudes toward computer technology instruments - ACT (Milbrath & Kinzie, 2000); 19 items; $\alpha = .81$ Computer technology integration survey - CTIS (Wang et al., 2004); 21 items; $\alpha = .94$ | Perceived comfort with computer technology was found to be a significant predictor of self-efficacy beliefs towards technology integration, while perceived usefulness was not found to have a significant predictive relationship. This study also found that all of the groups demonstrated a significant increase in self-efficacy beliefs while enrolled in a course focusing on technology integration even though the courses varied in course design and weekly instructional time. |
| Al-Awidi & Alghazo (2012) | 62 pre-service teachers | <ul style="list-style-type: none"> Computer technology integration survey (Wang et al., 2004); 21 items; $\alpha = .96$ | Results showed a significant effect of student teaching experiences on participants' judgment of their self-efficacy about technology integration. Mastery experience and vicarious experience reported to be the most influential sources of self-efficacy to integrate technology among pre-service elementary teachers. |
| Akpınar & Bayramoğlu (2008) | 156 in-service teachers | <ul style="list-style-type: none"> Web attitude scale (Liaw, 2002); Turkish version with 4 subscales (web self-efficacy, enjoyment, usefulness and intention to use the web); 16 items; $\alpha = .80$ | The training created a positive and significant difference on the participants' web attitude, web self-efficacy and perceived web usefulness scores. Although the post training scores of perceived web enjoyment and behavioral intention to use the web were higher than the pre training scores, the differences were not significant. |

| Authors | Participants | Instruments | Main Findings |
|------------------------------|--------------------------|--|---|
| Aremu, Fasan & Ibadan (2011) | 589 in-service teachers | <ul style="list-style-type: none"> • Computer self-efficacy of secondary school teachers-CSESST (Cassidy & Eachus, 2002); 30 items; $\alpha = .94$ | Computer self-efficacy of the teachers is mostly average and it is a good indication that majority of the teachers would actually be comfortable with the use of computers. |
| Bakar & Mohamed (2008) | 675 pre-service teachers | <ul style="list-style-type: none"> • Ability to integrate ICT in teaching (11 items; $\alpha = .94$) | The study showed that trainee teachers were quite confident integrating ICT with teaching. Older students were more confident integrating ICT in teaching than younger students. |
| Bursal & Yigit (2012) | 310 pre-service teachers | <ul style="list-style-type: none"> • ICT usage and material design efficacy (16 items; $\alpha = .89$) | The scale is concluded to be a valid and reliable instrument. Based on the results of this pilot study, the efficacy level significantly changed by the income level and computer usage experience. |
| Chen (2012) | 300 in-service teachers | <ul style="list-style-type: none"> • Teachers' computer phobia scale (Rosen & Weil, 1992); 20 items; $\alpha = .91$ • Computer thoughts survey (Rosen & Weil, 1992); 20 items; $\alpha = .89$ • Computer self-efficacy scale (Durnell, Haag, & Laithwaite, 2000); 29 items; $\alpha = .94$ | Results indicated that teachers have moderate to high computer phobia and low computer self-efficacy. It is evidenced that computer phobia is negatively associated with computer self-efficacy. Also, it was found that teachers who frequently used computers showed lower computer phobia. Male teachers perceived themselves as having higher computer self-efficacy, and younger teachers tended to have a lower level of computer phobia and higher computer self-efficacy. |

| Authors | Participants | Instruments | Main Findings |
|--|--------------------------|--|---|
| Chifari, Ottaviano, D'Amico & Cardaci (2000) | 43 in-service teachers | <ul style="list-style-type: none"> • Computer self-efficacy scale (Cassidy & Eachus, 2002); 30 items; $\alpha = .91$ • Computer Experience (10 items; $\alpha = .64$) | Results revealed high correlation between self-efficacy and computer experience, suggesting that Self-efficacy is an important cognitive correlate of expertise in the use of ICT. |
| Erdem (2007) | 68 in-service teachers | <ul style="list-style-type: none"> • Information literacy (IL) self-efficacy scale (Kurbanoglu et al., 2006); 28 items; $\alpha = .92$ • Computer literacy (CL) self-efficacy scale 32 items; $\alpha = .73$ | Results revealed that most teachers' self-efficacy for IL and CL are at a high level in Turkey context. |
| Hsu (2010) | 3729 in-service teachers | <ul style="list-style-type: none"> • Teachers' ICT integration scale for Taiwanese teachers (45 items; $\alpha = .96$) | The established scale examines the existing concerns for technology, pedagogy and professional development at once with a new addition of ethical and safety issues, which demand growing attention in teachers of future generation. |

| Authors | Participants | Instruments | Main Findings |
|---|--------------------------|--|---|
| Kao & Tsai (2009) | 421 in-service teachers | <ul style="list-style-type: none"> • Attitudes toward web-based professional development (Wu & Tsai, 2006); 21 items; $\alpha = .91$ • Internet Self-efficacy Survey (Wu & Tsai, 2006); 14 items; $\alpha = .92$ • Beliefs about web-based learning (Yang & Tsai, 2008); 22 items; $\alpha = .85$ | Results supported that teachers' internet self-efficacy and beliefs about web-based learning were important predictors of their attitudes toward web-based professional development. The belief for the positive consequences of web-based learning is very important for the favorable attitudes toward web-based professional development. |
| Kreijns, Van Acker, Vermeulen & Van Buuren (2013) | 1209 in-service teachers | <ul style="list-style-type: none"> • Intention to use digital learning materials (Ajzen, 2010); 4 items; $\alpha = .95$ • Attitude towards using digital learning materials (Ajzen, 2010); 3 items; $\alpha = .93$ • Subjective norm (1 item) • Self-efficacy (1 item) • Perceived knowledge and skills to use digital learning materials (1 item) • Colleagues' usage of digital learning material (3 items; $\alpha = .78$) | Mediation analysis revealed that attitude, subjective norm, and self-efficacy towards digital learning materials were significant predictors of teachers' intention to use digital learning materials. The contribution of subjective norm, however, was modest. Attitude, subjective norm and self-efficacy mediated the effects of the following two variables on intention: perceived knowledge and skills to use digital learning materials, and colleagues' usage of digital learning materials. |

| Authors | Participants | Instruments | Main Findings |
|-------------------------------------|--------------------------|--|---|
| Kurbanoglu, Akkoyunlu & Umay (2006) | 415 in-service teachers | <ul style="list-style-type: none"> Information literacy self-efficacy scale (28 items; $\alpha = .91$) | The results indicated that 28-item scale could be considered highly reliable. It is of reasonable length and should prove to be a useful tool for researchers who are interested in measuring individual's self-efficacy levels for information literacy. |
| Littrell, Zugumny & Zugumny (2005) | 168 in-service teachers | <ul style="list-style-type: none"> Instructional technology use for classroom management and instructional development (14 items; $\alpha = \text{NA}$) | Results supported the hypothesis that teachers were using instructional technology primarily for classroom management tasks. Teachers' computer self-efficacy significantly predicted IT utilization. |
| Markauskaite (2007) | 217 pre-service teachers | <ul style="list-style-type: none"> Task-specific self-efficacy for cognitive capabilities (10 items; $\alpha = \text{NA}$) Task-specific self-efficacy for technical capabilities (25 items; $\alpha = \text{NA}$) | It was found that general cognitive and technical capabilities are two separate areas of ICT literacy; however basic ICT capabilities are an important component of both areas. |
| Milbrath & Kinzie (2000) | 300 pre-service teachers | <ul style="list-style-type: none"> Attitude towards computer technologies (Kinzie et al., 1994); 19 items; $\alpha = .89$ Self-Efficacy with computer technologies (Kinzie et al., 1994); 46 items; $\alpha = .98$ | Significant time effect is found in frequency of using technologies, and in both the variables measured. |

| Authors | Participants | Instruments | Main Findings |
|---|---|--|---|
| Mueller, Wood, Willoughby, Ross & Specht (2008) | 185 primary and 204 secondary in-service teachers | <ul style="list-style-type: none"> • Computer integration (8 items; $\alpha = .82$) • Comfort with computer (2 items) • Computer use (19 items; $\alpha = .83$) • Computer training (1 item) • Computer attitude (7 items; $\alpha = .77$) • Experiences with computer technology (9 items; $\alpha = \text{NA}$) • Teacher efficacy scale (Hoy & Woolfolk, 1993); 9 items; $\alpha = .77$ • Teaching philosophy (Benjamin, 2003); 14 items; $\alpha = .80$ • Attitudes toward work (25 items; $\alpha = .78$) | Analysis indicated that positive teaching experiences with computers; teacher's comfort with computers; beliefs supporting the use of computers as an instructional tool; training; motivation; support; and teaching efficacy are the variables that discriminate between teachers who integrate computers and those who do not. |
| Niederhauser & Perkmen (2010) | 92 pre-service teachers | <ul style="list-style-type: none"> • Instructional technology outcome expectation (ITOE) scale (25 items; $\alpha = .93$) | Findings revealed that outcome expectation is a multifaceted construct consisting of three components (performance, self-evaluative and social outcome expectations), and that the ITOE scale shows good validity and psychometric properties. |

| Authors | Participants | Instruments | Main Findings |
|--------------------------------------|--------------------------|--|---|
| Paraskeva, Bouta & Papagianni (2008) | 268 in-service teachers | <ul style="list-style-type: none"> • General perceived self-efficacy scale (Schwarzer & Jerusalem, 2000); 10 items; $\alpha = \text{NA}$ • Rosenberg self-esteem scale (Rosenberg, 1965); 10 items; $\alpha = \text{NA}$ • Computer self-efficacy scale (Murphy, Coover, & Owen, 1989); 32 items; $\alpha = .96$ | Teachers' sense of computer self-efficacy is moderate to high, as a result of their high sense of general self-efficacy and confidence in their capabilities, combined with their desire to master and use modern technologies. |
| Sadaf, Newby, & Ertmer (2012) | 190 pre-service teachers | <ul style="list-style-type: none"> • Open-ended questions to enable examination of pre-service teachers' behavioral, normative, and control beliefs associated with intentions to use Web 2.0 technologies | Findings suggest that pre-service teachers' intentions to use Web 2.0 technologies are related to their beliefs about the value of these technologies for improving student learning and engagement, its ease of use (behavioral beliefs), its ability to meet the needs/expectations of digital age students (normative beliefs), the participants' high self-efficacy in use, and its potential for affording students anytime/anywhere access to learning and interaction (control beliefs). |
| Saadé & Kira (2009) | 645 pre-service teachers | <ul style="list-style-type: none"> • Perceived ease of use (4 items; $\alpha = .89$) • Anxiety (4 items $\alpha = .77$) • Computer self-efficacy (10 items $\alpha = .92$) | The findings demonstrate the importance of self-efficacy as a mediator between computer anxiety and perceived ease of use of a learning management system. |

| Authors | Participants | Instruments | Main Findings |
|-------------------------|-------------------------|--|---|
| Shapka & Ferrari (2003) | 56 pre-service teachers | <ul style="list-style-type: none"> • Computer attitude scale (Gressard & Loyd, 1986); 30 items; $\alpha = .90$ • Proximal and distal self-efficacy (2 items) | No gender differences were found for any of the computer attitudes or for outcomes from the computer task. Participants training to teach at the secondary level had higher computer self-efficacy, and were less likely to predict that they would give up or avoid a challenging computer task than were elementary teacher-candidates. |
| Yuen & Ma (2008) | 152 in-service teachers | <ul style="list-style-type: none"> • Intention to use (Fishbein & Ajzen, 1975); 2 items • Perceived usefulness (Davis, 1989); 5 items; $\alpha = \text{NA}$ • Perceived ease of use (Davis, 1989); 4 items; $\alpha = \text{NA}$ • Subjective norm (Fishbein & Ajzen, 1975); 2 items • Computer Self-Efficacy (Compeau Higgins, & Huff, 1999); 6 items; $\alpha = \text{NA}$ | It was found that subjective norm and computer Self-Efficacy serve as the two significant perception anchors of the fundamental constructs in Technology Acceptance Model (Davis, 1986). However, contrary to previous literature, perceived ease of use became the sole determinant to the prediction of intention to use, while perceived usefulness was non-significant to the prediction of intention to use. |

The literature reviewed provided in this section shows that self-efficacy of teachers using technology is an interesting research path that has been quite explored. The relationship between computer self-efficacy and technology training was a recurring issue in the articles proposed in Table 1.2. Abbitt and Klett (2007) noticed a significant increase in computer self-efficacy in teachers enrolled in a course focusing on technological integration. Similar results were obtained by Akpinar and Bayramoğlu (2008). In their study, teachers increased their web self-efficacy after training in technology integration. Chen (2012) observed the importance of computer usage as factor to increase computer self-efficacy and decrease computer phobia. Bursal and Yigit (2012) confirmed Chen's findings, claiming that computer usage and experience are factors that may increase computer self-efficacy.

Some articles proposed in Table 3.1 reported studies about computer self-efficacy and other related constructs. Kao and Tsai (2009) observed that teacher internet self-efficacy and beliefs about web-based learning were important predictors of teacher attitudes toward web-based professional development. Kreijns, et al., (2013) found that attitude, subjective norm, and self-efficacy towards digital learning materials were significant predictors of teacher's intention to use digital learning materials. Moreover, Mueller and colleagues (2008) indicated that positive teaching experiences with computers, teacher's comfort with computers, beliefs supporting the use of computers as an instructional tool, training, motivation, support, and teaching efficacy are variables that discriminate between teachers who integrate computers and those who do not. Furthermore, Saadé and Kira (2009) demonstrated the importance of computer self-efficacy as a mediator between computer anxiety and perceived ease of use of a learning management system.

It emerged that there is not a wide consensus on a specific measurement scale that can assess self-efficacy of K-12 teachers using technology in their activities. In fact, several researchers (e.g., Akpinar & Bayramoğlu, 2008; Chifari et al.,

2000) used a general computer self-efficacy scale to measure teachers' use of technology. Other researchers (e.g., Niederhauser & Perkmen, 2010; Saadé & Kira, 2009) created *ad hoc* scales to measure computer self-efficacy of teachers, whose use is not widespread in the research community yet. Furthermore, Yuen and Ma (2008) claimed that in order to predict and understand teachers' technology beliefs and use, a well defined framework is essential. The studies proposed in Table 3.1 may not respond to this requirement contributing to the weakening of the measurement scales that they proposed. The following section explores the framework that will be used to develop the new scale.

3.2. Theoretical underpinnings of the scale

Bandura (1986) pointed out that it is fundamental to clarify which are the skills required to accomplish an activity in order to measure self-efficacy truly affecting that activity. This section presents three resources, which have been relevant for the design of the new teacher self-efficacy scale. Specifically, (3.2.1) Technological Pedagogical Content Knowledge (TPACK) is selected as leading framework for the scale design, due to its focus on technology as the fundamental piece of teachers' knowledge. The 21st Century Skills (3.2.2) and International Society for Technology in Education (ISTE) standards (3.2.3) are considered as reference in defining teachers' skills and knowledge about technology.

3.2.1. TPACK framework and its measures

“Technological Pedagogical Content Knowledge (TPACK) attempts to define the nature of knowledge required by teachers for technology integration in their teaching, while addressing the complex, multifaceted and situated nature of teacher knowledge. At the heart of the TPACK framework, is the complex interplay of three primary forms of knowledge: Content (CK), Pedagogy (PK),

and Technology (TK)” (Mishra & Koehler, 2006, p. 1017). This framework proposes a dynamic overview of the knowledge/competence needed by teachers working with technology, as shown in the figure below.

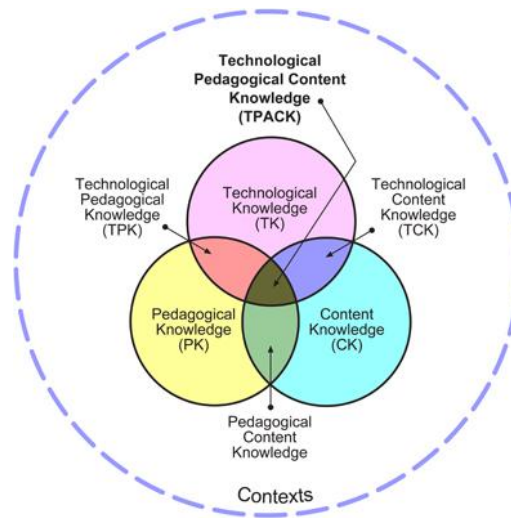


Figure 3.1 TPACK Scheme (Mishra & Koehler, 2006)

TPACK framework is built on Lee Shulman’s idea of Pedagogical Content Knowledge (PCK). “Within the category of pedagogical content knowledge I include, for the most regularly taught topics in one’s subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations – in a word, the ways of representing and formulating the subject that make it comprehensible to others” (Shulman, 1986, p. 9). In the following years the PCK definition has been widely used and extended by scholars (Cox, 2008; Mishra & Koehler, 2006). In 2006, Punya Mishra and Matthew Koehler presented the first definition of the TPACK framework, adding a new kind of knowledge, aside from the *pedagogical* and the *content* ones: the *technological* knowledge. As shown in Figure 3.1, the TPACK framework is defined by the interplays of the three main kinds of knowledge that create a total of seven different components.

