THE RELATIONSHIP BETWEEN TEACHERS'TRAINING, PERSONAL SENSE OF EFFICACY AND ICT INTEGRATION: ANALYSING ITS STRENGTH AND STABILITY

Ana Santos
University of Lisbon

Neuza Pedro
University of Lisbon

Portugal

Abstract

In the literature it is still discussed whether teachers' ICT training is in fact a critical factor for promoting technology integration in classrooms. For contributing to intensify the debate, a study was developed (a) to assess how teachers' ICT training may or may not contribute to increase the level of ICT use in classrooms as well as teachers' level of computers self-efficacy and (b) to identify the persistency/volatility of these possible increments. For this purpose, an in-service training program was developed for 50 teachers, who were asked to complete two self-report scales at three different moments. Teachers' scores were compared and significant effects were found.

ICT, Teachers & Education

Digital technologies have become a central element of the structure of today's society and being able to proficiently use them is considered a vital skill for any citizen of the 21st-century. Its unquestionable potential in different sectors of professional activities makes technology a powerful tool for solving economic and societal problems and, ultimately, to increase the quality of human life conditions. The youngest, teenagers and children are their main adopters, their natural users. Nowadays, it is confirmed that Information and Communication Technologies (ICT) are widely used in European schools, however, it is difficult to ensure that they are being used with the innovative purposes that were expected (Sánchez & Hernández, 2008). In Portugal, like in many other European countries, research studies have found that ICT has been poorly adopted in classroom activities; its use is fussy, not yet systematic, carefully planned and pedagogically oriented (Paiva, Paiva, & Fiolhais, 2002; Pedro, 2011a; Peralta & Costa, 2007).

In order to understand and justify this reality regarding the use of ICT in schools' practices, several studies have tried to identify its main barriers and obstacles. Many authors indicate that teachers' competences and attitudes are crucial factors (Culp, Honey, & Mandinach, 2003; Hasselbring, Barron, & Risko, 2000; Lambert & Gong, 2010; Lawless & Pellegrino 2007, Norris,

Soloway, & Sullivan, 2002). If teachers do not feel comfortable in using ICT, these tools will hardly be envisaged as a useful resource and even less as a strategy for innovative teaching and learning activities.

This study aims to contribute for developing and systematize some knowledge in the area of ICT-teacher training, focusing in the analysis of the influence of in-service training on teachers' sense of efficacy as computer users and in their level of ICT- integration in their professional practices, both in a short term and in a medium-term perspective. For achieving this aim, an in-service training program was implemented, focusing on developing teachers' technical-pedagogical competences on 'Educational use of Moodle, Google Sites and other Web 2.0 tools'. Training effects on teachers' professional practice were analysed previously and after teachers enrolled in the program.

Research Background

In Portugal, as in most European countries in the early '80s, the educational use of computers began to be explored in schools, mainly through the implementation of research projects. Thereafter, national programs were created by the Ministry of Education and in the last 5 years a significant amount of investment was put into technologically equipping schools, with updated hardware and software. However, the fact that there are now much more computers available in schools, as well as data projectors and interactive whiteboards, does not, in itself, guarantee an effective use of ICT in teaching and learning activities. According to a recent study supported by the Ministry of Education, ICT persists to be barely used by teachers in the classrooms (GEPE, 2008).

In other countries, despite ICT-adoption in school activities appears to be settled, no significant changes could be found in teaching practices, teacher-centred instructive activities still govern classrooms and the desirable renewal of teaching methods doesn't seem to have occurred (Coll, Mauri, & Onrubia, 2009; Sanchez & Hernandez, 2008). For this reason, researchers have sought to identify its underlying causes. According to Wild (1996) the following factors need to be considered: (a) scarce opportunities for a regular use of computers, (b) lack of schools' technological equipment, (c) teachers' stress, (d) teachers' reduced competences and confidence regarding ICT, (e) lack of knowledge about the real impact of ICT in educational contexts, (f) few experiences with ICT in teachers' pre-service education and continuous professional development; in all of these lies the reasons that lead to the reduced integration of ICT in classrooms. Several authors have argued that an effective integration of ICT in students' learning activities will require their presence in teachers' training. It is very difficult for teachers to be able to use ICT in a productive way and within a curriculum-oriented approach if they were not given the time to explore, understand and plan teaching activities and projects where such technologies do have an expression (Bravo & Fernández, 2009; Coll, Mauri, & Onrubia, 2009; Costa & Peralta, 2007; Costa & Viseu, 2007; Munoz, 2009).