- *Technological knowledge.* Technological knowledge (TK) comprehends the exploitation of different types of technologies. To be conscious of the existence of a specific tool it is the Basic TK. To be skilled to use specific software or to program in a computer language consists instead in a more advanced TK (Mishra & Koehler, 2006; Schmidt, et al., 2009).
- *Pedagogical knowledge.* The knowledge of the common procedures and approaches in teaching and learning through different content areas is called Pedagogical Knowledge (PK). Handling a classroom, encouraging students to learn, planning a lesson and being up to date about the different methods of learning are some of the important issues included in the Pedagogical Knowledge (Mishra & Koehler, 2006; Schmidt, et al., 2009).
- *Content knowledge.* Content knowledge (CK) concerns the characteristic of a specific domain, such as the understanding of facts and specific skills, including the description of approaches for improving new knowledge (Mishra & Koehler, 2006; Schmidt, et al., 2009).
- *Technological pedagogical knowledge.* Technological pedagogical knowledge (TPK) is the understanding of the methods of using technologies that could be used in a general teaching context. The TPK approach considers how to use technology for teaching, e.g. searching information, preparing and doing multimedia presentations, and sharing information (Mishra & Koehler, 2006; Schmidt, et al., 2009).
- *Pedagogical content knowledge.* Pedagogical content knowledge (PCK) is to recognize the best way to teach a specific content area. This includes: knowing illustrations, comparisons and descriptions that have an impact in that specific domain. Moreover it is necessary to know also the main students' difficulties in learning that specific content, considering both previous experience and the main pedagogies of that content (Mishra & Koehler, 2006; Schmidt, et al., 2009).
- *Technological content knowledge.* To be aware of a specific technology related to a specific domain is the technological content knowledge (TCK).

This means to know the existence of adequate technologies, including how to use them in that domain (Mishra & Koehler, 2006; Schmidt, et al., 2009).

- *Technological pedagogical and content knowledge.* Technological pedagogical content knowledge (TPACK) is the knowledge of how to use technology to support content-specific pedagogical methods and strategies (Mishra & Koehler, 2006; Schmidt, et al., 2009).

This framework has been broadly accepted to better understand the body of knowledge required to teachers in order to use ICT in their teaching activities (Niess, 2008). It has also been integrated into specific subject areas (AACTE, 2008; Wentworth et al., 2009). In Graham's work (2011) it emerges that TPACK framework presents some weaknesses, in particular related to components' definitions that lack in clarity. According to his study, "researchers must clarify the boundary conditions that enable one element in the framework to be distinguished from adjacent elements" (p. 1959).

After TPACK affirmation as teacher's knowledge framework, researchers started working on the assessment of teachers' level of TPACK. Khoeler and Mishra (2006) evaluated changes in teachers' understanding of TPACK components in their activities over an instructional course. Archambault and Crippen (2009) designed a questionnaire measuring teacher's TPACK components' level. They tested it with 596 k-12 teachers working in online setting, finding high correlation within the TPACK components, specifically between "pedagogy" and "content". Schmidt and colleagues (2009) worked with pre-service teachers studying the seven components of the framework. They designed a reliable 75-items instrument for teacher's self-assessment. In 2010, Chai, Koh, and Tsai used the questionnaire designed by Schimdt et al. (2009) with 889 pre-service teachers in Singapore. In 2011, Sahin tested a 47-items questionnaire with 348 pre-service teachers, validating a new instrument. Koehler, Shin, and Mishra, in 2011, wrote a book chapter entitled "How Do We Measure TPACK? Let Me Count the Ways". In this work he and his team classified 141 instruments into five categories: self-report measures, open-end questionnaires, performance

assessments, interviews, and observations. They also studied validity and reliability of each instrument. In 2012, Kabakci Yurdakuland and colleagues validated a 33-item TPACK scale with 995 pre-service teachers, finding the scale reliable.

3.2.1.1. Self-efficacy scales for TPACK

Only a few self-efficacy measurement instruments for TPACK have been designed so far. In 2009, Graham and colleagues validated in-service teachers' confidence related to the four TPACK constructs that involve technology – Technological Knowledge, Technological Pedagogical Knowledge, Technological Content Knowledge, and Technological, Pedagogical, Content Knowledge - with a focus on Science content. Lee and Tsai (2010) studied 558 teachers from primary to high school level in Taiwan, with the aim to investigate teacher's self-efficacy about Technological Pedagogical Content Knowledge-Web (TPCK-W). They developed a 26-item questionnaire divided into 5 sections: web-general, web-communicative, web-content knowledge, web-pedagogical-content knowledge, and attitude toward web-based instruction. In 2010, Burgoyne investigated the reliability and the construct validity of a Self-Efficacy Scale for TPACK for pre-service teachers. She designed a 32-items questionnaire structured in 7 sections according to the TPACK components, and tested it with a sample of 333 pre-service primary school teachers.

In 2011, Abbitt designed a questionnaire measuring self-efficacy of TPACK based on Schimdt et al. (2009) questionnaire. Rohaan, Taconis, and Jochems (2012) studied the relationship among subject matter knowledge, pedagogical content knowledge, attitude, and self-efficacy of 354 primary school teachers. They measured pedagogical content knowledge through the Teaching of Technology Test (TTT), composed by 18 multiple choice items with four answer alternatives. Self-efficacy has been measure through the Science Teaching

Efficacy Belief Instrument (STEBI), originally proposed by Enochs and Riggs (1990). Results showed that “subject matter knowledge is an important prerequisite for both pedagogical content knowledge and self-efficacy. Subsequently, teachers’ self-efficacy was found to have a strong influence on teachers’ attitude towards technology” (p. 271).

In 2012, Semiz and Ince examined the relationship among Technological Pedagogical Content Knowledge (TPACK), Technology Integration Self-Efficacy (TISE) and Instructional Technology Outcome Expectations (ITOE) of pre-service teachers. They found TPACK, TISE, and ITOE moderately related with each other, and positively influenced by teachers’ perception of university instructors’ technology integration into teaching activities. Chai and colleagues in 2013 validated a TPCK efficacy survey by implementing it with an Asian group of 550 pre-service teachers. The 36-item instrument has been found to be valid and reliable with alpha coefficient greater than 0.8.

As the literature review about self-efficacy for TPACK scales reveals, several research paths are still to be explored. Only two studies (Graham, 2009; Lee and Tsai, 2010) tested the scale with a sample composed of in-service teachers. Moreover, in these studies the Self-Efficacy for TPACK scale refers to two specific content areas. Graham’s study (2009) measured the self-efficacy for TPACK of Science teachers; Lee and Tsai (2010) applied the scale to the Web. A scale measuring self-efficacy for TPACK of in-service teachers with no definition of content area is still needed.

The TPACK framework was selected as structure for the design of the new teacher self-efficacy scale. Specifically, 3 components related to technology - Technological Pedagogical Knowledge, Technological Content Knowledge, and Technological Pedagogical Content Knowledge - were chosen as hypothesized subscales. Moreover, the TPACK framework gave to the scale not only the structure but also the name. In fact, the scale was named Self-Efficacy for TPACK scale, and it is composed by 3 subscales named as the 3 selected

components of the TPACK framework. Items in each subscale were created according to the definition of the component that gives the name to the subscale, and having as reference the 21st Century Skills framework and ISTE standards, which are proposed and defined in the following sections.

3.2.2. 21st Century Skills framework

The 21st Century Skills framework provides an overview of students' outcomes required to succeed in life and future work as well as the support systems necessary to lead students mastering these skills. This framework is one of the most spread and agreed reference about technology integration in educational context. Several organizations (e.g., European Union; Metiri Group) and researchers (e.g., Gardner, 2007; Zhao, 2009) have done studies concerning these core skills essential to live nowadays. The 21st Century Skills Partnership (P21), established in 2002 to set 21st Century Skill as a priority in the USA K-12 education system, is one of the most active organizations. Specifically, P21 aims at creating collaborative partnerships among communities and government leaders. One of the P21's projects is *Route 21*, which offers resources and support in the implementation of P21's activities.

The 21st Century Skills framework is composed by two main parts, which are shown in the following figure (Figure 3.2).

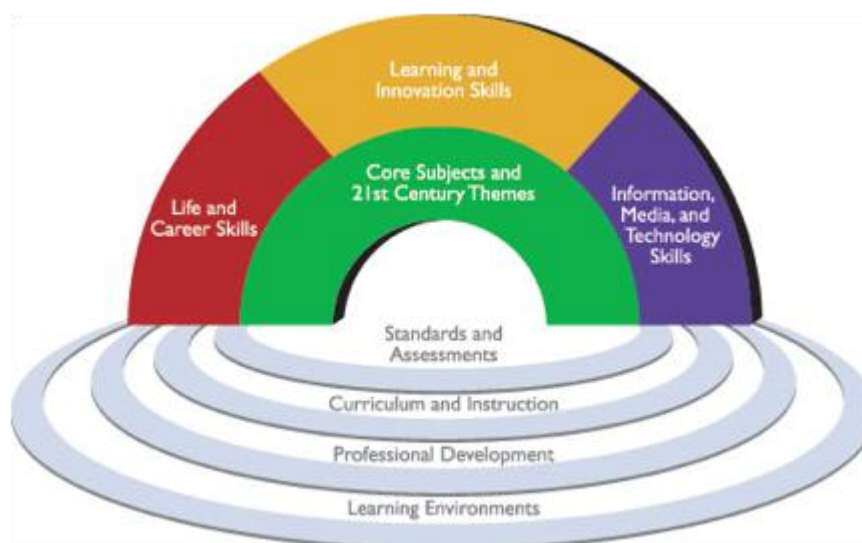


Figure 3.2 21st Century Student Outcomes and Support Systems (Partnership for 21st Century Skill Framework, 2009)

The colored parts of the figure above represent students' outcomes; the grey part, instead, represents the support systems. The main parts of the framework are presented in the following lines:

- *Core subjects and 21st Century themes* include English, Reading or Language arts, World languages, Arts, Mathematics, Economics, Science, Geography, History, Government and Civics. Interdisciplinary themes are Global Awareness, Financial, Economic, Business and Entrepreneurial Literacy, Civic Literacy, Health Literacy and Environmental Literacy (Partnership for 21st Century Skill Framework, 2009).
- *Learning and Innovation skills* foresee a focus on Creativity and Innovation, Critical thinking and Problem solving, and Communication and Collaboration (Partnership for 21st Century Skill Framework, 2009).
- *Information, Media and Technological skills* include Information Literacy, Media Literacy, and ICT Literacy (Partnership for 21st Century Skill Framework, 2009).

- *Life and Career skills* includes Flexibility and Adaptability, Initiative and Self-direction, Social and Cross-cultural skills, Productivity and Accountability, and Leadership and Responsibility (Partnership for 21st Century Skill Framework, 2009).

The support systems proposed by the framework are the following:

- *21st Century Standards*
 - Build understanding across and among core subjects as well as 21st century interdisciplinary themes.
 - Engage students with the real world data, tools and experts they will encounter in college, on the job, and in life (Partnership for 21st Century Skill Framework, 2009).
- *Assessment of 21st Century Skills*
 - Supports a balance of assessments, including high-quality standardized testing along with effective formative and summative classroom assessments.
 - Emphasizes useful feedback on student performance that is embedded into everyday learning.
 - Enables development of portfolios of student work that demonstrate mastery of 21st century skills to educators and prospective employers (Partnership for 21st Century Skill Framework, 2009).
- *21st Century Curriculum and Instruction*
 - Focus on providing opportunities for applying 21st century skills across content areas and for a competency-based approach to learning.
 - Enable innovative learning methods that integrate the use of supportive technologies, inquiry and problem-based approaches and higher order thinking skills.

- Encourage the integration of community resources beyond school walls (Partnership for 21st Century Skill Framework, 2009).
- *21st Century Professional Development*
 - Balances direct instruction with project-oriented teaching methods.
 - Illustrates how a deeper understanding of subject matter can actually enhance problem-solving, critical thinking, and other 21st century skills.
 - Encourages knowledge sharing among communities of practitioners, using face-to-face, virtual and blended communications.
 - Uses a scalable and sustainable model of professional development (Partnership for 21st Century Skill Framework, 2009).
- *21st Century Learning Environments*
 - Create learning practices, human support and physical environments that will support the teaching and learning of 21st century skill outcomes.
 - Support professional learning communities that enable educators to collaborate, share best practices and integrate 21st century skills into classroom practice (Partnership for 21st Century Skill Framework, 2009).

This framework confirms the relevance of technology integration in learning and teaching activities. It highlights some pieces of knowledge and skills necessary not only to students, but also to teachers to work more effectively in the knowledge society.

Despite that, some critiques have been raised against this framework. First of all, it is worthy to remember that several skills and pieces of knowledge proposed by

this model and emphasized as a novelty of the 21st Century, were essential to teaching and learning process also in previous ages. Second, concerning the dimensions related to the ICT, this model does not take into account contexts in which there is a *digital divide*, which is an inequality in accessing and using technology. In these contexts several skills of this model cannot be developed because of the lack of technology. Finally, another concern has been raised by the American organization named *Common Core*, active in improving education level and standards in the USA. They mainly criticized the excessive focus on skills to the detriment of knowledge (Common Core, 2009). It is worthy to specify that so far, this debate had more media coverage, such as articles in newspapers (e. g., The Washington Post, 2009) and posts in blogs (e. g., Education Week, 2009), than scientific studies.

Nevertheless, some components of this framework have been useful as resources for designing the items of the Self-Efficacy for TPACK scale.

3.2.3. ISTE standard

A further reference in technology integration in educational context is the research and the tools proposed by the International Society for Technology in Education (ISTE). Specifically, ISTE developed the National Educational Technology Standards (NETS), which are standards for evaluating skills and knowledge needed in an increasingly connected global and digital society. These standards are diversified for teachers (NETS-T), students (NETS-S), schools' administrators (NETS-A), and coaches (NETS-C). NETS-T are specific to evaluate skills and knowledge that teachers have to master to teach in a society permeated by technology.

In the following lines, the NETS-T main guidelines are illustrated:

- *Facilitate and Inspire Student Learning and Creativity*

Teachers use their knowledge of subject matter, teaching and learning, and technology to facilitate experiences that advance student learning, creativity, and innovation in both face-to-face and virtual environments (ISTE, 2012).

- *Design and Develop Digital Age Learning Experiences and Assessments*
Teachers design, develop, and evaluate authentic learning experiences and assessment incorporating contemporary tools and resources to maximize content learning in context and to develop the knowledge, skills, and attitudes identified in the NETS-S (ISTE, 2012).
- *Model Digital Age Work and Learning*
Teachers exhibit knowledge, skills, and work processes representative of an innovative professional in a global and digital society (ISTE, 2012).
- *Promote and Model Digital Citizenship and Responsibility*
Teachers understand local and global societal issues and responsibilities in an evolving digital culture and exhibit legal and ethical behavior in their professional practices (ISTE, 2012).
- *Engage in Professional Growth and Leadership*
Teachers continuously improve their professional practice, model lifelong learning, and exhibit leadership in their school and professional community by promoting and demonstrating the effective use of digital tools and resources (ISTE, 2012).

The ISTE standards suggest some guidelines to evaluate technology integration in teaching practice, which have been taken into account as resources for designing the items of the Teacher Self-Efficacy for TPACK Scale.

3.3. Aim of the study and research questions

The purpose of this work is to investigate the relationship between teacher self-efficacy and teachers' use of technology. The first part of this thesis (Part I) addressed the first research question of the study (RQ1) - What is the relationship between teacher self-efficacy and computer self-efficacy? - through the literature

review offered in chapter 1, and the results of the two exploratory field case studies proposed in chapter 2. Results obtained in part 1 suggested the need for a new teacher self-efficacy scale, which considers technology as part of teachers' body of knowledge and skills. The aim of part II is threefold. First, it aims at providing a psychometrically sound instrument that can measure teachers' beliefs about their use of technology. This scale allows researcher to deeply explore the relationship between self-efficacy and teachers' technology use. Second, it aims at illuminating whether teachers' technology self-efficacy differs as a function of age, gender, ethnicity, school level, years of teaching experience, and professional development experience with technology. Finally, it explores the predictive relationship between self-efficacy and teachers' use of technology.

Therefore, part II addresses the following research questions:

1. (RQ2) What are the psychometric properties of the items on the Self-Efficacy for TPACK scale?
2. (RQ3) Are there mean differences in the self-efficacy for TPACK as a function of teachers':
 - a. age
 - b. gender
 - c. ethnicity
 - d. school level
 - e. years of teaching experience
 - f. professional development with technology?
3. (RQ4) What is the relationship between self-efficacy for TPACK and teachers' technology use?

The next chapter (Chapter 4) explains the methodology that led this study to answer the abovementioned research questions.

Chapter 4: Methodology

This chapter presents the method used to carry out the study. Specifically, it presents the participants in the study (section 4.1), outlines the data collection (section 4.2), describes the instrumentation used (section 4.3), and explains the steps followed during the data analysis procedure (section 4.4) from the data screening (4.4.1) to each research questions analysis (sections 4.4.2, 4.4.3, and 4.4.4).

4.1. Participants

This study involved 218 K-12 teachers from public schools in the state of Kentucky. Teachers volunteered to participate in completing the survey, after having been invited by their principals. Details of the sampling procedure are described in the next section (4.2). Only 192 questionnaires were considered in the analysis phase according to their level of completion. Questionnaires less than 60% ($n = 26$) completed were excluded from the data analysis.

The sample consisted of 192 teachers, 78% of them female ($n = 150$), and 22% male ($n = 42$). The majority of the sample (95%) reported that their ethnicity was Caucasian/White. Participants were nearly equally divided in the four age available categories: 23% were between 20 and 30 years old, 28% were between 31 and 40, 24% were between 41 and 50, and 25% were older than 50. A similar distribution was found for *years of teaching*: 23% of the sample had been teaching less than 5 years, 21% between 6 and 10 years, 14% between 11 and 15 years, 18% between 16 and 20 years, and 24% for more than 20 years. Teachers in the sample were working in elementary schools (48%), middle schools (22%), and high schools (30%), from 73 schools in 51 different Kentucky counties (see Appendix 1 for the complete list of the schools and the counties involved in the study). The majority of the teachers in the sample (47%, $n = 89$) indicated that their school was located in a rural area. Seventeen percent ($n = 32$) indicated that their school was located in a city. The remaining 37% ($n = 71$) of the sample described their work locale as town. This distribution accords with the data published by the National Center for Education Statistics (NCES). In the school year 2010/2011, 54% of the school district is in rural areas and 26% in urban areas.

4.2. Data collection procedure

To respect school policies for participating in surveys, the researcher decided to first contact the principals of each school to inform them about the details of the study. The researcher invited each principal via email (see Appendix 2 for the complete email message) to allow teachers in their school to participate and to encourage teachers to complete the survey. The researcher never contacted any teachers directly - all correspondence was routed through school principals. An online search of email addresses of principals of Kentuckian K-12 schools was conducted during February and March 2013. Addresses were mainly obtained from school website. Email addresses ($N = 1,520$) were collected and archived along with some basic information about each school.

The teacher recruitment procedure consisted of different steps, which are outlined in Figure 4.1.

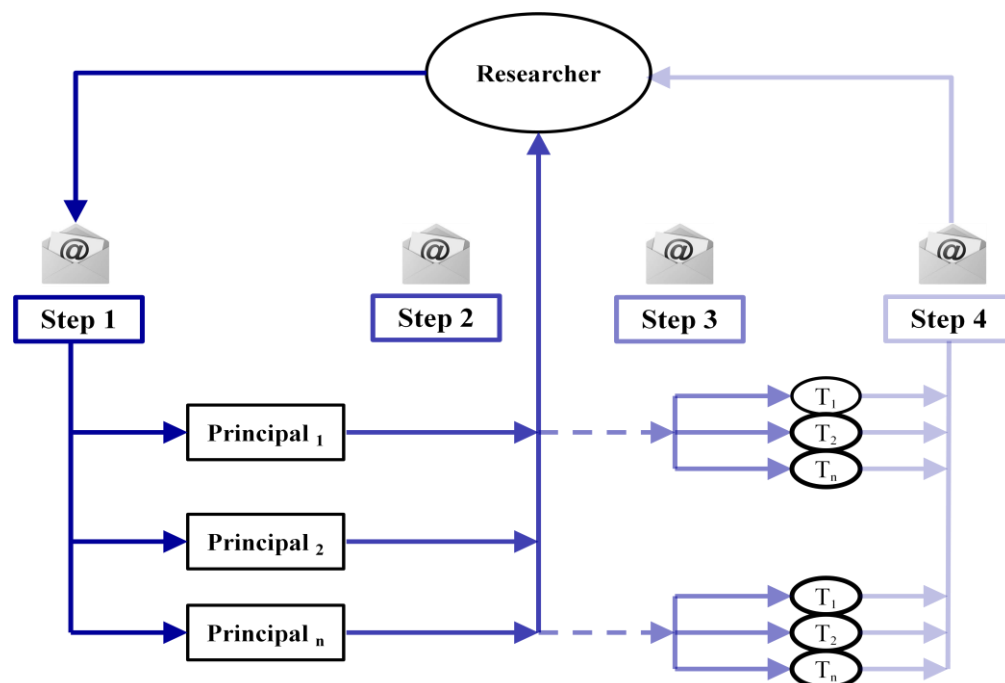


Figure 4.1 Data Collection Procedure

During the first step, the researcher sent a survey invitation (containing a link to the questionnaire) to respective principals. Principals were asked to communicate to the researcher their interest (or not) in the research (Step 2). Once principals agreed to participate in the study, they forwarded the survey invitation to their teachers (Step 3). During the last step (Step 4), teachers completed the questionnaire.

Step 1 was conducted through Microsoft Word's Mail Merge tool. Three panels of principals' email addresses were created. The first was composed of 1520 email addresses, and was sent out on April 8, 2013. The timeframe for completing the survey was set for April 8-19, 2013. During this time three reminders were sent out to the principals. Sixty-one principals opted out; 182 email addresses were undeliverable. A second panel was created, and was composed of 98 principals' email addresses. Email addresses for panel 2 were taken from the 182 undeliverable of panel 1, and 98 were corrected by checking other online sources (e.g., government websites). The second panel of emails was sent out on April 20. For this panel, the timeframe for completing the survey was set for April 20 - May 1, 2013. During this time, three reminders were sent, five principals opted out, and three emails were undeliverable. After the first two panels, 186 teachers completed the survey. The researcher decided to create a third panel composed of email addresses of principals who never communicated their interest to participate in the survey. This panel was composed of 1183 email addresses and was sent on May 14. The timeframe for completing the survey was set for May 14 - June 2 2013. During this time, three reminders were sent, and 164 principals opted out.

At the end of the data collection procedure, 1,279 principals were contacted. Among them, 297 replied: sixty-seven invited their teachers to complete the survey, and 230 expressed disinterest in the survey. It is not possible to define the response rate, because the exact number of teachers reached is not known.

Assuming that a Kentucky public school employs on average 20 teachers, approximately 25,580 teachers may have been contacted. Two hundred and eighteen teachers (0.8%) volunteered to participate in the survey. Online response rates are difficult to compare among studies due to the diversity of variables involved in the different methodologies (Duetskens et al., 2004). In an analogous study with US teachers, Hutchison and Reinking (2011) obtained a similar rate of response (2%).

As proposed by Porter and Whitcomb (2003), a deadline for survey completion was included in reminder emails to respondents as a means to increase response rates. No incentives were offered to teachers. However, school principals were informed that if a representative number of their teachers (at least 50%) had completed the survey, they would receive a customized report of the survey results for their school/district. No school in this study reached the representative number of participants to receive the report. As study by Kypri, Gallagher, and Cashell-Smith (2004) indicated that incentives did not increase response rates in their online survey. They suggested, rather, that careful planning was more effective.

4.3. Instrumentation

The instrument used in this study was an online self-report survey created in *Qualtrics*. The questionnaire included items asking for demographic information and for descriptions of habits and perceptions around using technology in and outside of the school environment. Questions about teachers' access to technology – availability at school and at home – were also included. A small-scale pilot study was conducted to fine-tune the questionnaire. This entailed the facilitation of a focus group with 7 teachers in a public elementary school in Kentucky. Teachers completed the survey online while the researcher was present. During and after the completion of the survey, teachers were encouraged

to raise questions and comments about the instrument. The researcher participated in the discussion and noted items that seemed confusing or unnecessary to the teachers. These items were either modified to make them clearer or removed from the survey.

Before and after the pilot study, a group of experts in teachers' technology use (i.e., collaborators from the New Media in Education Laboratory - NewMinE Lab, Switzerland; and the Center for the Advanced Study of Technology Leadership in Education - CASTLE, United States), reviewed the questionnaire and suggested modifications. The same process was conducted with two teacher self-efficacy experts, namely Dr. David Morris and Dr. Helenrose Fives. The final instrument reflects changes made based on their feedback.

In the following sections, the specifics of each scale and variables involved in the study are presented. Specifically, the Self-Efficacy for TPACK Scale (section 4.3.1), the variables related to teachers' technology use (section 4.3.2), and teachers' demographic variables (section 4.3.3) are presented. Moreover, the Teacher Sense of Efficacy Scale (section 4.3.4) and the Computer Self-Efficacy Scale (section 4.3.5), involved in the study for validity purposes, are also illustrated.

4.3.1. Self-Efficacy for TPACK Scale

The Self-Efficacy for TPACK Scale was developed to measure teachers' confidence in technology use. Items in the scale have been created and validated through the following steps.

1. The researcher selected the TPACK components relevant for the Self-Efficacy for TPACK Scale. As proposed in previous studies (Archambault & Crippen, 2009; Chai, Koh & Tsai, 2010; Schmidt et al., 2009), only the technology-related items (i.e., Technological Content

Knowledge, Technological Pedagogical Knowledge, and Technological Pedagogical Content Knowledge) were selected because they focus on specific technology skills and knowledge sets in teachers activity.

2. Per each TPACK component, a list of teachers' skills and knowledge sets about technology was created based on the 21st Century Skills (section 3.1.2) and the International Society for Technology in Education (ISTE) standards (section 3.1.3).
3. Experts in teacher training and technology were consulted to discuss and integrate the list created in Step 2.
4. The fourth step involved coupling each entry of the list with a related task. This ensured the task-oriented structure required by the items of self-efficacy scales (Bandura, 2006).
5. Each task was converted into an item measuring self-efficacy on a scale from 1 (*not at all confident*) to 6 (*totally confident*). All items were designed in accordance with Bandura's (2006) guidelines for creating self-efficacy scales. Some items were designed based on previous studies about self-efficacy for TPACK scales (Archambault & Crippen, 2009; Burgoyne, 2010; Schmidt et al., 2009). Appendix 3 indicates which items were adapted from previous works.
6. The sixth step consisted of a pilot study with a small group of teachers ($n = 7$) who were asked to provide feedback on questionnaire items to ensure teachers' comprehension of the scale. Unclear items were modified or removed.
7. Finally, a scale composed of 28 items was administered to 218 K-12 teachers in Kentucky. After careful analysis and examination of the psychometric properties of the items, which is more fully described in section 4.5.1 and 5.1, 20 items were selected to make up the Self-Efficacy for TPACK scale (see Table 5.2). The scale is composed of 3 subscales, namely *Technological Content Self-Efficacy (TeCoSE)*, 6

items), *Technological Pedagogical Self-Efficacy (TePeSE)*, 11 items), and *Technological Pedagogical Content Self-Efficacy (TPCSE)*, 3 items).

4.3.2. Teachers' technology use and professional development with technology

Teachers' technology variables were created to respond to the fourth research question of this study. They were designed considering both previous studies on teachers' use of technology (Christensen & Knezek, 2009; Hutchison & Reinking, 2011), and studies about the US educational context (IES, 2013). According to Bebell, Russell and O'Dwyer (2004), it is essential to have multiple measures to examine teachers' technology use in order to have a more accurate assesment. Three different variables were developed to measure *use* of technology, *communication* using technology, and professional *development* with technology.

The variable *use of technology* was assessed by two primary questions: the first one querying the frequency with which teachers use 6 technologies (Word processing software, spreadsheets and graphing software, graphics and image-editing software, presentation software, websites, blogs and/or wikis, and social networking websites) *outside* of school. The second question asked about teachers' use of 10 technologies (word processing software, spreadsheets and graphing software, software for managing student records, graphics and image-editing software, presentation software, learning management systems, software for administering tests, subject-specific software, websites, blogs and/or wikis, social networking websites) *at school* for class preparation, instruction or administrative tasks. For both questions, teachers answered each item on a scale from 1 (*never*) to 4 (*daily*). Responses to items in each question were added together to create a raw score variable: *technology use at school* with minimum score = 10 and maximum score = 40; *technology use outside of school* with

minimum score = 6 and maximum score = 24. The raw score for each variable was then transformed into a standardized score (z-score variable) to perform regression analyses.

The variable *communication* using technology was assessed by three primary questions referring to communication (a) with students, (b) with students' parents, and (c) with colleagues. Each of these questions asked about communication with 8 technologies (phones, email, instant messaging, Twitter, Facebook, online bulletin board for class discussion, personal websites or blog, and school websites). Teachers answered using a scale from 1 (*never*) to 4 (*always*). Those responses were added together to create a raw score (min. score = 24; max. score = 96) for the variable *communication* using technology. The raw score was then transformed into a standardized score (z-score variable) to perform regression analyses.

Teachers' professional *development* with technology was measured through the following question: "Which of the following best characterizes your professional development experience with technology?" Teachers placed themselves in one of the following four categories – *extensive*, *moderate*, *occasional*, *no technology training* – according to their professional development experience with technology.

4.3.3. Teachers' demographic variables

The study also included five demographic variables to address the second research question. The *age* variable was divided into three categories in 10-year age spans and a fourth category for teachers over 51. The first category (from 20 to 30) was coded as 1, the second (from 31 to 40) as 2, the third (from 41 to 50) as 3, and the fourth (more than 51) as 4. The variable *gender* was coded as 1 for male, and 0 for female. The *ethnicity* variable was coded as follows: Caucasian / White as 1, African American / Black as 2, Asian / Asian American as 3,

Hispanic / Latino (a) as 4, and Native American / First Nations as 5. The *teaching level* variable was coded as follows: elementary school level as 1, middle school level as 2, and high school level as 3. The variable *years of teaching* was coded in five categories: less than 5 years as 1, 6 to 10 years as 2, 11 to 15 years as 3, 16 to 20 years as 4, and more than 20 years as 5.

4.3.4. Teachers Sense of Efficacy Scale

The Teacher Sense of Efficacy Scale was used to measure teachers' self-efficacy. This scale has been used in several studies in different contexts. Researchers reported reliability coefficients ranging from .86 to .95 (Cheung, 2008; Fives & Buehl, 2010; Klassen et al., 2009; Klassen & Chiu, 2010). The scale is composed of 12 items, 4 for each of the three aspects of teacher self-efficacy: *Student Engagement* ("I can motivate students who show low interest in school work?"), *Instructional Strategies* ("I can craft good questions for students?"), and *Classroom Management* ("I can control disruptive behavior in the classroom?"). Teachers answered on a 6-point Likert-type scale (1 = *not at all confident*; 6 = *completely confident*). This scale was used as a means of assessing concurrent validity.

4.3.5. Computer Self-Efficacy Scale

The Computer Self-Efficacy Scale, designed and validated by Compeau and Higgins (1995), was used to measure computer self-efficacy of the teachers in the sample. This scale has been applied in different contexts, and researchers reported reliability coefficients ranging from .81 to .94 (Compeau & Higgins, 1995; Johnson & Marakas, 2000; Staples, Hulland & Higgins, 1998). The scale is composed of 10 items that measure self-efficacy about computer use (e.g. "I can use a specific technology if there is no one around to tell me what to do as I go"). Teachers answered on a 6-point Likert-type scale (1 = *not at all confident*;

6 = completely confident). The Computer Self-Efficacy scale was included as a means of assessing concurrent validity.

4.4. Data analysis

This section describes the data analysis method, from data screening (section 4.4.1) to the steps taken to address each research question (4.4.2, 4.4.3, and 4.4.4).

4.4.1. Data screening

The dataset was automatically created in *Qualtrics* and downloaded in SPSS format. SPSS Version 21.0 was used to organize and clean all data for the analysis. Demographic data were categorized as proposed in section 4.2.5. Cross tabulations were executed to provide interrelation between demographic variables.

During the data screening process, descriptive statistics such as means, standard deviations, and standardized measures of skew and kurtosis were performed for all items of the Self-Efficacy for TPACK subscales. Univariate normality was examined performing the Shapiro-Wilk test of normality, and observing histograms of the variables involved in the study. To identify univariate outliers, scores of all the items of the variables were converted in z -scores. According to Hair et al. (2003), if the sample size is larger than 80 cases, a case is an outlier if its standard score is ± 3.0 or beyond. Cases with a z -score exceeding this critical value were flagged for further review. Multivariate outliers were identified using the Mahalanobis distance index. Raykov and Marcoulides (2008) proposed a critical value to be calculated as chi-square distribution with degrees of freedom equal to the number of variables included in the calculation with an $\alpha < .001$. In other words, a case is a multivariate outlier if the probability associated with its

Mahalanobis distance (in square unit) is 0.001 or less. Such cases were flagged for further review.

Items with absolute values of skewness greater than 3.0 (Curran, West, & Finch, 1997), and absolute values of kurtosis greater than 10.0 (Kline, 2005), were flagged for further consideration. Finally, inter-item and item-total correlations for the items of the Self-Efficacy for TPACK subscales were examined. Items with an inter-item correlation lower than .30 were flagged for removal as well as items with an item-scale total correlation lower than .40.

In the following sections, the procedures conducted to answer research questions are presented. As mentioned in the previous chapter, research question 1 (RQ1) was analyzed and studied in chapter 2.

4.4.2. Research question 2: Psychometric properties of Self-Efficacy for TPACK scale

To address the second research question of this thesis, the psychometric properties of the Self-Efficacy for TPACK scale were investigated. The first step was to conduct an Exploratory Factor Analysis (EFA). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was considered to determine if the sample size was adequate. Bartlett's test of sphericity was also used to ensure that a sufficient correlation between the items was present. Both the KMO value and Bartlett's test of sphericity justified the use of factor analysis (Field, 2009). The maximum likelihood extraction method was adopted to determine the factor structure of the scale. The Kaiser criterion was applied to define the number of factors to retain. This method suggests retaining factors with eigenvalues greater than 1.0 (Kaiser, 1970). The factor pattern loadings for each item were considered and items with a factor loading lower than .40 were removed (Field, 2009). Conceptual clarity was considered as primary method to ensure a simple factor structure.