However, Pratt (2002) has already advocated that even when engaged in training and claiming to possess the required skills, teachers still remained

presenting low levels of technology use in the classroom. Many authors have therefore stated that the integration of in-service training in the area appears as a factor with limited predictive power of an effective educational use of technology and that it was teachers' beliefs and perceptions of the benefits of ICT use that could result in ICT-adoption (Ertmer, 2005; Vannatta & Fordham, 2004).

As a psychological construct that presents to be a good predictor of human behaviour, self-efficacy belief is presented as people's judgments of their capabilities to organize and execute courses of action required to attain a designated performance (Bandura, 1997). It's a motivational and self-regulator construct based on one's appreciation of which determines how environmental opportunities and restrictions are perceived and consequently what activity is initiated, how much effort is invested, and how long an individual will persevere through obstacles to competence (Tschannen-Moran & Hoy, 2007). As future-oriented belief that goes beyond individual present performance and skills, self-efficacy reveals a prospective nature (Bandura, 2005), in the extent that people tend to avoid engaging in a task where their sense of efficacy is low and enrol in activities that they belief they can do (Bandura, 1977; 1997).

Within Bandura's Social Cognitive Theory, the concept of teachers' self-efficacy beliefs has been presented as individual teachers' beliefs in their own abilities to plan, organize, and carry out activities required to attain given educational goals. Pedro (2011 b) refers to it as an intermediate variable of teachers' conduct in the classroom.

It has been proved that teachers perceived self-efficacy affects teachers' professional goals and aspirations (Muijs & Reynolds, 2002), their involvement on planning instructional activities, enthusiasm in classroom (Schwazer & Schwitz, 2004) and attitudes toward innovation (Smylie, 1998).

Method

This study aims to respond to the following research problem: What effects can be associated with teachers' enrolment in ICT-training program regarding a) their sense of proficiency in using ICT (computers-use self-efficacy) and b) their level of ICT integration in professional practices?

Thus, this research problem was decomposed into the following questions: (a) Can the implementation of an ICT training program produces positive effects on teachers' sense of efficacy as computer-user? (b) Can the implementation of an ICT training program produces positive effects on teachers' level of ICT-use in professional practices, considering different categories of teachers' tasks? (c) Do the effects associated with enrolling in ICT-training program, both in teachers' self-efficacy and technology-use in professional practices, remain over time?

Assuming a pre-experimental design, also known as a *non-design* (Tuckman, 1999), this study can be described as a single group pre-test post-test study. It was designed with the ambition of comparing teachers' attitudes and perceptions of professional practices regarding ICT before enrolling in an in-

service training program, immediately after finishing it and two months after its end. The same group of teachers was followed in order to analyse the immediate and/or deferred *influence* exerted by enrol in a training program as well as the stability or volatility of this *influence* over time.

Participants

This study involved 50 elementary and secondary schools' teachers, whom took part of an ICT-training program organized in a 50 hours-workshop that covered the following topics: using MOODLE learning management system and exploring Google docs and other Web 2.0 web tools for educational purposes. The workshop registration process was open in October of 2009 and for this study, 50 teachers were selected according to the order of entry. The group was constituted by 12 male and 38 female teachers, three pre-school teachers from primary to secondary schools. The group presented an age mean of 42.24 years (standard deviation= 8.63)

Instruments and Procedures

Data was collected by an online questionnaire built on *Google Docs*. It integrates two different scales: Computer Self-Efficacy Scale (Cassidy & Eachus, 2002) and Measure Teacher´s Technology Use Scale (Bebel, Russel, & O´Dwyer, 2004). The Computer Self-Efficacy Scale was developed by Cassidy and Eachus (2002). The authors present the instrument as "domain-specific." The instrument is composed by 30 items with 5 points options of Likert format scale (ranging from 1- "totally disagree" to 5- "totally agree"). The Measure Teacher's Technology Use Scale is proposed by Bebel, Russel, and O´Dwyer (2004) as a multidimensional instrument that considers that teachers' technology use does not happen with equal intensity in different professional tasks. The scale is organized into seven dimensions. Each dimension aims to represent a separate and distinct category of technology use and it is expected that the frequency and distribution of teachers' technology use varies considerably across the seven measures (Bebel, Russel, & O´Dwyer, 2004).

Table 1.