To assess scale reliability, Cronbach's alpha coefficient for the items in the scale was calculated (Cortina, 1993; Field, 2009). Construct validity of the Self-Efficacy for TPACK subscale was attempted by developing items that aligned closely with Bandura's (2006) guidelines for assessing self-efficacy. Both a group of experts in teachers' technology use and two experts in teacher self-efficacy reviewed the scales. Moreover, a small-scale pilot study was conducted as a check for content validity. Concurrent validity was assessed by examining the correlations between the Self-Efficacy for TPACK subscale and related constructs (i.e., teacher self-efficacy and computer self-efficacy). Items with particularly weak correlations ($|r| < .30$) were flagged as candidates for removal from the study. Finally, predictive validity was assessed by calculating correlations between the Self-Efficacy for TPACK subscale and teacher's self-reported use of technology.

4.4.3. Research question 3: Mean differences

The researcher investigated whether mean differences were present for self-efficacy for TPACK subscales based on age, gender, ethnicity, school level, years of teaching experience, and professional development experience with technology. For ethnicity, the examination was not possible, because the sample sizes for teachers who reported to be African American / Black ($n = 7$) and Hispanic / Latino ($n = 2$) were small and did not provide enough power for the analyses.

In order to proceed with the other analyses, scores for each subscale were computed.

Univariate comparisons were conducted as first step instead of preliminary MANOVA, which according to Huberty and Morris (1989) is an unnecessary step. One-way ANOVAs for each independent variable (age, gender, school level, and years of teaching experience) were conducted to determine whether mean differences were present. For each ANOVA, the self-efficacy for TPACK

subscales were inserted as the dependent variables. The first analyses examined differences in technological pedagogical self-efficacy by age, by gender, by school level, and by years of teaching experience. To examine these group differences, four separate one-way ANOVAs, one of each of the independent variables (i.e., age, gender, school level, school level, and years of teaching experience, respectively), were conducted. The second analyses examined differences in technological content self-efficacy by age, by gender, by school level, and by years of teaching experience. Four separate one-way ANOVAs, one of each of the independent variables, were conducted. The last analyses examined differences in technological pedagogical content self-efficacy by age, by gender, by school level, and by years of teaching experience. Four separate one-way ANOVAs, one of each of the independent variables, were conducted. To account for multiple comparisons among means and protect against inflated Type 1 error, a Bonferroni correction (i.e., $\alpha/c = *p = .05/4 = .0125$; $**p = .01/4 = .0025$) was applied (Dunn, 1961; Field, 2009). Partial eta-squared was reported as a measure of effect size (Richardson, 2011).

Mean differences for self-efficacy for TPACK subscales based on professional development experience with technology were studied through an independent samples *t*-test. Due to the sample sizes in each category, the categories for this variable (*extensive*, *moderate*, *occasional*, and *no professional development with technology*) were treated as follows: *extensive* and *moderate* were merged ($n = 84$); the category *occasional* ($n = 99$) remained unchanged; and the category *no professional development with technology* ($n = 9$) was not considered for analysis. The researcher decided not to merge the category *occasional* and *no professional development with technology* due to evidence that teachers who receive at least some professional development may be distinct from those who receive none. In fact, teachers who received – at least occasional - professional development with technology were found to be more confident to use technology in their profession than those who did not (Abbitt and Klett, 2007; Bakar and Mohamed, 2008).

Cohen's d was reported as a measure of effect size (Cohen et al., 2003) for the independent sample t -test. Although researchers should interpret effect size according to each particular context, Cohen has offered directions suggesting that an effect size, d , of .20 is small, .50 is medium, and .80 is large (Cohen et al., 2003).

4.4.4. Research question 4: The relationship between self-efficacy for TPACK and teachers' technology use

The final research question investigates the relationship between self-efficacy for TPACK variables and teachers' use of technology. A correlation matrix with Pearson coefficients was calculated with the variables involved in the analysis. Multiple linear regression analyses were conducted to address this question. The forced entry method was selected for theoretical reasons (Field, 2009). Predictors were entered simultaneously and in no specific order. Three models were studied as follows:

The predictive validity of self-efficacy for TPACK variables on the following dependent variables:

- (Model 1) teachers' technology use at school;
- (Model 2) teachers' technology use outside of school,
- (Model 3) teachers' communication using technology.

The self-efficacy for TPACK variables (i.e., technological pedagogical self-efficacy, technological content self-efficacy, technological pedagogical content self-efficacy) were entered in each model as independent variables.

Multicollinearity was analyzed checking the correlation matrix of the predictors. Variance inflation factor (VIF) and a tolerance statistic were also considered. The VIF can be a cause of concern if the statistic is larger than 10 (Myers, 1990). Tolerance below 0.2 indicates a problem of collinearity (Menard, 1995).

Chapter 5: Results

In this chapter, the results of the analyses are presented. The first section (5.1) shows the results of the descriptive statistics both for the demographic data related to teachers' technology use and the self-efficacy for TPACK subscales. Section 5.2 presents the results from the exploratory factor analysis, and describes the psychometric properties of the self-efficacy for TPACK subscales. Section 5.3 presents the results from tests of mean differences in self-efficacy for TPACK subscales based on group membership (age, gender, school level, teaching years of experience, and professional development experience with technology). Finally, section 5.4 illustrates the results of the regression analyses that examine the predictive relationship between teachers' TPACK self-efficacy and their reported use of technology.

5.1. Descriptive statistics

A description of the sample according to demographic data has been provided in the previous chapter (4.1). Teachers' responses to the questions related to their use of technology at school and outside school are presented below.

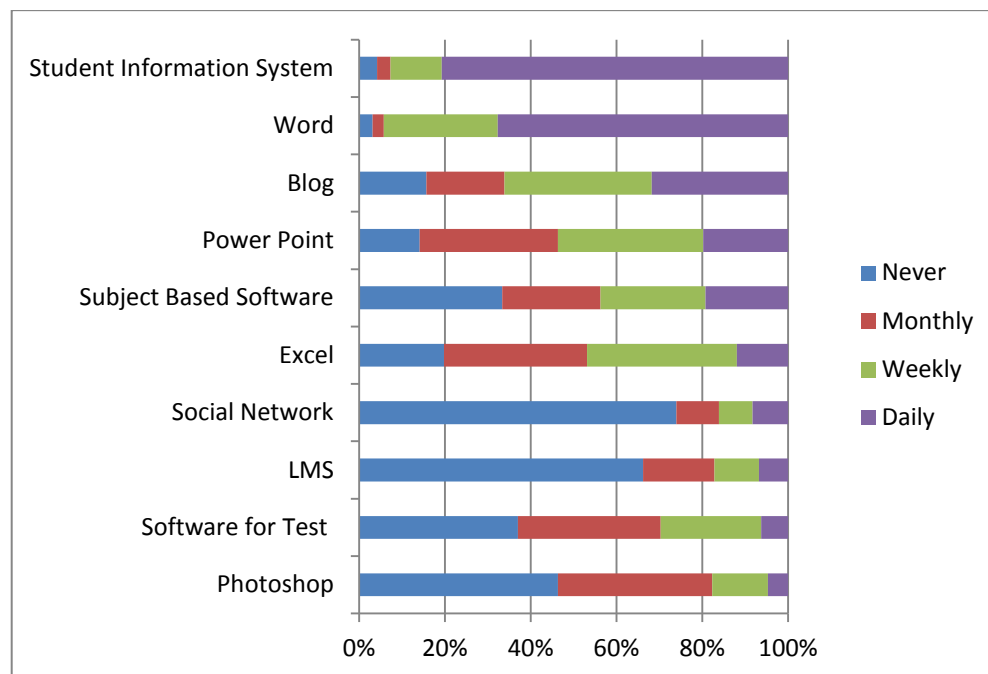
Regarding their access to technology (see Table 5.1), the majority of teachers – ranging from 57% to 89% depending on the type of technology – reported to possess the concerned technologies (i.e. smartphone, desktop PC, laptop, tablet, Mp3 player, DVD player, camera). Moreover, teachers reported having access to desktop PCs (95%), projectors (89%), interactive whiteboards (72%), DVD players (60%), tablets (56%), and laptops (54%) in their schools. Only 11% of teachers had access to videoconference equipment.

Table 5.1 Descriptive Statistics for Teachers' Technology Ownership and Availability in their School

| Technology | Owned | Available at school |
|-------------------------|-------------------|---------------------|
| Smartphone | 84% ($n = 162$) | 34% ($n = 65$) |
| Desktop PC | 68% ($n = 130$) | 95% ($n = 180$) |
| Laptop | 85% ($n = 163$) | 54% ($n = 103$) |
| Tablet | 61% ($n = 117$) | 56% ($n = 107$) |
| Mp3 player | 57% ($n = 110$) | 13% ($n = 24$) |
| DVD player | 89% ($n = 171$) | 60% ($n = 115$) |
| Camera | 89% ($n = 170$) | 59% ($n = 114$) |
| Interactive Whiteboard* | - | 72% ($n = 139$) |
| Videoconference* | - | 11% ($n = 22$) |
| Projector* | - | 89% ($n = 171$) |

Note. * Question pertained only to the availability of these technologies at the participant's school. $N = 192$.

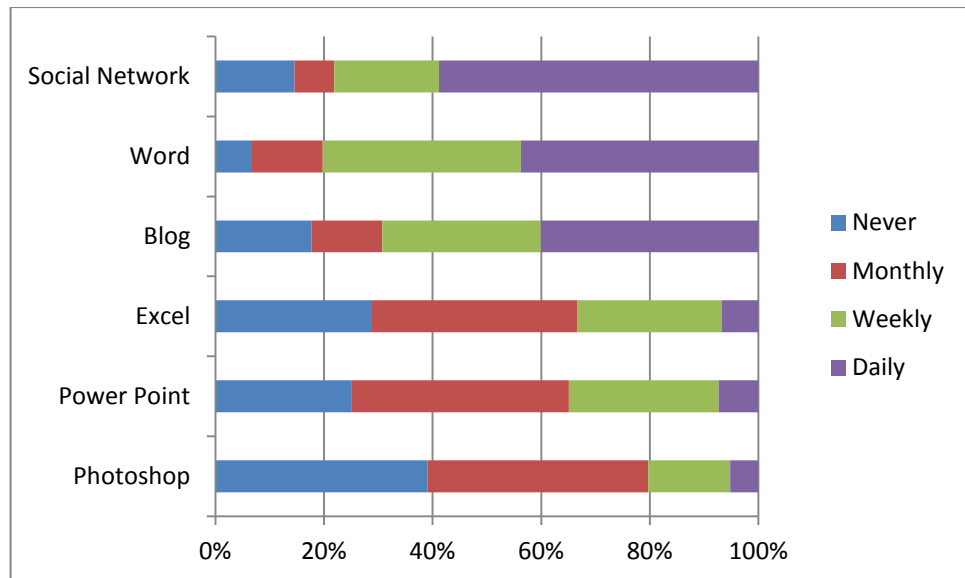
With regard to teachers' use of technologies at school (see Figure 5.1), teachers reported using word processing editors (e.g. Microsoft Word) and student information systems (e.g. Infinite Campus) on a daily basis. The majority of teachers reported using blogs, presentation editors (e.g. Microsoft Power Point), and spreadsheet editors (e.g. Microsoft Excel) weekly. Most teachers reported never using social networks (e.g. Twitter), software for preparing tests, or subject-based software at school.



Note. $N = 192$.

Figure 5.1 Descriptive Statistics for Teachers' Technology Use at School

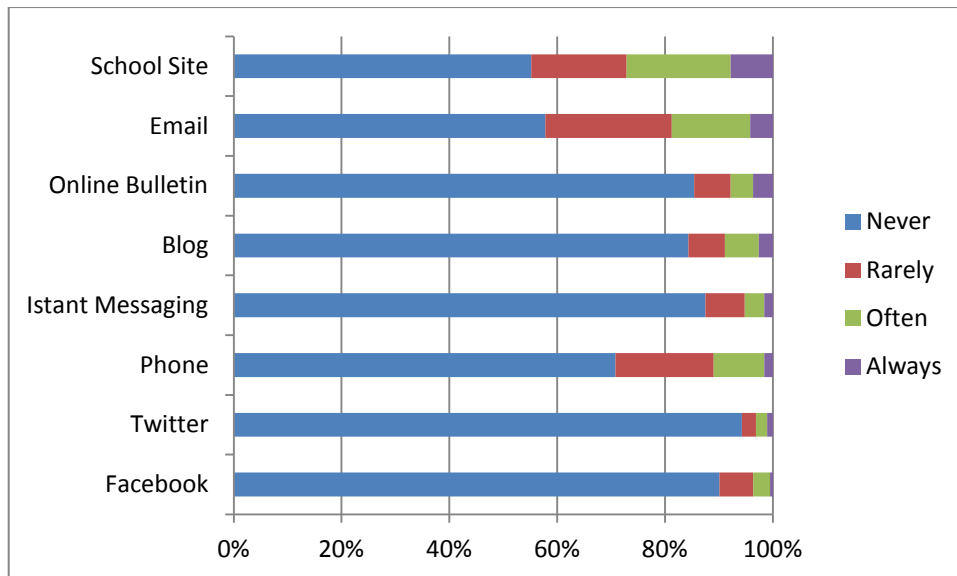
Teachers' use of technology outside of school was somewhat different (see Figure 5.2). Teachers reported using word processing editors (e.g. Microsoft Word), blogs and social networks daily; spreadsheet editors (e.g. Microsoft Excel), presentation editors (e.g. Microsoft Power Point) and Adobe Photoshop are used with a monthly frequency.



Note. $N = 192$.

Figure 5.2 Descriptive Statistics for Teachers' Technology Use Outside of School

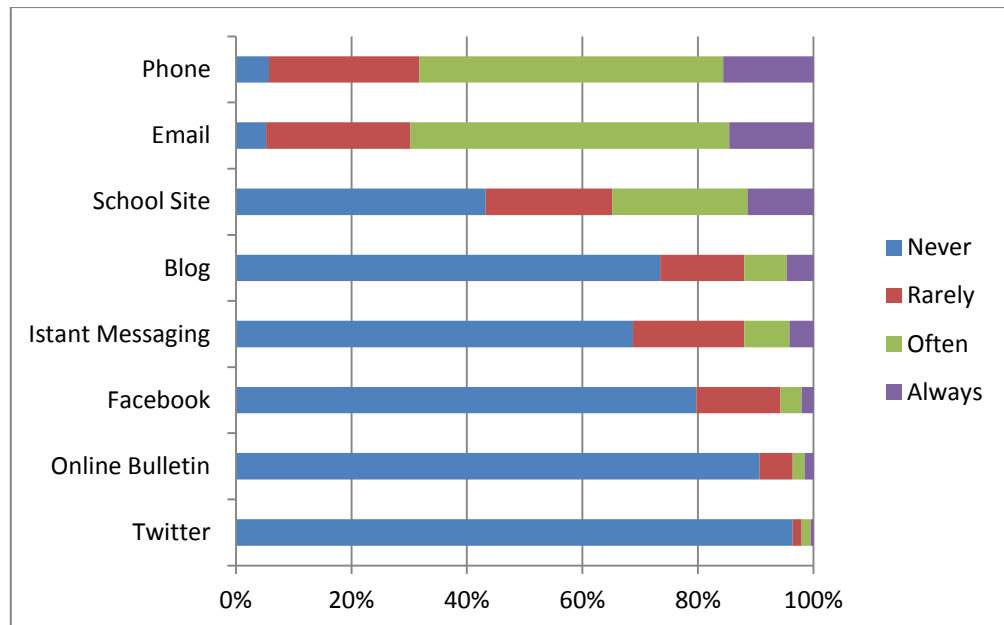
Communication is another important aspect related to technology that has been explored. Specifically, teachers were asked about their communication habits using technology with students, parents and colleagues. As indicated in figure 5.3, the majority of teachers reported that they *never* communicate with students via the technologies indicated (i.e. phone, email, social networks, school website, online bulletin, blog).



Note. $N = 192$.

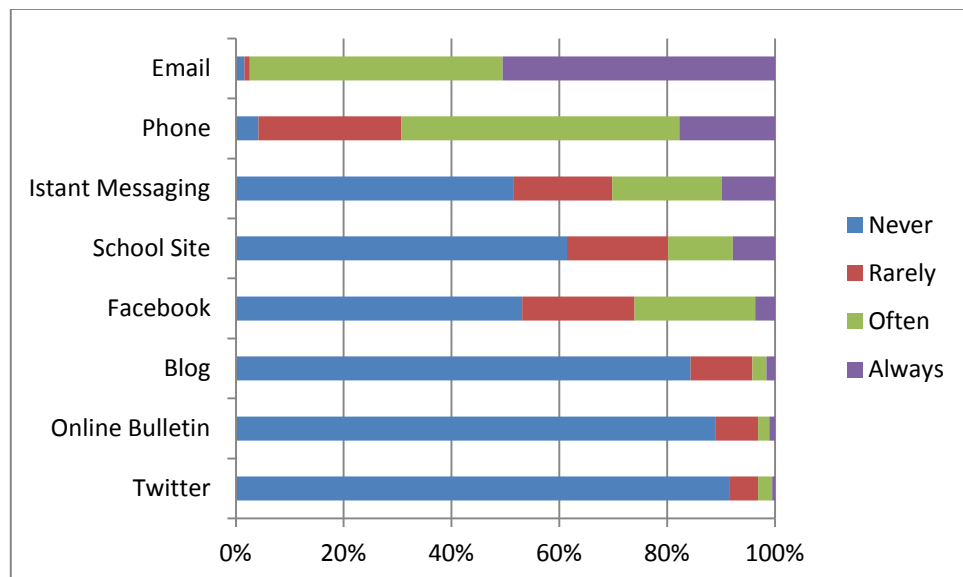
Figure 5.3 Descriptive Statistics for Teachers' Communication Using Technology with Students

Nonetheless, to communicate with parents, phones (53% chose the category *often*) and email (55% chose the category *often*) were the most used technology means (see Figure 5.4). Teachers communicate with their colleagues following a similar pattern: phones (51% chose the category *often*) and email (52% chose the category *always*) were the most used technology means (See Figure 5.5).



Note. $N = 192$.

Figure 5.4 Descriptive Statistics for Teachers' Communication Using Technology with Parents



Note. $N = 192$.

Figure 5.5 Descriptive Statistics for Teachers' Communication Using Technology with Colleagues

The majority of teachers (65%) reported to be at an *intermediate* level according to their competences of technology use; 13% reported to be at a *basic* level, and 22% at an *advanced* level.

Regarding teachers' professional development with technology, 52% reported to have had *moderate* exposure to professional development opportunities, 35% *occasional*, and 9% have not had any. Only 5% of teachers have had *extensive* professional development experience with technology. Male teachers (14%) were twice as likely to have had extensive professional development experiences with technology as female teachers (7%).

Finally, descriptive statistics for the Self-Efficacy for TPACK items were computed. Z-scores were calculated to identify univariate outliers for each of the subscales of the Self-Efficacy for TPACK scale. A small number of outliers (ranging from 4 to 8 for each subscale) with no extreme scores were identified. Cohen and colleagues (2003) suggested that if the number of outliers is small and the standardized scores are not extreme, it is appropriate to include them in the analysis. Following this guideline, all the outliers were kept for further analysis. The Mahalanobis distance index was performed, and no cases were detected as multivariate outliers.

5.2. Research question 2: Psychometric properties of Self-Efficacy for TPACK scale

The analysis of the psychometric properties started with 28 items. These items were grouped conceptually around three primary themes: Technological Content Self-Efficacy (*TeCoSE*), Technological Pedagogical Self-Efficacy (*TePeSE*), and Technological Pedagogical Content Self-Efficacy (*TPCSE*). These three areas were considered to be hypothesized subscales. Descriptive statistics of responses to each of the 28 items are provided in Table 5.2.

Table 5.2 Descriptive Statistics for the Initial 28 Self-Efficacy for TPACK Items

| Item | <i>M</i> | <i>SD</i> | Skewness | Kurtosis |
|-----------|----------|-----------|--------------|--------------|
| TeCoSE_1 | 5.44 | .93 | -2.03 | 4.52 |
| TeCoSE_2 | 5.33 | 1.01 | -1.85 | 3.77 |
| TeCoSE_3 | 3.76 | 1.79 | -0.12 | -1.34 |
| TeCoSE_4 | 4.19 | 1.74 | -0.54 | -1.03 |
| TeCoSE_5 | 5.48 | .86 | -1.89 | 3.31 |
| TeCoSE_6 | 5.03 | 1.28 | -1.24 | .68 |
| TeCoSE_7 | 5.25 | 1.10 | -1.58 | 2.00 |
| TeCoSE_8 | 5.48 | .94 | -2.34 | 5.94 |
| TePeSE_1 | 5.78 | 0.84 | -4.33 | 19.11 |
| TePeSE_2 | 5.68 | 1.05 | -3.55 | 11.97 |
| TePeSE_3 | 4.97 | 1.39 | -1.21 | .39 |
| TePeSE_4 | 5.16 | 1.12 | -1.26 | .80 |
| TePeSE_5 | 5.54 | 0.96 | -2.35 | 5.24 |
| TePeSE_6 | 5.82 | 0.57 | -3.77 | 14.73 |
| TePeSE_7 | 4.54 | 1.58 | -.69 | -.71 |
| TePeSE_8 | 4.95 | 1.32 | -1.18 | .64 |
| TePeSE_9 | 5.11 | 1.15 | -1.33 | 1.25 |
| TePeSE_10 | 4.90 | 1.28 | -.99 | .16 |
| TePeSE_11 | 5.09 | 1.14 | -1.22 | .93 |
| TePeSE_12 | 5.10 | 1.13 | -1.11 | .23 |
| TePeSE_13 | 4.87 | 1.29 | -.98 | .11 |
| TePeSE_14 | 5.02 | 1.28 | -1.25 | .73 |
| TePeSE_15 | 4.88 | 1.37 | -1.14 | .31 |
| TPCSE_1 | 5.23 | 1.12 | -1.55 | 1.86 |
| TPCSE_2 | 5.04 | 1.23 | -1.24 | 0.69 |
| TPCSE_3 | 5.30 | 1.22 | -1.92 | 3.13 |
| TPCSE_4 | 5.18 | 1.29 | -1.68 | 2.15 |
| TPCSE_5 | 4.11 | 1.83 | -.46 | -1.22 |

Note. TeCoSE = Technological Content Self-Efficacy. TePeSE = Technological Pedagogical Self-Efficacy. TPCSE = Technological Pedagogical Content Self-Efficacy. Statistics in bold were deemed beyond a desirable range.

Items that did not meet criteria for appropriate levels of skewness and kurtosis were eliminated from further consideration, as they violated underlying assumptions of most statistical analyses. Kline (2005) suggested that standardized kurtosis with an absolute value greater than 10.0 suggests a problem. Similarly, standardized skew with an absolute value greater than 3.0 indicates extreme skew in the data (Curran, West, & Finch, 1997). Several of

these items indicated a ceiling effect and a lack of variability in teachers' responses. Three such items (*TePeSe_1*, *TePeSE_2*, *TePeSE_6*) were removed prior to factor analysis.

In the next step, the 25 remaining items were subjected to exploratory factor analysis using the Maximum Likelihood method of extraction and an oblique, Promax rotation. Promax rotation assumes that the factors are correlated (Gorsuch, 1983). In this study, the factors derived from the items are believed to correlate with each other. Eigenvalues greater than one were used to identify emerging factors. At every point during factor analysis the researcher gave priority to conceptual clarity and always sought a simple factor structure.

A KMO value higher than .50 (KMO = .93) indicated that the sample size was adequate for factor analysis (Cerny & Kaiser, 1977; Field, 2009). Moreover, Bartlett's test of sphericity indicated that the variables were significantly correlated ($\chi^2(190) = 4056.589$, $p < .001$; Fields, 2009) confirming the adequacy of factor analysis.

The factor analysis showed four factors with eigenvalues greater than one. The first factor had an eigenvalue of 15.3. The next three factors had lower eigenvalues at 1.6, 1.1, 1.0. A careful examination of the conceptual similarity of items within each factor was conducted. Only two items loaded on the fourth factor (*TeCoSE_3* and *TeCoSE_4*). Both items had to do with online teaching. Due to the fact that many teachers in the sample may not have had experience with online teaching, the researcher decided to eliminate these two items from further analysis.

The factor analysis was rerun with 23 items. A three-factor solution emerged with eigenvalues at 14.1 for Factor 1, 1.2 for Factor 2 and 1.1 for factor 3. Items with a factor loading less or equal to $|\lambda| \leq .40$ were flagged for removal from the analysis. One such item (*TePeSE_5*) demonstrated weak loadings on all three factors, and was eliminated. After a careful examination of the conceptual

similarity of items within each factor, two additional items (*TPCSE_1* and *TPCSE_2*) were removed.

The final scale contained 20 items loading on three factors. Eleven items loaded on Factor 1 (loadings ranged from .94 to .55), which was labeled *Technological Pedagogical Self-Efficacy (TePeSE)*. Six items loaded on Factor 2 (loadings ranged from .96 to .52), which was labeled *Technological Content Self-Efficacy (TeCoSE)*. Three items loaded on Factor 3 (loadings ranged from .94 to .50), and was labeled *Technological Pedagogical Content Self-Efficacy (TPCSE)*. Examination of the proportion of variance accounted for by the three factors revealed that Factor 1 accounted for 63% of the variance, Factor 2 accounted for 6%, and Factor 3 accounted for 5%. Table 5.2 shows final factor loadings and communalities for exploratory factor analysis of the Self-Efficacy for TPACK Items.

Table 5.3 Final Factor Loadings and Communalities for Exploratory Factor Analysis of the Self-Efficacy for TPACK Items

| Item | TePeSE | TeCoSE | TPCSE | h^2 |
|--|------------|--------|-------|-------|
| Technological Pedagogical Self-Efficacy ($\alpha = .95$) | | | | |
| I can use technology to improve my teaching productivity. | .94 | .02 | -.10 | .85 |
| I can promote students' creative thinking through the use of technology. | .93 | -.06 | .03 | .87 |
| I can use technology to assess students' learning. | .87 | .10 | -.21 | .71 |
| I can use technology to promote cultural understanding and global awareness. | .79 | -.01 | .03 | .61 |
| I can use technology to keep students motivated. | .80 | -.06 | .06 | .76 |

| Item | TePeSE | TeCoSE | TPCSE | h^2 |
|---|------------|------------|------------|-------|
| I can adapt new technologies I'm learning to different teaching activities. | .77 | .05 | .12 | .82 |
| I can choose technology that enhances students' learning for a lesson. | .76 | .09 | .09 | .62 |
| I can use technology to have students interact online for learning. | .73 | -.07 | .04 | .73 |
| I can help students explore real-world issues by using technology. | .68 | .26 | -.06 | .60 |
| I can think critically about how to use technology in my classroom. | .67 | .06 | .20 | .82 |
| I can use technology to work with students in groups. | .55 | .15 | .01 | .86 |
| Technological Content Self-Efficacy ($\alpha = .93$) | | | | |
| I can use technology to explore a specific topic of my content area. | -.06 | .96 | -.00 | .84 |
| I can use technology to find and select resources for my content area. | -.09 | .91 | .00 | .70 |
| I can use technology to share resources with colleagues in my content area. | .05 | .84 | -.04 | .80 |
| I can use technology to prepare an activity in my content area. | .16 | .77 | .02 | .83 |
| I can use technology to improve a class in my content area. | .13 | .78 | .02 | .85 |
| I can use technology to create resources in my content area. | .15 | .52 | .08 | .82 |
| Technological Pedagogical Content Self-Efficacy ($\alpha = .82$) | | | | |
| I can teach my specific content with a presentations editor (e.g., MS Power Point). | -.06 | -.04 | .94 | .73 |
| I can teach my specific content with a word processor (e.g., MS Word). | -.02 | .10 | .84 | .69 |
| I can teach my specific content with a spreadsheets editor (e.g., MS Excel). | .26 | -.02 | .50 | .53 |

| Item | TePeSE | TeCoSE | TPCSE | h^2 |
|------------------------|--------|--------|-------|-------|
| Percentage of variance | 63.63% | 6.45% | 5.45% | |

Note. TeCoSE = Technological Content Self-Efficacy. TePeSE = Technological Pedagogical Self-Efficacy. TPCSE = Technological Pedagogical Content Self-Efficacy. Factor loadings > .40 are shown in bold. h^2 = communality coefficient.

Table 5.4 presents inter-item and item-total correlations of final Self-Efficacy for TPACK Items. Inter-item correlations among *TePeSE* items ranged from .53 to .87. Inter-item correlations among *TeCoSE* items ranged from .62 to .90. Inter-item correlations among *TPCSE* items ranged from .57 to .79. Item-to-subscale total correlations ranged from .68 to .88 for *TePeSE* factors; from .70 to .86 for the *TeCoSE* factors, and from .63 to .76 for the *TPCSE* factors. These values demonstrate adequate internal consistency. The alpha coefficients for the subscales of the Self-Efficacy for TPACK scale were .95 for the *Technological Pedagogical Self-Efficacy*, .93 for the *Technological Content Self-Efficacy*, and .82 for the *Technological Pedagogical Content Self-Efficacy*.

Table 5.4 Inter-Item and Item-Total Correlations of Self-Efficacy for TPACK Items

| Item | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|----|
| 1. TeCoSE_1 | .83 | | | | | | | | | | | | | | | | | | | |
| 2. TeCoSE_2 | .90 | .86 | | | | | | | | | | | | | | | | | | |
| 3. TeCoSE_5 | .72 | .75 | .82 | | | | | | | | | | | | | | | | | |
| 4. TeCoSE_6 | .57 | .63 | .65 | .70 | | | | | | | | | | | | | | | | |
| 5. TeCoSE_7 | .72 | .76 | .75 | .71 | .85 | | | | | | | | | | | | | | | |
| 6. TeCoSE_8 | .80 | .79 | .77 | .62 | .79 | .85 | | | | | | | | | | | | | | |
| 7. TePeSE_3 | .56 | .59 | .43 | .44 | .51 | .54 | .68 | | | | | | | | | | | | | |
| 8. TePeSE_4 | .59 | .60 | .50 | .47 | .55 | .50 | .66 | .78 | | | | | | | | | | | | |
| 9. TePeSE_7 | .55 | .54 | .41 | .42 | .47 | .41 | .56 | .53 | .69 | | | | | | | | | | | |
| 10. TePeSE_8 | .69 | .70 | .58 | .58 | .63 | .62 | .60 | .68 | .67 | .84 | | | | | | | | | | |
| 11. TePeSE_9 | .71 | .74 | .63 | .59 | .64 | .65 | .59 | .76 | .67 | .86 | .88 | | | | | | | | | |
| 12. TePeSE_10 | .70 | .72 | .60 | .63 | .65 | .64 | .60 | .72 | .67 | .85 | .87 | .88 | | | | | | | | |
| 13. TePeSE_11 | .63 | .63 | .53 | .50 | .56 | .58 | .56 | .63 | .57 | .65 | .71 | .70 | .78 | | | | | | | |
| 14. TePeSE_12 | .68 | .71 | .55 | .52 | .59 | .61 | .58 | .70 | .58 | .74 | .79 | .80 | .78 | .86 | | | | | | |
| 15. TePeSE_13 | .67 | .70 | .54 | .57 | .60 | .57 | .58 | .73 | .62 | .74 | .79 | .80 | .75 | .83 | .88 | | | | | |
| 16. TePeSE_14 | .71 | .75 | .58 | .57 | .64 | .67 | .61 | .60 | .53 | .67 | .71 | .72 | .69 | .77 | .80 | .82 | | | | |
| 17. TePeSE_15 | .58 | .61 | .48 | .54 | .54 | .60 | .52 | .62 | .56 | .69 | .69 | .72 | .59 | .72 | .78 | .84 | .79 | | | |
| 18. TPCSE_3 | .61 | .63 | .51 | .49 | .53 | .57 | .47 | .55 | .46 | .67 | .65 | .63 | .45 | .55 | .60 | .56 | .55 | .73 | | |
| 19. TPCSE_4 | .51 | .52 | .45 | .44 | .41 | .46 | .41 | .46 | .40 | .56 | .55 | .59 | .40 | .48 | .55 | .48 | .47 | .79 | .76 | |

| Item | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------------|
| 20. TPCSE_5 | .47 | .50 | .36 | .51 | .47 | .43 | .44 | .50 | .43 | .52 | .50 | .57 | .40 | .52 | .57 | .54 | .54 | .57 | .61 | .63 |

Note. TeCoSE = Technological Content Self-Efficacy. TePeSE = Technological Pedagogical Self-Efficacy. TPCSE = Technological Pedagogical Content Self-Efficacy. Item-total correlations between each item and its subscale counterparts appear on diagonal. Items within each given subscale appear in grayscale. All correlations were significant at the $p < .01$ level.

To examine concurrent validity, bivariate correlations matrix for scores on the Self-Efficacy for TPACK subscales, Teacher Sense of Efficacy Scale, and the Computer Self-Efficacy Scale was performed. Results are presented in Table 5.5.

Table 5.5 Bivariate Correlations for Self-Efficacy for TPACK Subscale, Teacher Sense of Efficacy Scale, Computer Self-Efficacy Scale

| | <i>M</i> | <i>SD</i> | TePeSE | TeCoSE | TPCSE | TSOE |
|--------|----------|-----------|--------|--------|-------|------|
| TePeSE | 4.96 | 1.08 | | | | |
| TeCoSE | 5.33 | .90 | .79 | | | |
| TPCSE | 4.86 | 1.27 | .69 | .64 | | |
| TSOE | 5.25 | .70 | .49 | .44 | .31 | |
| CSE | 4.98 | .95 | .74 | .73 | .69 | .39 |

Note. TeCoSE = Technological Content Self-Efficacy. TePeSE = Technological Pedagogical Self-Efficacy. TPCSE = Technological Pedagogical Content Self-Efficacy. TSOE = Teacher Sense of Efficacy. CSE = Computer Self-Efficacy.