Dimensions Of Measure Teachers' Technology Use Scale

Dimensions of technology use scale	Items
1. Preparation: Teachers' use of technology for class preparation	*e.g., How often do you make hands-out for students using a computers?*
2. Professional E-mail: Teachers' professional e-mail use	*e.g., How often do you use email communication with school and district administration?*
3. Delivering Instruction: Teachers' use of technology for delivering instruction	*e.g., How often do you use a computer to deliver instruction to your class?*
4. Accommodation: Teachers' use of technology for accommodation	*e.g,, How often do you adapt an activity to students individual needs using a computer?*

5. Student Use: Teacher-directed student use of technology during class time	ex: *During class, how often students work individually using a computer, this year?*
6. Student Products: Teacher-directed student use of technology to create products	*e.g., How often do you ask students to produce a multimedia project using technology*?
7. Grading: Teachers' use of technology for grading	*e.g., How often do you record students grades using a computer?*

The scale presents five-point response options, which correspond to the frequency of technology use, ranging from 'Mostly never' (1 point) to 'Very frequently' (5 points). Scale items validation procedures using an expert panel (n=3) were previously conducted. The instruments have also been used in other studies of the same authors (Pedro, 2011a) and has been revealed to have very good reliability indexes, both for the Computer self-efficacy scale (r=.93) and for the Measure teacher's technology use scale (r=.96). Data collection procedures tool place from October 2009 to March 2010. Teachers were asked to answer to the same scales in three different moments:

- 1st moment (pre-test): before enrolling in the workshop, in order to define the baseline level of each teacher;
- 2nd moment (post-test #1): instantly after finishing the workshop, meaning by the end of the activities in its last session, in order to identify the immediate changes promoted by being enrolled in the training activities;
- 3rd moment (post-test #2): two months after the end of the workshop, in a *follow-up* perspective data were collected again to analyse the possible ulterior effects of training in teachers professional practices. For minimizing the bias caused by the learning effect, structural changes in the items order where conducted in the 2nd and 3rd moments of data collection.

Results

The responses of the 50 teachers to the computers' self-efficacy scale in each moment of data collection made possible to see that teachers present a moderate level of self-efficacy (mean values superior to 3) although is was more accentuated in the third moment, meaning two months after being involved in the workshop.

Likewise, the responses given by teachers to 24 items constituting the technology-use scale also evidences a growing tendency in the scores. Comparing the first, second and third moment of data collection, mean values persistently tend to increase. The mean difference from the first to the third moment is near 1 point (0.81).

Table 2

Descriptive Statistic Indicators of Computer Self-efficacy Scale Measure Teachers' Technology Use Scale

Computers' Self-Efficacy	Min	Max	Mean	SD
1. Pre-test	2.47	4.59	3.18	0.55
2. Post-test #1	2.52	4.59	3.70	0.57
3. Post-test #2	2.66	4.69	3.72	0.58
Teachers' Technology Use	Min	Max	Mean	SD
1. Pre-test	1.54	4.42	2.59	0.58
2. Post-test #1	1.42	4.38	3.00	0.60
3. Post-test #2	1.21	4.83	3.40	0.71

In order to test the statistical significance of the mean differences, a one-way within-subjects repeated measure analysis of variance (ANOVA) was conducted for both self-efficacy scores and for teachers' technology use scores. To this end, it was previously ensured the compliance of all requirements for applying ANOVA-test, specifically, the validation of sphericity. This was secured for both variables.

The calculation of the repeated measures ANOVA showed that there were significant differences in the computers' self-efficacy score (F (2.96) = 3.096, p= .049), as well as in the teachers' technology use scores (F (2.96) = 4.729, p= .011), considering the three different moments of analysis. Therefore a Student t-test for repeated measures was conducted, considering each of the pairs formed between the three time points examined (Pre-test - Post-test #1, Post-test #1 - Post-test #2, Pre-test - Post-test #2) in order to realize where the significant differences were found.

As it can be seen in table III, the differences in teachers' computer self-efficacy were significant between the first and second moment of data collection and between the first and the third moment. The same statistical procedures were also conducted for the mean values found in teachers' technology-use, in the three moments of analysis. As it can be seen in Table 3, the differences proved to be statistically significant only between the first and the third moment (i. e., from the score presented before teachers enroll in the workshop and two months after its end).

Table 3

Students T-Test for Comparison of Group Means in Computer Self-Efficacy Scale and Measure Teachers' Technology-Use Scale

Computer Self-efficacy	Mean Difference	*t*	*p*
Pre-test - Post-test #1	0.520	-2.078	.043
Post-test #1 - Post-test #2	0.020	-.063	.950

Pre-test - Post-test #2	0.540	-2.086	.042

Technology-Use	Mean Difference	*t*	*p*
Pre-test - Post-test #1	0.410	-.499	.620
Post-test #1 - Post-test #2	0.400	-1.997	.051
Pre-test - Post-test #2	0.810	-3.998	.000

As it can be seen in Table 4, the seven dimensions that constitute the multidimensional teachers' technology-use scale were also analysed. Mean values for each dimension was calculated for each of the moments: before, immediately after and two months after the workshop. It was possible to conclude that the dimension that presented the highest score in all the moments was the dimension 1 related to preparation of teaching and learning activities. In the opposite direction the dimension that revealed the lowest mean values was dimension 6 'Students product' which was related to adopting ICT as a supportive tool for students' productions'. Among these two dimensions, a difference of 1.41 points was found in the first moment. This difference was persistently maintained also in the post-test #1 (1.03 points) and in the post-test #2 (1.18 points).