All correlations were significant at the $p < .01$ level.

All three Self-Efficacy for TPACK subscales were significantly and positively correlated with both the Teacher Sense of Efficacy scale and the Computer Self-Efficacy scale.

5.3. Research question 3: Mean differences

The third research question (RQ3) of this thesis examines whether there are mean differences in the self-efficacy for TPACK subscales as a function of teachers' age, years of teaching experience, gender, school level, and professional development experience with technology. Table 5.6 presents the results of the one-way ANOVAs conducted to address this question. A Bonferroni correction was applied to account for multiple comparisons.

The author first examined whether any of the self-efficacy for TPACK measures differed by age. A significant difference was detected in technological

pedagogical content self-efficacy as a function of teachers' age ($F(3, 188) = 8.046, p < .001$). Teachers older than 51 reported a significantly lower level of technological pedagogical content self-efficacy ($M = 4.23, SD = 1.56$) than did those ages 20-30 ($M = 5.09, SD = 1.07$), and 41-50 ($M = 4.75, SD = 1.25$). There were no significant differences in technological pedagogical self-efficacy and technological content self-efficacy based on age.

As a function of years of teaching, significant differences were found ($F(4, 187) = 5.906, p < .001$). Teachers who have been working for *more than 20 years* reported a significantly lower level of technological pedagogical content self-efficacy ($M = 4.13, SD = 1.54$) than did those who have been working for *less than 5 years* ($M = 5.08, SD = 1.06$), *6-11 years* ($M = 5.22, SD = 1.02$), and *11-15 years* ($M = 5.15, SD = 1.06$).

As a function of gender, no significant differences emerged for any of the self-efficacy for TPACK subscales.

The analyses of the variable school level revealed no significant differences for any of the self-efficacy for TPACK measures. However, the partial eta square value for both technological content self-efficacy and technological pedagogical self-efficacy ($\eta^2 = .42$) suggested that there may be practically significant differences as a function of school level groups. Sample size may be one possible explanation for the fact that these differences are not statistically significant.

Table 5.6 Means, Standard Deviations, and One-Way Analysis of Variance Results

| | TeCoSE | TePeSE | TPCSE |
|-------------------------------|-------------|-------------|---------------------|
| Age | | | |
| 20 – 30 (<i>n</i> = 44) | 5.51 (.71) | 5.11 (.93) | 5.09b (1.07) |
| 31 – 40 (<i>n</i> = 53) | 5.52 (.61) | 5.02 (.92) | 5.35 (.84) |
| 41 – 50 (<i>n</i> = 46) | 5.18 (.94) | 4.84 (1.11) | 4.75b (1.25) |
| More than 51 (<i>n</i> = 49) | 5.10 (1.17) | 4.67 (1.26) | 4.23a (1.56) |
| <i>F</i> | 2.99 | 2.52 | 8.04* |
| η^2 | .04 | .03 | .11 |
| Gender | | | |
| Female (<i>n</i> = 150) | 5.31 (.90) | 4.93 (1.08) | 4.78 (1.29) |
| Male (<i>n</i> = 42) | 5.39 (.88) | 5.07 (1.09) | 5.14 (1.15) |
| <i>F</i> | .25 | .56 | 2.59 |
| η^2 | .00 | .00 | .01 |
| School level | | | |
| Elementary (<i>n</i> = 93) | 5.42 (.75) | 5.05 (1.02) | 4.79 (1.34) |
| Middle (<i>n</i> = 42) | 4.97 (1.20) | 4.54 (1.18) | 4.61 (1.30) |
| High (<i>n</i> = 57) | 5.44 (.83) | 5.11 (1.05) | 5.16 (1.08) |
| <i>F</i> | 2.74 | 2.76 | 1.69 |
| η^2 | .42 | .42 | .02 |
| Teaching years | | | |
| Less than 5 (<i>n</i> = 45) | 5.38 (.94) | 4.99 (1.11) | 5.08b (1.06) |
| 6 – 10 (<i>n</i> = 40) | 5.45 (.74) | 5.18 (.87) | 5.22b (1.02) |
| 11 – 15 (<i>n</i> = 26) | 5.60 (.54) | 5.25 (.95) | 5.15b (1.06) |
| 16 – 20 (<i>n</i> = 34) | 5.37 (.89) | 4.99 (1.02) | 4.94 (1.17) |
| More than 20 (<i>n</i> = 47) | 5.01 (1.07) | 4.54 (1.23) | 4.13a (1.54) |
| <i>F</i> | 2.30 | 2.74 | 5.90* |
| η^2 | .04 | .05 | .11 |

Note. TeCoSE = Technological Content Self-Efficacy. TePeSE = Technological Pedagogical Self-Efficacy. TPCSE = Technological Pedagogical Content Self-Efficacy.

Group means for a dependent variable (row) that are in bold and followed by different letters are statistically different ($\alpha < .01$).

$p < .05^*$ $p < .001^{**}$

Results of mean differences in the self-efficacy for TPACK subscales as a function of teachers' professional development experience with technology are presented in Table 5.7.

Table 5.7 Means, Standard Deviations, and Independent Sample T-Test Results

| | TeCoSE | TePeSE | TPCSE |
|---|------------|-------------|---------------------|
| Professional development with technology | | | |
| Extensive/Moderate (<i>n</i> = 84) | 5.51 (.81) | 5.22 (1.00) | 5.13a (1.10) |
| Occasional (<i>n</i> = 99) | 5.34 (.68) | 4.88 (.98) | 4.81b (1.17) |
| <i>F</i> | .70 | .57 | 1.52* |
| Cohen's <i>d</i> | .22 | .34 | .28 |

Note. TeCoSE = Technological Content Self-Efficacy. TePeSE = Technological Pedagogical Self-Efficacy. TPCSE = Technological Pedagogical Content Self-Efficacy.

Group means for a dependent variable (row) that are in bold and followed by different letters are statistically different ($\alpha < .01$).

$p < .05$ * $p < .001$ **

A significant difference was detected in technological pedagogical content self-efficacy as a function of professional development experience with technology. Teachers who received extensive/moderate professional development with technology reported higher levels of confidence in technological pedagogical content ($M = 5.13$, $SD = 1.10$) than those who received occasional professional development with technology ($M = 4.81$, $SD = 1.17$). Effect size for technological pedagogical self-efficacy (Cohen's $d = .34$) suggested that there may be practically significant differences as a function of professional development with technology groups. Sample size may be one possible explanation for the fact that these differences are not statistically significant.

5.4. Research question 4: The relationship between self-efficacy for TPACK and teachers' technology use

To explore the final research question of this thesis, a correlation matrix with the variables of teachers' technology use and the self-efficacy of TPACK was tabulated. In Table 5.8 correlation coefficients are reported. All the variables correlated positively with coefficient ranging from .26 to .79.

Table 5.8 Bivariate Correlations for Self-Efficacy for TPACK Subscale and Teachers' Technology Use Variables

| | M | SD | 1 | 2 | 3 | 4 | 5 |
|-------------------------------------|-------|------|-----|-----|-----|-----|-----|
| 1. TePeSE | 4.96 | 1.08 | | | | | |
| 2. TeCoSE | 5.33 | .90 | .79 | | | | |
| 3. TPCSE | 4.86 | 1.27 | .69 | .64 | | | |
| 4. Technology use at school | 24.21 | 4.55 | .42 | .41 | .44 | | |
| 5. Technology use outside of school | 15.46 | 3.48 | .36 | .42 | .42 | .54 | |
| 6. Communication using technology | 13.30 | 2.46 | .33 | .26 | .26 | .39 | .30 |

Note. TeCoSE = Technological Content Self-Efficacy. TePeSE = Technological Pedagogical Self-Efficacy. TPCSE = Technological Pedagogical Content Self-Efficacy.

All correlations were significant at the $p < .01$ level.

A series of multiple linear regressions was computed. The first model (Model 1) explores the relationship between self-efficacy for TPACK variables and teachers' technology use at school; Model 2 explores the relationship between self-efficacy for TPACK variables and teachers' technology use outside of school; and Model 3 explores the relationship between self-efficacy for TPACK variables and teachers' communication using technology. The self-efficacy for TPACK variables (i.e., technological pedagogical self-efficacy, technological content self-efficacy, technological pedagogical content self-efficacy) were entered as independent variables. Table 5.9 presents the regression results.

The diagnostic statistics conducted to check for collinearity were in an acceptable range for each analysis. Specifically, the VIF value was between 2.02 to 3.20; the tolerance values ranged from .31 to .49.

Table 5.9 Standardized Regression Results for the Prediction of Self-Efficacy for TPACK Variables on Technology Use at School, Technology Use Outside of School and Communication using Technology

| | Use of technology at school (z-score) | Use of technology outside of school (z-score) | Communication using technology (z-score) |
|-----------------------|--|--|---|
| TeCoSE (β) | .13 | .29* | -.02 |
| TePeSE (β) | .12 | -.06 | .30* |
| TPCSE (β) | .27* | .28* | .06 |
| <i>F</i> | 18.775 | 17.757 | 8.120 |
| <i>R</i> ² | .23** | .22** | .11** |

Note. TeCoSE = Technological Content Self-Efficacy. TePeSE = Technological Pedagogical Self-Efficacy.

TPCSE = Technological Pedagogical Content Self-Efficacy.

p < .05* p < .001**

Technological pedagogical content self-efficacy was the only significant predictor of use of technology at school. Use of technology outside of school, conversely, was significantly predicted by both technological pedagogical content self-efficacy and technological content self-efficacy. Technological pedagogical self-efficacy was the only significant predictor of communication using technology. The three subscales of the Self-Efficacy for TPACK scale accounted for 23% of the variance in the model with use of technology at school as outcome, $R^2 = .23$, $F(3, 188) = 17.775$, $p < .001$; 22% of the variance in the model with use of technology outside of school as outcome, $R^2 = .22$, $F(3, 188) = 18.757$, $p < .001$; and 11% of the variance in the model with communication using technology as outcome, $R^2 = .11$, $F(3, 188) = 8.120$, $p < .001$.

Chapter 6: Discussion

Because of the growing attention to teacher self-efficacy in educational research (e.g., Guskey & Passaro 1994; Tschannen-Moran et al. 1998; Tschannen-Moran & Woolfolk-Hoy 2001), and the importance of technology integration in teaching activities (e.g., Abbitt & Klett, 2007; Erdem, 2007; Teo et al., 2008), this study aimed to study the relationship between teachers' use of technology and their confidence in teaching with technology. The first part of the study (Part 1) examined this relationship by determining the correlation between teacher self-efficacy and computer self-efficacy in two exploratory field studies. Results of these studies were discussed in chapter 2. In this section, results of the second part of the study (Part 2) are discussed. This discussion is guided by addressing each of the three research questions posed in part 2 of the study.

6.1. Research question 2: Psychometric properties of Self-Efficacy for TPACK scale

The Self-Efficacy for TPACK scale was created to explore teachers' confidence in using technology in their profession and to contribute to research about teachers' self-efficacy and technology use. The TPACK was selected as a framework that defines the primary knowledge teachers have to master in order to teach effectively with technology. In this study, three TPACK forms of knowledge were taken into account. *Technological pedagogical knowledge* represents an understanding of the methods of using technologies in a general teaching context (Mishra & Koehler, 2006; Schmidt, et al., 2009). *Technological content knowledge* is to be aware of a specific technology related to a specific domain (Mishra & Koehler, 2006; Schmidt, et al., 2009). *Technological pedagogical content knowledge* is the knowledge of how to use technology to support content-specific pedagogical methods and strategies (Mishra & Koehler, 2006; Schmidt, et al., 2009).

As noted in chapter 3, few studies have been conducted on this topic thus far. Therefore, comparisons with previous studies are in some cases partial.

Exploratory factor analysis indicated that the Self-Efficacy for TPACK scale loaded on three factors. This result confirms the hypothesized three subscales - Technological Pedagogical Self-Efficacy (TePeSE), Technological Content Self-Efficacy (TeCoSE), and Technological Pedagogical Content Self-Efficacy (TPCSE) - selected by the author as essential components of the Self-Efficacy for TPACK scale. Teachers hold distinct - though related - efficacy beliefs about their use of technology, and those are efficacy beliefs about their understanding of methods of using technologies in teaching context (technological pedagogical self-efficacy); efficacy beliefs about be aware of specific technologies related to specific domain (technological content self-efficacy); and efficacy beliefs about how to use technology to support content-specific and pedagogical strategies in their practice (technological pedagogical content self-efficacy). It is worth noting

that the analysis also offers strong evidence that may tempt researchers to consider the scale as unidimensional. The three factors, in fact, are highly correlated. However, the three-factor solution was supported by Kaiser's criterion. It specifies that only factors with an eigenvalue greater than 1.0 should be retained in the factor analysis (Tinsley & Tinsley, 1986). In this case, eigenvalues for the second and third factors were 7.0 and 6.0, and therefore the factors were retained.

Items in each subscale were internally consistent indicating a satisfactory level of reliability.

The items in the scale demonstrated an adequate content validity. Items were created following Bandura's (2006) guidelines: items were created respecting the *I can* formula; gradations of difficulties in the items were given; and items were designed in a task-driven way in accordance with Bandura's directions about Self-Efficacy measurement scales. Moreover, items were designed in accordance with standards for teachers' technology skills and knowledge, such as ISTE and 21st Century Skills, and with definitions in TPACK literature.

Evidence for construct validity was also found. The inter-item and item-total correlation matrix demonstrated satisfactory validity for the three subscales.

Concurrent validity analysis indicated that the magnitude of the correlation coefficient of the three self-efficacy for TPACK subscales was higher with Computer Self-Efficacy scale (Compeau & Higgins, 1995) than with the Teacher Sense of Efficacy scale (Tschannen-Moran & Woolfolk-Hoy 2001). Correlation coefficients for the Computer Self-Efficacy scale ranged from .69 to .74; those for the Teacher Sense of Efficacy scale ranged from .31 to .49. The strong technology content of the self-efficacy for TPACK items may explain the strong correlation with Computer Self-Efficacy scale. An interesting result is that items in the technological pedagogical self-efficacy subscale were more strongly

correlated with both Computer Self-Efficacy and Teacher Sense of Efficacy scales than were the other two self-efficacy for TPACK measures.

Referring to Rivoltella's (2005) consideration about technology in teaching experience (see Chapter 1), there is a difference in using technology as strategy to teach – related to the technological *pedagogical* self-efficacy subscale and using technology to teach a specific subjects – related to the technological *content* self-efficacy subscale. Even if teachers in the sample feel more confident in technological content self-efficacy ($M = 5.33$; $SD = .90$) than in technological pedagogical self-efficacy ($M = 4.96$; $SD = 1.08$), their technological pedagogical self-efficacy may be more closely related to their confidence in teaching and computer use. In a similar study where the TPACK self-efficacy for science was explored (Graham et al., 2009), results suggested that teachers' confidence in technological content was lower than their confidence in technological pedagogy. This result is in contrast with the one obtained in the current study. A possible explanation is that defining the content – science, in Graham's study – allowed teachers to have a more specific and concrete idea of the items concerning the technological content self-efficacy subscale. The general wording of the items in the technological content self-efficacy subscale in the current study – such as “in your content area”, could have prevented teachers from giving a considered answer to those questions.

6.2. Research question 3: Mean differences

The third research question explored differences in self-efficacy for TPACK subscales as function of age, years of teaching, gender, school level, and professional development experience with technology.

As a function of age, a significant difference in technological pedagogical content self-efficacy was observed. Teachers *51 years of age and older* reported

a significantly lower level of technological pedagogical content self-efficacy than did those in the categories 20-30 and 41-50.

Due to the fact that in the age of teachers in the sample is positively correlated with teachers' years of teaching experience, a similar trend was found as a function of years of teaching. Teachers who have been working for *more than 20 years* reported a significantly lower level of technological pedagogical content self-efficacy (TPCSE) than did those who have been working for *less than 5 years*, *6-11 years*, and *11-15 years*. The negative relationship between age/years of teaching and self-efficacy for TPACK subscales is not an unexpected result. Studies on self-efficacy of teachers using technology (Lee & Tsai, 2010; Yaghi, 2001) confirmed that teachers with more years of teaching experience tend to have less confidence in their technological capabilities. However, studies on teacher self-efficacy (Cheung, 2008; Cruz & Arias, 2007; Tschannen-Moran & Woolfolk-Hoy, 2007) reveal that experienced teachers rated themselves significantly higher in terms of teaching confidence than did novice teachers. These findings suggest that familiarity with technology - usually higher in younger people (OECD, 2012) - has more influence in altering teacher self-efficacy for TPACK than teaching experience.

No significant gender differences in self-efficacy for TPACK subscales were observed. The fact that 78% of the sample was composed of female teachers may explain the lack of variability in the self-efficacy for TPACK subscales as function of gender. However, studies on teacher self-efficacy (Cheung, 2008; Erdem & Demirel, 2007) indicated that female teachers reported higher levels of teacher self-efficacy than did male teachers. But when technology is a component of teacher self-efficacy, the result is different. Studies on the role of gender in technology self-efficacy (see Bandura, 1997; Cassidy & Eachus, 2002; Miura, 1987; Smith, 2001) have indicated that men report higher levels of confidence in technology use than women.