Table 4

Mean and Standard Deviation of the Degree of Use for Seven Categories of Measure Teachers' Technology Use Scale

Dimensions	Pre-test		Post-test #1		Post-test #2	
	M	SD	M	SD	M	SD
1. Preparation	3.67	0.91	3.42	0.93	3.76	0.87
2. Professional E-mail	3.09	0.83	3.10	0.95	3.30	0.99
3. Delivering Instruction	3.18	0.88	3.25	0.97	3.46	0.99
4. Accommodation	2.79	0.88	2.86	0.98	3.04	0.95
5. Student Use	2.88	0.83	2.92	0.73	3.39	0.88
6. Student Products	2.26	0.75	2.39	0.76	2.58	0.92
7. Grading	3.06	1.06	3.10	0.98	3.75	1.01

A one-way within-subjects repeated measures ANOVA was also conducted and thus evidenced that the differences found were significant, the extent to dimensions 2 'Professional E-mail' ($F(2.96) = 3.329$, $p=0.040$), 3 'Delivering Instruction' ($F(2.96) = 3.304$, $p=0.041$), 5 'Student Use' ($F(2.96) = 2.294$, $p=0.016$) and 6 'Student Products' ($F(2.96) = 3.522$, $p=0.033$).

Therefore, Student's t-tests (Table 5) for repeated measures were calculated, considering each of the pairs formed between the three time periods analysed (Pre-test - Post-test #1, Post-test #1 - Post-test #2, Pre-test - Post-test #2).

Table 5

Students T-Test for Comparison of Group Means in the Seven Categories of Measure Teachers' Technology Use Scale

Dimensions of Technology Use scale	Pre-test - Post-test #1		Post-test #1 - Post-test #2		Pre-test – Post-test #2	
	t	*p*	*t*	*p*	*t*	*p*
2. Professional E-mail	0.707	.483	-2.491	.016	-1.984	.053
3. Delivering Instruction	-0.495	.623	-1.638	.108	3.743	.000
5. Student Use	-.388	.700	-1.398	.169	2.523	.015
7. Grading	-0.287	.776	2.005	.051	2.899	.006

In dimension 2, it was found that the differences only evidenced to be significant between the second and third moment. In dimension 3, 5 and 7 the differences were only significant when comparing the first and third moment, the pre-test and the post-test #2.Consequently it was possible to conclude that at the third moment it was always possible to identify significant differences in these four dimensions.

Conclusions

By recovering each research question and considering the collected data, it is possible to conclude that ICT-training presents significant effects on teachers' beliefs and perception of own professional practices. For the first research question it was seen that before training teachers showed a less favourable sense of self-efficiency in using ICT. Immediately after the end of the training, self-efficacy scores increased and two months after the end of the training it increased again. There was an increment of 0.54 points between the first and last evaluation.

The same tendency was observed in the levels of teachers' technology use in teaching practices, where increases were seen in the scores registered at each moment, especially between the first and third moment of data collection (0.81). Overall, improvements in the perception of self-efficiency were registered, as well as in the levels of technology use. The differences within the two variables revealed to be significant in the values registered before training and those registered several months after the end of training.

These results are aligned with the conclusions found by other authors, such as Karagiorgi and Charalambous (2003), where continuous professional training in ICT is pointed out as being one of the most viable solutions for promoting

teachers adoption of technologies in classes, both in a short term and long term perspective.
Regarding the differences of teachers' level of ICT adoption in different professional tasks, the results were found to be coherent with what was expected. Considering the different dimensions identified by the multidimensional scale developed by Bebell, Russell and O'Dwyer (2004), it was also possible to verify that in different activities teachers do evidence different levels of ICT use and that the use that teachers made of computers also changed through time. The results point out to significant differences in the scores registered, in the three moments under analysis, regarding the 'Professional e-mail' dimension, between the second and third moment. In the following dimensions 'Delivering instruction', 'Students use' and 'Grading' significant differences were only found between the first and third moment of evaluation.

The statistical significance of the differences found between the first and the third moment of data collection, as well as the increases in the total score of the self-efficiency scale and in the levels of ICT-use show that: (i) the impact of training in teaching practice is favourable, promoting improvements in the adoption of ICT in teachers professional tasks, (ii) the effects of training are more pronounced and more visible for teachers not immediately after being involved in the workshop but two-months after its conclusion or, in other words, the real effects of training in teaching practices are better perceived by teachers not instantly, but later on when they can apply what they have learned and explored in their daily practices (and, of course, if they see that it can be applied and how it can be applied).

The multidimensional perspective of analysis of teachers' technology use regarding different professional practices allowed the identification of the dimensions of teachers' work where ICT have the strongest presence and the areas of teachers' work where ICT integration tends to be difficult to achieve. Dimensions related to preparation of teaching-learning activities (dimension 1) and to the development of instructional activities (dimension 3) were the two that stood out. Based on these results, it is possible to conclude that, not only the frequency of ICT-use presents to be differentiated in teachers' professional tasks, but also that ICT are more frequently mobilized to prepare teaching activities, meaning that ICT integration tends to be developed mostly outside of the classroom context and not inside as expected. This study evidenced that there is still a long way to go in regard of classroom technology integration and to make it be used to support students' learning, to uphold activities that promote higher-order levels of thinking and more complex competences, the kind of competences that any citizen will be expected to have in the 21st-century.

Regarding the last research question, it is possible to conclude that the retrospective evaluation of the ICT-training effects on teachers' computers self-efficacy and perception of ITC-use in teaching activities is stable and reliable. It was also possible to evidence that improvements in teachers' sense of self-efficiency in the use of technologies are linked to increasing levels of ICT-use in professional practices. This means that the promotion of more

favourable rates in one of the constructs may be followed by equally more favourable levels in the other.
Given the results obtained and considering previous studies (Bravo & Fernández, 2009; Costa & Peralta, 2007; Karagiorgi & Charalambous, 2003; Lambert & Cuper, 2008; Munõz, 2009; Vockley, 2008) it was possible to verify that ICT-training, as one of the forms of teachers continuous professional development, is essential for preparing teachers to take full advantage of ITC in their classes, because it contributes to the development of more positive attitudes regarding teachers' ability to efficiently handle technologies for educational purposes. Teachers in-service training, namely by promoting the contact with new web tools and applications in a safe and supportive environment, but also by stimulating resources sharing, by encouraging open communication regarding individual experiences, difficulties and fears, and by conducting activities of joint reflection about the costs and benefits of ICT-use in teaching and learning processes, can highly contribute to the acquisition and development of more positive attitudes and higher levels of confidence, comfort and ICT- proficiency.

This study allowed for the confirmation of the existence of a favourable relation between the two psychological constructs that were analysed: teachers' computer self-efficiency (the perception of self-competency to act in this domain) and teachers' perception of technologies use. These results emphasize the need to design in-service training programs that consider not only knowledge acquisition, both technical and pedagogical, but also teachers' attitudes, beliefs and conceptions when the aim is the implementation of innovation in teachers' practices.

Finally, it was still observed that an analysis of the teachers' levels of ITC-use, in a single dimension or generic approach, where it is merely categorized as 'achieved' or 'not yet achieved,' is not reliable. This will produce biased results and lead to misconceptions about teachers' practices. For different professional tasks, teachers present different levels of ICT-use, therefore, the differences need to be discriminatively measured.

Considering the seven dimensions in the Bebell, Russell and O´Dwyer (2004) scale, it was found that it is in the activities related to preparing teaching activities (planning learning exercises, selecting resources and creating the materials to support the work to be done with students in the classroom, etc.) that ICT are more frequently used. This shows that the ICT-integration in school activities is not yet fully achieved; not infrequently, these preparatory activities don't even take place in the school context. Many teachers prepare their classes at home. Aspiring to the integration of ICT in teaching and learning activities, especially with the aim of placing ICT at the service of students' learning, this study alerts us to the need of more profound revision of the way technologies are used, not only at what level are they being used but mostly in what situations, for what purposes, and within which pedagogical approach.

In summary, the present study (although developed with a reduced number of participants, based on self-report and with limited spectrum of results

representativeness) gathered relevant information which can support the development of further research in this area, because more attention needs to be put in the analysis of the impact of in-service training and ICT-adoption in teachers' professional activities, not only in a short-term perspective, but also through medium and long-term approaches, and not only based on teachers' perceptions of their own professional practices but complemented/confronted with the analysis of the projects and activities really conducted in the classrooms. It is also seen as useful the investment in studies that pursue the identification of the mechanisms that can potentiate and extend the favourable effects of teachers' involvement in ICT-training, as well as the personal or contextual restrictive factors that dilute these effects and prevent them to last in time.

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