No significant differences in self-efficacy for TPACK subscales based on school level were observed. However, effect size measure for technological content self-efficacy and technological pedagogical self-efficacy suggested that there may be *practically* significant differences as a function of school level groups. Sample size may be one of the explanations for the fact that these differences are not statistically significant. Moreover, the majority of the sample (48%) was composed of elementary teachers, thus reducing the chance of variability of teachers' answers as function of school level. Findings on this topic in the literature are controversial. On one hand, some authors (Fives & Buehl, 2010; Shapka & Ferrari, 2003; Wolters & Daugherty, 2007) have found that elementary teachers report significantly higher teaching efficacy than those teaching in middle or high school. Conversely, some authors (Chester & Beaudin, 1996; Mueller et al., 2008; Soodak & Podell, 1996) have reported no significant differences in teaching efficacy beliefs in terms of school level.

Professional development with technology experience was another lens through which to explore differences in self-efficacy for TPACK. Results indicated that teachers who received extensive/moderate professional development with technology reported higher levels of confidence in technological pedagogical content than those who had occasional professional development experiences with technology. This result is aligned with other studies (see Chifari et al., 2000; Mueller et al., 2008), and with those findings related to teachers' years of teaching in the current study. Experiences with technology, especially in teaching activities, are important considerations as positive influence on teachers' confidence in TPACK. According to Bandura (1997), mastery experiences are one of the four hypothesized sources of self-efficacy, and are the most influential. Mastery experiences "provide the most authentic evidence of whether one can muster whatever it takes to succeed" (p. 80). Successful experience increase one's self-efficacy; failures weaken it (Bandura, 1997). Results of this study seem to suggest that teacher training with technology is an essential component in the development of teachers' self-efficacy for using technology.

6.3. Research question 4: The relationship between self-efficacy for TPACK and teachers' technology use

The fourth research question addresses the relationship between self-efficacy for TPACK and teachers' technology use.

According to Social Cognitive Theory (Bandura, 1986), personal factors, behavior, and environment influence each other and create a process of triadic reciprocity. This theory supports the hypothesis that self-efficacy for TPACK (personal factors) and teachers' technology use (behavior) influence and alter each other. Through a series of linear regressions, this relationship was studied to analyze how self-efficacy for TPACK informs teachers' behavior about technology. The three models analyzed in this study indicated that self-efficacy for TPACK positively influence teachers' technology use. Specifically, teachers' use of technology at school was significantly predicted by technological pedagogical content self-efficacy: teachers' beliefs about how to use technology to support content-specific pedagogical strategies influence the way their integrate technology in their teaching activities. These findings suggest that teachers' beliefs predict their actual use, although more research is needed to confirm this relationship. The measure used in this study was a self-report questionnaire, and that may cause response biases.

The relationship between efficacy beliefs and teachers' use of technology in schools is a noteworthy result for school principals and other leaders involved in teacher preparation. This finding demonstrates that, in order to facilitate teachers' technology integration in their activities, it is necessary not only to provide them with technology knowledge and skills, but also to increase their confidence in technology use. As suggested by Ertmer and Ottenbreit-Leftwich (2010), "although knowledge of technology is necessary, it is not enough if teachers do not also feel confident using that knowledge to facilitate student learning" (p. 261). Similar studies (see Albion, 2001; Abbitt, 2011; Graham et al., 2009; Wang

et al., 2004) have also confirmed relationship between teachers' beliefs and their use of technology.

It is worth noting that a large proportion of the variance in teachers' technology usage is still unaccounted for. Self-efficacy for TPACK explained 23% of the variance of technology use at school (Model 1), 22% of the variance of use of technology outside of school (Model 2), and only 11% of the variance of communication using technology (Model 3). Consequently, teachers' technology use is influenced by other factors not measured in the current study. Several factors, in fact, may influence teachers in using technology (Ertmer, 1999). Among them, the context in which teachers are working (Hennessy, Ruthven, & Brindley, 2005), availability or lack of resources (Hew & Brush, 2006), and other existing belief systems (Ertmer & Ottenbreit-Leftwich, 2010) can have a great influence on teachers' technology integration.

6.4. Limitations and future research

This work presents several limitations that are noted in this section. Some suggestions for future research are also reported.

This work is based on self-reported data. Studies that involve this kind of data rely on participants' honesty in their answers. In this case, some measures regarding data confidentiality were taken to encourage teachers to be honest, such as ensuring the anonymity of teachers' responses. They were informed that only the researcher in charge of the study would be able to see their responses, and were reminded that responses were combined with responses from others before being analyzed. They were informed thus that they were not to be personally identified in any way. These remarks formed part of the informed consent briefing at the beginning of the questionnaire (see Appendix 4). Still, some teachers may have had reservations and have not responded honestly.

Furthermore, this study relies only on quantitative methods. Qualitative analysis may provide a different lens through which to understand respective results, and may provide further insights about self-efficacy of teachers using technology. Semi-structured interviews may be an example of a means to deepen the understanding of current research.

The size of the sample used in this study was limited. Although analogous studies have used similar sample size (e.g. Hutchison & Reinking, 2011) a larger sample may give more weight to the study's findings.

A limitation related to the sampling is its variability according to some demographic variables, such as gender, ethnicity, school level, and location. The majority of teachers participating in the study were female (78%), Caucasian / White (95%), and working in elementary schools (48%). This distribution limited some analyses. Moreover, due to logistic constraints, teachers involved in the research were only from Kentucky schools. A more diversified sample may give more variability to the results. Moreover, due to sampling issues not all the categories of the variable teachers' professional development with technology were represented with enough power to conduct analysis. Teachers who reported not to have had professional development with technology were 9 ($n = 9$). It may be possible that people who have not experienced professional development with technology – and in some cases less familiar with technology - are not likely to fill an online questionnaire. A paper and pencil questionnaire may be an option to encourage this category of teachers to fill a questionnaire about confidence in using technology. Due to these sampling limitations, generalizability to different demographic groups is therefore limited.

Another relevant issue explored in the current study was the differences in self-efficacy for TPACK as a function of years of teaching. Several studies (Cheung, 2008; Cruz & Arias, 2007; Tschannen-Moran & Woolfolk-Hoy, 2007) about teacher self-efficacy of novice and experienced teachers showed that experienced teachers report higher self-efficacy than do novice teachers. According to

Bandura (1997) “efficacy beliefs are most at play early in learning and, once established, become resistant to change” (as cited in Tschannen-Moran & Woolfolk-Hoy, 2007, p. 949). Future studies may explore changes in self-efficacy for TPACK across time, both in novice and experienced teachers. It may be hypothesized that in the next decade, once technology fully penetrates teacher training curricula, this trend may change. With the same level of technology exposure and training, experienced teachers may report higher levels of self-efficacy for TPACK than novice teachers, given their experience in teaching activities.

This research is a preliminary study that explored the predictive validity of self-efficacy for TPACK on teachers’ technology use. According to Bandura’s Social Cognitive Theory, personal factors, behavior, and environmental influences create interactions that result in a process of triadic reciprocity. Future studies may also explore the influence of behavior – teachers’ technology use - on teacher self-efficacy. A rigorously designed longitudinal study may also allow future researchers to explore the reciprocal effect of these two variables. Moreover, future research may also study other teaching aspects related to self-efficacy for TPACK, and investigate their relationship. Studies of teacher self-efficacy, for example, have found evidence of correlation with teaching activities, such as instructional strategies, classroom management, and student engagement (Klassen et al., 2009; Tschannen-Moran & Woolfolk Hoy, 2001), job satisfaction (Caprara et al., 2003; Klassen & Chiu, 2010), and commitment to teaching (Coladarci, 1992).

Exploring the role of contextual factors may also contribute to the improvement of this study. In fact, “teachers are not ‘free agents’ and their use of ICT for teaching and learning depends on the interlocking cultural, social, and organizational contexts in which they live and work” (Somekh, 2008, p. 450). The present study presented three different cultural contexts: Brazil, South Africa in the pilot studies, and United States in the main study. Due to research

constraints, the role played by the different cultural contexts has not been taken into account in the analysis. As suggested by Tschannen-Moran and Woolfolk Hoy (2007), contextual variables such as available resources may affect teachers' beliefs about technology. Teachers who have less chance to be exposed to technology (e. g., Brazilian and South African teachers) may consider their beliefs about technology more important than those who have been extensively exposed (e. g., US teachers). US teachers, more experts in the use of technology in comparison to Brazilian and South African, may have an asset of mastery experiences on which to base their self-perceptions. Another relevant contextual factor is the school environment. Zhao and Frank (2003) noted that "a technology innovation was less likely to be adopted if it deviated too greatly from the existing values, beliefs, and practices of the teachers and administrators in the school". Teachers need to value technologies as an instructional tool to effectively introduce them in their practice. This may vary according to the phase of technology adoption of the context - school community or Country. Referring to Rogers' categories of adoption (2003), *pioneers* teachers in the use of technology may consider their self-efficacy more influential than those working in a school where technology are in place and considered as meaningful pedagogical tools. Future study in this direction may concern the validation of the Self-efficacy for TPACK scale in Brazil and South Africa to allow multinational comparison.

This study may be improved by adding more evidence of discriminant validity. Some variables could not be included in the questionnaire due to length and to facilitate teachers' completion rates. For example, the Computer Anxiety scale (Conrad & Munro, 2008; Heinssen et al., 1987; Marcoulides, 1989; Thatcher & Perrewé, 2002) might be a useful measure to include to better study and feature teachers' confidence in technology use. Teachers' attitude toward technology use may also be added to increase the possibility of comparisons with analogous studies (e.g., Graham et al., 2009; Lee & Tsai, 2010).

Future research may include in the questionnaire a series of questions about teachers' knowledge of TPACK areas. Some authors (Abbitt, 2011; Pajares, 1992) have discussed the relationship between knowledge and beliefs, and its importance on teaching activities. The relationship among teachers' TPACK knowledge and teachers' confidence in TPACK may be studied and compared with previous studies (see Rohaan et al., 2012; Semiz et al., 2012).

Furthermore, a study of the sources of self-efficacy for TPACK may deepen understanding about teachers' confidence in their use of technology at school. A measure of Bandura's (1997) four hypothesized sources of self-efficacy - mastery experience, vicarious experience, social persuasion, and emotional and psychological states related to the TPACK framework may allow researchers to better explore which elements more affect and inform teachers' confidence in teaching with technology. Results of this study may help also schools principals and people working in the educational field plan teacher training in a more effective way. As suggested by Albion (2001) teacher training "should be structured using approaches which build confidence in their capacity for effective computer use" (p. 345). The uncovering of sources that influence teachers' confidence in using technology may help improve professional development with technology.

Finally, another research agenda may be to explore principals' confidence in technology use. These two groups – teachers and principals are strictly connected in the school context, and influence each other in several educational processes (Hannah et al., 2008). And technology integration in the teaching activity is one of them. Moreover, according to Chemers et al. (2000), principals' self-efficacy affects the attitudes and behaviors of their staff. A better understanding of principals' confidence in technology use may contribute to research on self-efficacy for teachers' using technology in their activities.

Conclusions

As Pajares pointed out, “what we know, the skills we possess, or what we have previously accomplished are not always good predictors of subsequent attainments because the beliefs we hold about our capabilities powerfully influence the ways we behave” (cited in Madewell & Shaughnessy, 2003, p. 381). Consequently, behavior can generally be better predicted by the beliefs people have about their capabilities to accomplish a particular task than by their actual capabilities (Bandura, 1977).

This thesis explored the efficacy beliefs teachers hold about their technology use. Its purpose was to investigate the relationship between teachers’ self-efficacy and their technology use through the design and validation of a self-efficacy measure to assess teachers’ beliefs about technology use in their profession.

The first part of this thesis (Part I) explored the relationship between teacher self-efficacy and computer self-efficacy (RQ1). An extended literature review and two exploratory field cases gave rise to the hypothesis of a correlation between them. However, results of the first part of this thesis were controversial, and led the author to extend the research with the specific aim of providing a tool that can measure teachers’ beliefs about their use of technology.

In the second part of the thesis (Part II), the other research questions (RQ2, RQ3, and RQ4) were addressed. Specifically, a psychometrically sound instrument to assess teachers’ efficacy beliefs about using technology in their profession was developed. Through feedback from external experts, a small-scale pilot study, and a large-scale questionnaire to a sample ($n = 218$) of K-12 teachers in the United States the new scale was validated. This scale is based on the Technological, Pedagogical and Content knowledge (TPACK) framework (Mishra & Koehler, 2006) and on the standards put forth by the International Society for Technology in Education (ISTE) and by the Partnership for 21st

Century Skills (P21). It is composed of 20 items, organized in three subscales: *Technological Pedagogical Self-Efficacy* (11 items), *Technological Content Self-Efficacy* (6 items), and *Technological Pedagogical Content Self-Efficacy* (3 items).

Moreover, this study illuminated the role played by years of teaching experience, professional development with technology, age, gender, ethnicity, and school level in the development of teacher self-efficacy for TPACK. On one hand, experienced teachers reported to have less confidence in technology use. On the other hand, teachers who received extensive/moderate professional development with technology reported higher levels of self-efficacy for TPACK. The role of teacher training in technology use emerged to be essential in increasing their self-efficacy for TPACK. No significant differences were detected in self-efficacy for TPACK as function of gender, ethnicity, and school level.

Finally, in addressing the fourth research question (RQ4), this research confirmed the role of self-efficacy in predicting teachers' use of technology. Results showed that self-efficacy for TPACK positively predicts teachers' technology use.

This thesis presents a significant contribution to the debate about technology diffusion in teaching activities, both through the instructional technology and motivation lens. The importance of the beliefs teachers hold about their use of technology is confirmed to be a relevant aspect to be studied. Moreover, in this study the researcher developed a psychometrically sound instrument to assess teachers' efficacy perceptions about working with and using technology in their profession. This tool may be an important instrument for individuals involved in the educational process, and may offer a new perspective to the issue of teachers' confidence in technology use.

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Appendix 1

List of the schools and the counties involved in the study

| School name | County |
|-----------------------------|------------|
| Abraham Lincoln Elementary | Larue |
| Austin Tracy Elementary | Barren |
| Bate Middle | Boyle |
| Bath County Middle | Bath |
| Beechwood High | Kenton |
| Bell Central School Center | Bell |
| Black Mountain Elementary | Harlan |
| Blake Elementary | Jefferson |
| Bourbon Central Elementary | Bourbon |
| Bourbon County Middle | Bourbon |
| Brodhead Elementary | Rockcastle |
| Burlington Elementary | Boone |
| Calvert City Elementary | Marshall |
| Cane Run Elementary | Jefferson |
| Carlisle County High | Carlisle |
| Casey County High | Casey |
| Caverna High | Hart |
| Central Elementary | Clark |
| Christian County Middle | Christian |
| Corbin Middle | Whitley |
| Crossroads Elementary | Campbell |
| Cumberland Trace Elementary | Warren |
| Danville Bate Middle | Boyle |
| East Bernstadt Independent | Laurel |
| Fannie Bush Elementary | Clark |
| Garrard County High | Garrard |

| | |
|---------------------------------|------------|
| Hancock County High | Hancock |
| Henry County High | Henry |
| Highland Elementary | Lincoln |
| Highland Elementary | Barren |
| Hillsboro Elementary | Fleming |
| Hopkins County Central High | Hopkins |
| Kathryn Winn Primary | Carroll |
| Lakewood Elementary | Hardin |
| Lee County High | Lee |
| Logan County High | Logan |
| Logan County Alternative School | Logan |
| Lone Oak Elementary | McCracken |
| Louisa East Elementary | Lawrence |
| Mapleton Elementary | Montgomery |
| Maryville Elementary | Bullitt |
| McNabb Elementary | McCracken |
| Middlesboro High | Bell |
| Morningside Elementary | Hardin |
| Mt. Vernon Elementary | Rockcastle |
| Newport Primary | Campbell |
| North Middle | Hardin |
| Old Mill Elementary | Bullitt |
| Owen County High | Owen |
| Owingsville Elementary | Bath |
| Painted Stone Elementary | Shelby |
| Pikeville High School | Pike |
| Pulaski County Elementary | Pulaski |
| Rangeland Elementary | Jefferson |
| Richard Cartmell Elementary | Carroll |
| Rosa Parks Elementary | Fayette |

| | |
|----------------------------|-----------|
| Rowan County Middle | Rowan |
| Russell High | Greenup |
| Saffell Street Elementary | Anderson |
| Sebree Elementary | Webster |
| Somerset High | Pulaski |
| South Green Elementary | Barren |
| Southern Elementary | Ohio |
| Southside Elementary | Hopkins |
| Southwest Elementary | Calloway |
| Stamping Ground Elementary | Scott |
| T.T. Knight Middle | Jefferson |
| The Academy | Franklin |
| The J. Graham Brown School | Jefferson |
| The Providence School | Jessamine |
| Waco Elementary | Madison |
| Watson Lane Elementary | Jefferson |
| Whitesville Elementary | Daviess |

Appendix 2

Email message sent to the principals

Dear Principal *Last Name*,

I am a doctoral student from the University of Lugano (Switzerland), and I am currently spending a year at the University of Kentucky as a visiting scholar working in the P20 Motivation and Learning Lab.

I have designed a study to measure **teachers' attitudes and beliefs about their use of technology**. The focus of my study will be K-12 teachers across the state of Kentucky, and I would really appreciate the contribution of your school. The study consists of a simple, **15-minute** computer survey for teachers.

In return for participation, I will provide leaders in participating districts with a report of study results that offers information about teachers' beliefs and attitudes about the use of technology in terms of **ISTE's NETS standards for teachers** (<http://www.iste.org>). In this report, aggregated responses from your district and/or school will be compared to those of other schools like yours in Kentucky.

If you are willing to participate, I ask that you please send the following link to **your teachers**:

Teachers' survey link

I am also interested in your attitude and beliefs about technology as a school principal. If you would like to contribute anonymously to this study, I would greatly appreciate your insights. To access the principal survey, please follow this link or copy it in your browser:

Principals' survey link

Please note that both surveys, which take **only 15 minutes** to complete, will be active from **April, 18-26, 2013**.

Respondents will not be personally identified in any way. Individual responses will be **kept strictly confidential**. I will write about this study in terms of the **combined information** I have gathered.

For my own record-keeping purposes, I would greatly appreciate knowing whether you intend to allow your teachers to participate in the survey. In addition, if you

have questions, suggestions, or concerns about the study, please don't hesitate to contact me at **fanni.francesca@uky.edu** at any time.

Thank you very much in advance for your attention and your time. I look forward to hearing from you and hope to have the chance to contact you again to share with you the results of my study.

Best regards,

Francesca Fanni

Appendix 3

Initial items of the Self-Efficacy for TPACK scale and their reference

| Items | Reference |
|---|-------------------------------|
| I can use technology to prepare an activity in my content area. | |
| I can use technology to improve a class in my content area. | |
| I can use technology to implement an online course in my content area. | (Archambault & Crippen, 2009) |
| I can use technology to implement an online lesson in my content area. | |
| I can use technology to find and select resources for my content area. | |
| I can use technology to create resources in my content area. | |
| I can use technology to share resources with colleagues in my content area. | |
| I can use technology to explore a specific topic of my content area. | |
| I can use technology to take attendance. | |
| I can use technology to keep student grades. | |
| I can use technology to work with students in groups. | |
| I can use technology to keep students motivated. | |
| I can use technology to communicate with students' parents. | |
| I can use technology to communicate with other teachers. | |
| I can use technology to have students interact online for learning. | |

| Items | Reference |
|---|------------------------|
| I can think critically about how to use technology in my classroom. | (Schmidt et al., 2009) |
| I can choose technology that enhances students' learning for a lesson. | (Schmidt et al., 2009) |
| I can adapt new technologies I'm learning to different teaching activities. | (Schmidt et al., 2009) |
| I can use technology to assess students' learning. | (Burgoyne, 2010) |
| I can use technology to improve my teaching productivity. | (Burgoyne, 2010) |
| I can promote students' creative thinking through the use of technology. | NETS-T-Standards |
| I can help students explore real-world issues by using technology. | NETS-T-Standards |
| I can use technology to promote cultural understanding and global awareness. | NETS-T-Standards |
| I can teach my specific content area using technology. | |
| I can select appropriate technology to improve student learning of a difficult topic. | (Burgoyne, 2010) |
| I can teach my specific content with a word processor (e.g., MS Word). | |
| I can teach my specific content with a presentations editor (e.g., MS Power Point). | |
| I can teach my specific content with a spreadsheets editor (e.g., MS Excel). | |

Appendix 4

Teacher survey

INFORMED CONSENT

WHAT IS THE PURPOSE OF THIS STUDY?

By doing this study, we hope to learn about teachers' attitudes and beliefs about their use of technology.

WHO IS DOING THE STUDY?

The person in charge of this study is Francesca Fanni, a doctoral student in the New Media in Education Laboratory, at the Università della Svizzera italiana (USI - University of Lugano), Switzerland. She is a visiting scholar in the P20 Motivation and Learning Lab at the University of Kentucky.

HOW WILL I PARTICIPATE IN THE STUDY?

The study consists of a simple computer survey that takes approximately 15 minutes to complete.

WHO WILL SEE THE INFORMATION THAT YOU GIVE?

Only the researcher in charge of the study will see your responses. The responses you provide will be combined with responses from others before being analyzed. You will not be personally identified in any way, and your individual responses will be kept confidential. When I write about this study, I will write in terms of the combined information I have gathered.

WHAT IF YOU HAVE QUESTIONS, SUGGESTIONS, CONCERNS, OR COMPLAINTS?

You are invited to send questions, suggestions, concerns, or complaints about the study, to the investigator, Francesca Fanni at fanni.francesca@uky.edu at any time before or after your participation.

Your participation in this study is completely voluntary.

- ☐ I have read the statement above and understand that my participation is completely voluntary. I agree to participate in this study.
- ☐ I do not wish to participate in this study.

What is your age?

- ☐ 20
- ☐ 21
- ☐ 22
- ☐ 23
- ☐ 24
- ☐ 25
- ☐ 26
- ☐ 27
- ☐ 28
- ☐ 29
- ☐ 30
- ☐ 31
- ☐ 32
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- ☐ 40
- ☐ 41
- ☐ 42
- ☐ 43
- ☐ 44
- ☐ 45

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- 58
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- 64
- 65
- 66
- 67
- 68
- 69
- 70
- 71
- 72

- ☐ 73
- ☐ 74
- ☐ 75
- ☐ 76
- ☐ 77
- ☐ 78
- ☐ 79
- ☐ 80

What is your gender?

- ☐ Male
- ☐ Female

Which category best describes your racial/ethnic group?

- ☐ Caucasian / White
- ☐ African American / Black
- ☐ Asian / Asian American
- ☐ Hispanic / Latino (a)
- ☐ Native American / First Nations
- ☐ Other _____

What is your school's name?

In which County is your school located?

- ☐ Adair
- ☐ Allen
- ☐ Anderson
- ☐ Ballard
- ☐ Barren

- ☐ Bath
- ☐ Bell
- ☐ Boone
- ☐ Bourbon
- ☐ Boyd
- ☐ Boyle
- ☐ Bracken
- ☐ Breathitt
- ☐ Breckinridge
- ☐ Bullitt
- ☐ Butler
- ☐ Caldwell
- ☐ Calloway
- ☐ Campbell
- ☐ Carlisle
- ☐ Carroll
- ☐ Carter
- ☐ Casey
- ☐ Christian
- ☐ Clark
- ☐ Clay
- ☐ Clinton
- ☐ Crittenden
- ☐ Cumberland
- ☐ Daviess
- ☐ Edmonson
- ☐ Elliott

- ☐ Estill
- ☐ Fayette
- ☐ Fleming
- ☐ Floyd
- ☐ Franklin
- ☐ Fulton
- ☐ Gallatin
- ☐ Garrard
- ☐ Grant
- ☐ Graves
- ☐ Grayson
- ☐ Green
- ☐ Greenup
- ☐ Hancock
- ☐ Hardin
- ☐ Harlan
- ☐ Harrison
- ☐ Hart
- ☐ Henderson
- ☐ Henry
- ☐ Hickman
- ☐ Hopkins
- ☐ Jackson
- ☐ Jefferson
- ☐ Jessamine
- ☐ Johnson
- ☐ Kenton

- ☐ Knott
- ☐ Knox
- ☐ Larue
- ☐ Laurel
- ☐ Lawrence
- ☐ Lee
- ☐ Leslie
- ☐ Letcher
- ☐ Lewis
- ☐ Lincoln
- ☐ Livingston
- ☐ Logan
- ☐ Lyon
- ☐ Madison
- ☐ Magoffin
- ☐ Marion
- ☐ Marshall
- ☐ Martin
- ☐ Mason
- ☐ McCracken
- ☐ McCreary
- ☐ McLean
- ☐ Meade
- ☐ Meniffee
- ☐ Mercer
- ☐ Metcalfe
- ☐ Monroe

- ☐ Montgomery
- ☐ Morgan
- ☐ Muhlenberg
- ☐ Nelson
- ☐ Nicholas
- ☐ Ohio
- ☐ Oldham
- ☐ Owen
- ☐ Owsley
- ☐ Pendleton
- ☐ Perry
- ☐ Pike
- ☐ Powell
- ☐ Pulaski
- ☐ Robertson
- ☐ Rockcastle
- ☐ Rowan
- ☐ Russell
- ☐ Scott
- ☐ Shelby
- ☐ Simpson
- ☐ Spencer
- ☐ Taylor
- ☐ Todd
- ☐ Trigg
- ☐ Trimble
- ☐ Union

- ☐ Warren
- ☐ Washington
- ☐ Wayne
- ☐ Webster
- ☐ Whitley
- ☐ Wolfe
- ☐ Woodford

How do you describe the locale of your school?

- ☐ City
- ☐ Suburban
- ☐ Town
- ☐ Rural

Does your school implement any version of a 1:1 technology initiative (such as 1 laptop/tablet for each child)?

- ☐ Yes
- ☐ No

At what level do you currently teach?

- ☐ Elementary
- ☐ Middle
- ☐ High
- ☐ Other _____

What subject areas do you teach?

- ☐ Math
- ☐ Reading / Language Arts
- ☐ Art / Music
- ☐ Science
- ☐ Social Studies

- ☐ Physical Education
- ☐ Special Education
- ☐ Other _____

How many years have you been teaching?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7
- ☐ 8
- ☐ 9
- ☐ 10
- ☐ 11
- ☐ 12
- ☐ 13
- ☐ 14
- ☐ 15
- ☐ 16
- ☐ 17
- ☐ 18
- ☐ 19
- ☐ 20
- ☐ 21
- ☐ 22

- ☐ 23
- ☐ 24
- ☐ 25
- ☐ 26
- ☐ 27
- ☐ 28
- ☐ 29
- ☐ 30
- ☐ 31
- ☐ 32
- ☐ 33
- ☐ 34
- ☐ 35

How technologically "literate" do you consider yourself?

- ☐ Basic
- ☐ Intermediate
- ☐ Advanced

Approximately how many hours of technology-related professional development have you attended in the past 12 months?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7

- ☐ 8
- ☐ 9
- ☐ 10
- ☐ 11
- ☐ 12
- ☐ 13
- ☐ 14
- ☐ 15
- ☐ 16
- ☐ 17
- ☐ 18
- ☐ 19
- ☐ 20

Which of the following best characterizes your professional development experience with technology?

- ☐ I have had EXTENSIVE technology training.
- ☐ I have had MODERATE technology training.
- ☐ I have had OCCASIONAL technology training.
- ☐ I have had NO technology training.

Which of the following devices do you own? Please select all that apply.

- ☐ Smart phone
- ☐ Desktop computer
- ☐ Laptop computer
- ☐ Tablet device (e.g., e-Reader, iPad)
- ☐ Mp3 player (e.g., iPod, iPod touch)
- ☐ DVD player / Game console

☐ Digital camera

☐ None of the above

How frequently during the first half of this school year did you use the following OUTSIDE OF SCHOOL? Please use the provided scale from 1 to 4, where 1 stands for "never" and 4 stands for "daily".

| | Never | Monthly | Weekly | Daily |
|---|-----------------------|-----------------------|-----------------------|-----------------------|
| Word processing software (e.g., Word) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Spreadsheets and graphing software (e.g., Excel) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Graphics, image-editing software (e.g., Photoshop) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Software for making presentations (e.g., PowerPoint, Keynote) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Website, blogs and/or wikis | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Social networking websites | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Are these devices available to you DURING SCHOOL ACTIVITIES? Please select all that apply.

☐ Projector

- ☐ Videoconference unit
- ☐ Interactive whiteboard (e.g., SMART Board)
- ☐ Digital camera
- ☐ Tablet device (e.g., e-Reader, iPad)
- ☐ Smartphone
- ☐ Desktop computer
- ☐ Laptop
- ☐ DVD player / Game console
- ☐ Mp3 player (e.g., iPod, iPod touch)
- ☐ None of the above

How frequently during the first half of this school year did you use the following for class PREPARATION, INSTRUCTION, or ADMINISTRATIVE TASKS? Please use the provided scale from 1 to 4, where 1 stands for "never" and 4 stands for "daily".

| | Never | Monthly | Weekly | Daily |
|---|-----------------------|-----------------------|-----------------------|-----------------------|
| Word processing software (e.g., Word) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Spreadsheets and graphing software (e.g., Excel) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Software for managing student records (e.g., Infinite Campus) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Graphics, image-editing software (e.g., | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

| | | | | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|
| Photoshop) | | | | |
| Software for making presentations (e.g., PowerPoint) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Learning management system (e.g., Blackboard, Moodle) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Software for administering tests | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Subject-specific software | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Website, blogs and/or wikis | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Social networking websites | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Indicate how frequently during the first half of this school year did you use the following to COMMUNICATE with PARENTS, STUDENTS and COLLEAGUES? Please use the provided scale from 1 to 4, where 1 stands for "never" and 4 stands for "always"

| | Parents | | | | Students | | | | Colleagues | | | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| Phone | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Email | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Instant messaging | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Twitter | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Facebook | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Online bulletin board for class discussion (e.g., Blackboard, Moodle) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Personal website or blog | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| School website | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Indicate your opinion about each of the statements below. Please use the scale from 1 (strongly disagree) to 6 (strongly agree).

"Technology" refers to use of: Computer - eReader - Tablet - MP3 player - Smartphone - DVD player - Digital camera - Interactive whiteboard - Videoconference unit - Projector

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| My teacher preparation program trained me to use technology in my class. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| My teacher preparation program devoted a sufficient amount of time to technology use. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| My teacher preparation program provided me example of how to use technology. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| My teacher preparation program increased my confidence that I can use technology in my class. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

How confident are you that you can do the following activities? Please use the scale from 1 (not at all confident) to 6 (completely confident).

"Technology" refers to use of: Computer - eReader - Tablet - MP3 player - Smartphone - DVD player - Digital camera - Interactive whiteboard - Videoconference unit - Projector

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| I can use technology to prepare an activity in my content area. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use technology to improve a class in my content area. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use technology to implement an online course in my content area. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use technology to implement an online lesson in my content area. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use technology to find and select resources for my content area. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use technology to create resources in my content area. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use technology to share resources with colleagues in my content area. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use technology to explore a specific topic of my content area. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

How confident are you that you can do the following activities? Please use the scale from 1 (not at all confident) to 6 (completely confident).

"Technology" refers to use of: Computer - eReader - Tablet - MP3 player - Smartphone - DVD player - Digital camera - Interactive whiteboard - Videoconference unit - Projector

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| I can use technology to take attendance. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use technology to keep student grades. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use technology to work with students in groups. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use technology to keep students motivated. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use technology to communicate with students' parents. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use technology to communicate with other teachers. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use technology to have students interact online for learning. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can think critically about how to use technology in my classroom. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can choose technology that enhances students' learning for a lesson. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can adapt new technologies I'm learning to different teaching activities. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

| | | | | | | |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| I can use technology to assess students' learning. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use technology to improve my teaching productivity. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can promote students' creative thinking through the use of technology. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can help students explore real-world issues by using technology. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use technology to promote cultural understanding and global awareness. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

How confident are you that you can do the following activities? Please use the scale from 1 (not at all confident) to 6 (completely confident).

"Technology" refers to use of: Computer - eReader - Tablet - MP3 player - Smartphone - DVD player - Digital camera - Interactive whiteboard - Videoconference unit - Projector

| | 1 | 2 | 3 | 4 | 5 | 6 |
|-------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| I can teach my specific | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

| | | | | | | |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| content area using technology. | | | | | | |
| I can select appropriate technology to improve student learning of a difficult topic in my content area. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can teach my specific content with a word processor (e.g., MS Word). | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can teach my specific content with a presentations editor (e.g., MS Power Point). | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can teach my specific content with a spreadsheets editor (e.g., MS Excel). | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

How confident are you that you can do the following activities? Please use the scale from 1 (not at all confident) to 6 (completely confident).

"Technology" refers to use of: Computer - eReader - Tablet - MP3 player - Smartphone - DVD player - Digital camera - Interactive whiteboard - Videoconference unit - Projector

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| I can control disruptive behavior in the classroom. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can motivate students who show low interest in school work. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can get students to believe they can do well in school work. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can help my students value learning. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can craft good questions for my students. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can get students to follow classroom rules. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can calm a student who is disruptive or noisy. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can establish a classroom management system with each group of learners. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can use a variety of assessment strategies. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can provide an alternative explanation or example when students are confused. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

| | | | | | | |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| I can assist families in helping their children do well in school. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I can implement alternative strategies in my classroom. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

How confident are you that you can do the following activities? Please use the scale from 1 (not at all confident) to 6 (completely confident). I can use a specific technology...

"Technology" refers to use of: Computer - eReader - Tablet - MP3 player - Smartphone - DVD player - Digital camera - Interactive whiteboard - Videoconference unit - Projector

| | 1 | 2 | 3 | 4 | 5 | 6 |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| if there is no one around to tell me what to do as I go. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| if I have never used a technology like it before. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| if I have only the technology manual for reference. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| if I have seen someone else using it before trying it myself. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| if I can call someone for help if I got stuck. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| if someone else has helped me get started. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| if I have a lot of time to complete the activity for which the technology is provided. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| if I have just the built-in help facility for | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

| | | | | | | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| assistance. | | | | | | |
| if someone shows me how to do it first. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| if I have used similar technology before this one to do the same activity. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |