Teachers' perceptions of factors affecting the educational use of ICT in technology-rich classrooms

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Abstract

Introduction. The purpose of this study is to identify the main factors that influence teachers' decision-making regarding the educational use of ICT (Information and Communication Technologies) in technology-rich classrooms.

Method. We collected data for 278 teachers in Catalonia (Spain) working in eight primary and secondary education schools rich in educational technology. The specific questionnaire used to that end includes an extensive range of items to obtain information about the teachers' perceptions of the factors influencing the use of ICT in the classroom.

Results. We have identified and characterized five factors that influence the educational use of ICT in these classrooms, which in this study we call: utility and educational setting, teacher support, availability and access in the classroom, technological expertise and access outside the classroom.

Conclusion. These results may be useful for fostering improved integration processes for ICT in the classroom, and also for focusing teaching training about this content.

Keywords: Educational use of technology, Information and Communication Technologies (ICT), educational innovation and ICT, technology-rich classrooms, ICT and teacher.

Percepción de los docentes sobre los factores que afectan el uso educativo de las TIC en el aula equipada de tecnología

Resumen

Introducción. Este estudio tiene como finalidad identificar los principales factores que influyen en la toma de decisiones de los profesores sobre el uso educativo de las TIC (Tecnologías de la Información y la Comunicación) en aulas altamente dotadas de tecnología.

Método. Se han recogido datos sobre 278 profesores de Cataluña (España) que forman parte de ocho centros educativos de educación primaria y secundaria altamente dotados con tecnología educativa. El cuestionario específico utilizado para este fin incluye un conjunto amplio de ítems que permite obtener información de las percepciones de los profesores sobre los factores que influyen en el uso de las TIC en su aula.

Resultados. Hemos identificado y caracterizado cinco factores que influyen en el uso educativo de las TIC en este tipo de aulas, que en este estudio denominamos: utilidad y ajuste pedagógico, apoyo al profesor, disponibilidad y acceso en el aula, competencia tecnológica y acceso fuera del aula.

Conclusión. Estos resultados obtenidos pueden ser de utilidad para promover de manera más ajustada los procesos de integración de las TIC en el aula, y también para orientar los procesos de formación del profesorado sobre este contenido.

Palabras Clave: Uso educativo de la tecnología, tecnologías de la Información y la Comunicación (TIC), innovación escolar y TIC, clases altamente dotadas de tecnología, profesor y TIC.

Introduction

In Spain, several researchers have studied various factors that facilitate the integration of ICT in schools (Área, 2010; De Pablos, Colás & González, 2010; García-Valcárcel & Tejedor, 2010, Tejedor, García-Valcárcel & Prada, 2009). In overall terms, the key factors are material, personal and time-related, and include the lack of computers, lack of Internet access, the lack of expertise in computer use among teachers, and the teachers' lack of time for becoming involved in educational initiatives of this type.

These factors may now be less relevant in view of the fact that schools are increasingly technologically better equipped, and teachers are gradually becoming more competent in the use of ICT. In this study, we aim to identify and characterize the main factors taken into account by a specific group of teachers in primary and secondary education when making decisions on the educational use of ICT. These teachers work at schools that are highly innovative in the educational sphere, have extensive training in the educational use of ICT, and their classrooms are especially well equipped with technology (Craig, Ault & Niileksela, 2011; Khine & Fisher, 2003).

Teachers' perception of the factors facilitating the educational use of ICT in the classroom

A review of the educational literature on this subject shows that teachers believe that the integration of ICT in the classroom depends on two types of factors: contextual factors related to the conditions facilitating the integration of ICT, and factors related to the characteristics of the teacher.

Cultural, social and institutional factors

Teo (2008) coined the term facilitating conditions to describe the range of factors in the teacher's environment that influence the use of educational technologies in teaching. Four different groups of factors have been established: 1) Cultural values and norms; 2) Adaptation to external requirements; 3) Support for integration; and 4) Teacher training. Cultural values and norms may enhance or inhibit the use of ICT in the classroom. According to Albirini (2006), teachers' actions are based on their perceptions of the value and relevance that society and the school attribute to the use of technology in the classroom. According to Baek, Jung & Kim (2008), teachers are also influenced by external requirements (e.g. the demands of the

educational authority) and the expectations of other teachers (e.g. the belief that a good teachers should use technology when teaching their classes).

The integration of ICT may also be subject to the external support that is provided for teachers. Hogarty, Lang & Kromrey (2003) divide this support into two categories: general support from the school (academic and administrative) and technological support (human and technical). Innan & Lowther (2010) add that both aspects should be part of an integrated institutional support structure for teachers. Finally, teacher training also influences the process of ICT integration. Van Braak, Tondeur & Valcke (2004) argue that it has a positive impact on teachers' attitudes towards ICT, and Lowther, Inan, Strahl & Ross (2008) note that it is a precondition.

Factors relating to the teacher

We identified six characteristics of teachers that may influence the facilitation of the educational use of ICT in the classroom. They are as follows: 1) The perception of usefulness; 2) The ability to innovate; 3) Expertise; 4) Attitudes; 5) Beliefs about teaching and learning; and 6) Feelings in relation to ICT.

Sang, Valcke, van Braak, Tondeur & Zhu (2011) consider that the primary motivation for using technology is its perceived usefulness. Baek, Jung & Kim (2008) have identified four reasons for their use: a) To increase interest in learning; b) Because they enable digital materials to be handled easily; c) because they save time and physical effort; and d) because technology can simulate the real world. Van Braak (2001) and Van Braak, Tondeur & Valcke (2004) believe that teachers' personal attributes influence their degree of willingness to accept technological and pedagogical innovation. Vannatta & Fordham (2004) refer to this quality as *openness to change*, and it is defined by teachers' level of enthusiasm and comfort with the introduction of new teaching methods, even when they entail the possibility of taking risks and making mistakes.

According to Robertson, Calder, Fung, Jones & O'Shea (1995), and Albirini (2006), the teacher's expertise in using ICT refers to the teacher's self-assessment of his/her knowledge of computers and their use in education. Other authors have called this assessment the teacher's *self-efficacy* in the use of ICT (Mueller, Wood, Willoughby, Ross & Specht, 2008; Teo, 2009). Finally, it has also been defined by Innan & Lowther (2010) as the teachers' per-

ception of their capabilities and skills required to integrate technology into their classroom instruction.

Sang, Valcke, van Braak, Tondeur & Zhu (2011) defined the attitude towards ICT as the teacher's predisposition to respond favourably or unfavourably to the integration of ICT in their classrooms as a result of the confluence of cognitive, affective and behavioural components. These positive and negative attitudes have been defined by Hogarty, Lang & Kromrey (2003) as *technological affinity* and *technological aversion*. A positive attitude on the part of the teacher fosters Internet use in their classrooms (Ramírez, Cañedo & Clemente, 2012). Ertmer (2005) believes that the teacher's beliefs about teaching and learning influence the use of ICT in the classroom. Hermans, Tondeur, van Braak & Valcke (2008) have found crucial empirical evidence. There have been many contributions (Mueller, Wood, Willoughby, Ross & Specht, 2008; Sang, Valcke, van Braak, Tondeur & Zhu, 2011; Tondeur, Hermans, van Braak, & Valcke, 2008) which argue that the teacher's adoption of constructivist theories about teaching and learning has a positive impact on the use of computers, either directly or indirectly, and particularly on how they are used for teaching and learning.

Finally, the affective dimension of integration and the educational use of ICT in the classroom often translate into teachers' and students' positive and negative emotions towards computers. The three emotions most commonly cited by various authors (Leng, 2011; Robertson, Calder, Fung, Jones & O'Shea, 1995; Shapka & Ferrari, 2003; van Braak, Tondeur & Valcke, 2004; Yildrim, 2000;) are anxiety (negative emotion), and confidence and satisfaction (positive emotions). Other authors (Hogarty, Lang & Kromrey, 2003; Mueller, Wood, Willoughby, Ross & Specht, 2008) add comfort as a positive attitude to the use of ICT on the part of teachers.

Technology-rich classrooms and ICT infrastructure

A more specific categorisation of the educational uses of ICT would be very useful for technology-rich classrooms (Craig, Ault & Niileksela 2011; Khine & Fisher 2003; Levin & Wadmany 2006: Palak & Walls 2009), because these types of classrooms are characterised by a high level of access, both by teachers and students, to a wide variety of technologies supporting teaching and learning practices, and a high level of skills in the educational uses of these technologies.

The results presented here are based on data collected from eight schools that joined the special project for "Advanced ICT Integration" (In Catalonian: *Integració Avançada de les TIC, IA-TIC*), run by the Department of Education of the Catalonia Government (2004-2007), with the aim of fostering ICT integration in schools. Eight public schools (five kindergarten/primary and three secondary schools) were selected to participate in this innovative teaching experience.

IA-TIC project provided the best possible technological conditions of that time to the participant schools, including Internet access and computers, synchronous and asynchronous communication tools, educational software, teacher training and technical support. The main aim of the IA-TIC project is to support teachers and students adoption of ICT in their teaching and learning practices. More specifically, the eight schools maintained a full ICT infrastructure, consisting of: complete Internet access anywhere through Wi-Fi, school intranet, 42.9 computers connected to Internet per 100 pupils, plenty of educational software in all curricular areas, and enough technical and pedagogical support for the teachers in their own centre. Table 1 compares ICT infrastructure between IA-TIC schools and data gathered from a representative sample of conventional schools belonging to the Spanish educational system (Sigalés, Mominó, Meneses & Badia, 2009).

Table 1. **Comparison of ICT infrastructure IA-TIC schools and a representative sample of schools in Spain**

ICT infrastructure information	IA-TIC schools	Spanish schools
Mean of the total number of computers	197.50	55.7
Mean of the total number of computers used by teachers for educational purposes	15.33	10.6
Mean of the total number of computers used by students for educational purposes	176.83	43.20
Mean of the total number of computers with Internet access	197.50	49.90
% of schools with web page	100%	67.0%
% of schools with intranet	100%	58.5%
% of schools with Wi-fi connection	100%	49.8%
% of schools with Wi-fi access in the classrooms	100%	34.8%

% of schools that use laptops in the classrooms	100%	70.3%
% of schools that provide technical support to teachers	100%	73.4%
% of schools that provide pedagogical support to teachers	100%	57.2%

Objective

The main objective of this study is to identify and characterize the main factors that a particular group of teachers perceive as favouring school integration of the educational use of ICT. We will focus on analyzing a specific type of teachers who teach in classrooms characterized by a high availability and accessibility of ICT for teaching and learning, and a high level of expertise in their use among the teachers.

Method

Participants

The sample in this research study is intentional, and consists of 278 teachers (93 from kindergarten education, 89 from primary education and 96 from secondary education) from eight schools (see Table 2) who completed a questionnaire designed for the study about the introduction of ICT in schools, produced by Sigalés, Mominó, Meneses & Badia (2009).

Table 2. **Sample of participating teachers**

	School								
	1	2	3	4	5	6	7	8	Total
Kindergarten education	19	24		11	23			16	93
Primary Education	19	25		12	19			14	89
Secondary Education			34			30	19	13	96
Total	38	49	34	23	42	30	19	43	278

Approximately three quarters of the participants were women (72%), with a mean age of 41 years old (SD = 9.83). Half of the teachers (46.9%) had a diploma, 39.9% had a degree and 13.3% had master's or doctoral studies. Most of the teachers (89.6%) were State employees, with a mean experience as teachers of 16.45 years (SD = 10.62) and 8.98 years (SD = 8.82) of work in academic management at the same school. An 70.3% of the teachers felt they

had integrated ICT in the classroom as part of a common priority at their school, 84.2% of the teachers had been regular Internet users for more than three years, 87% go online at least 2-3 times a week, 84.2% had received training in the last three years on subjects related to educational use of ICT, and 86.4% of them rated the usefulness of this training as high or very high.

Instruments: data collection

The scale of factors related to the educational use of ICT was designed based on the literature review, and consisted of 22 items that included statements about the availability of resources, support, facilities and barriers to ICT use for educational purposes in teaching activities (see table 3). The response scale was a Likert type, with 5 alternatives: 1, strongly disagree; 2, quite disagree; 3, neither agree nor disagree; 4, quite agree; 5, strongly agree. The instructions accompanying the scale specified that the teacher always had to answer based on their experience, their school, the students they teach and the subject they teach.

Procedure

The teachers also provided information about their personal and professional characteristics, including sex, age, level of education, teaching experience, and their educational level and the subject they teach.

Data Analysis

In order to achieve the objectives of this research, we conducted an exploratory factor analysis with the items on the scale of factors related to the educational use of ICT. Principal component analysis revealed a multidimensional structure composed of five factors (KMO = 0.824 and a significant Bartlett's test, $p<.001$), which explains an acceptable total variance of 61.19%. To determine the possible correlation between the factors, a non-orthogonal solution with oblique rotation (Oblimin with Kaiser normalization) was calculated. Since positive correlations were obtained between the factors ranging between 0.162 and 0.344, the application of an orthogonal solution was ruled out.

A series of analysis of variance (ANOVA) tests were also conducted to examine the differences between teachers in kindergarten, primary and secondary education. To that end, the total scores for each factor were calculated, adding together the partial scores of their component items and dividing by the number of items to maintain the original scale of response and facilitate interpretation. We applied Levene's test to test the ANOVA assumption

about the homogeneity of variances between the groups (Glass, Peckham & Sanders, 1972). If the test is statistically significant, it can be concluded that the assumption of homogeneity of variances does not hold, and as such it is necessary to use an alternative test to the F test. In this case we use the Welch correction, which is a robust test for both the failure of this assumption and unequal group sizes (Tomarken & Serlin, 1986).

Results

Factors affecting the educational use of ICT in IE-TIC schools

Application of exploratory factorial analysis reveals a factorial structure composed of 5 factors affecting the educational use of ICT in technology-rich classrooms, which are presented in Table 3.

Table 3. Mean, standard deviation, explained variance and Cronbach's alpha of the five factors identified

Factors	Mean (SD)	Explained variance	Cronbach's alpha
Factor 1: Utility and educational setting of the ICT.	3.67 (0.57)	29.89%	0.85
Factor 2: Teacher support in the use of ICT.	4.11 (0.59)	10.83%	0.84
Factor 3: Teacher's self-perceived expertise in the educational use of ICT.	3.91 (0.66)	7.75%	0.73
Factor 4: Availability and access to ICT in the classroom.	4.43 (0.52)	6.51%	0.76
Factor 5: Access to ICT outside the classroom.	3.55 (0.90)	6.21%	0.77
Total	3.97 (0.46)	61.19%	0.88

The two factors that explain the highest amount of variance are factor 1 "Utility and educational setting of the ICT" (M=3.67, SD=0.57) and factor 2 "Support for the teacher in the use of ICT" (M=4.11, SD=0.59). Teachers' scores were higher in Factor 4 "Availability and access to ICT in the classroom" (M=4.43, SD=0.52) and factor 2 "Support for the teacher

in the use of ICT" (M=4.11, SD=0.59). By contrast, the lowest scores were obtained in factor 5 "Access to ICT outside the classroom" (M=3.55, SD=0.90). Each factor showed an acceptable realibility, with Cronbach's alpha ranging from 0.73 to 0.85.

We now present the overall factorial table obtained, which enables us to characterize the specific content of each of the five factors identified.

Table 4. Factorial loads of factors related to the use of ICT in technology-rich classrooms
(Oblimin rotation with Kaiser normalization)

Items	1	2	3	4	5
ICT improve the quality of my students' learning in the subject that I teach.	**0.83**	0.16	0.16	0.25	0.07
ICT can help me to improve my achievement of the educational goals with my students that I set myself.	**0.81**	0.24	0.09	0.30	0.28
The teaching and educational resources that ICT provide are well suited to the way I usually teach my subject and to the way I organize work with my students.	**0.78**	0.14	0.40	0.27	0.26
Students using ICT as a tool for study and learning obtain better results at school.	**0.74**	0.11	-0.03	-0.19	0.30
The type of communication and relationships established with students using ICT are interesting for my subject.	**0.71**	0.17	0.31	0.35	0.29
The characteristics of the information that can be accessed using the Internet are well adapted to the needs of my subject.	**0.65**	0.29	0.40	0.17	0.31
When I need to, I can easily find teaching support and advice about digital resources and ways of using the ICT in my subject.	0.25	**0.84**	0.13	0.32	0.18
I am satisfied with the support that my school receives from the education authorities in terms of the educational use of ICT.	0.11	**0.80**	-0.01	0.33	0.10

I am satisfied with the support that I receive from the managers of the school in terms of the educational use of ICT.	0.31	**0.79**	0.14	0.37	0.32
The range of training which I can access to learn about how to use ICT for teaching and/or learning in the subject I teach is sufficient and of high quality.	0.15	**0.70**	0.44	0.23	0.26
There is currently a wide range of training for learning to use ICT available.	0.12	**0.61**	**0.51**	0.24	0.28
In my school I am given sufficient technical support in the use, updating and implementation of the ICT that I use regularly.	0.26	**0.59**	0.11	**0.58**	0.24
My expertise in the educational use of ICT enables me to exploit the potential of ICT for teaching and learning activities in my subject to a large extent.	0.33	0.15	**0.87**	0.23	0.33
My expertise in the educational use of ICT enables me to easily use the programs and applications that are commonly used at my school.	0.23	0.20	**0.86**	0.22	0.17
The availability of Internet-connected computers in my school facilitates frequent use of ICT with my students.	0.31	0.26	0.25	**0.76**	0.11
The availability of of Internet-connected computers in the classroom where I usually teach my subject helps me to be able to use ICT regularly.	0.28	0.12	0.15	**0.73**	0.20
I have easy access to programs and other computer applications that are useful for my subject.	0.31	0.40	0.16	**0.71**	0.22
The characteristics of my school in terms of the layout and use of spaces facilitate use of ICT with students.	0.35	0.31	0.12	**0.68**	0.27
The speed and quality of the Internet connection with which I can work with my students is sufficient for my needs.	-0.04	0.33	0.03	**0.54**	-0.01
My students can access materials and course content outside classroom hours using ICT.	0.25	0.15	0.14	0.19	**0.85**

When I need to, I can easily communicate with my students using ICT from my school.	0.29	0.25	0.13	0.33	**0.76**
Most of my students can access the Internet and other digital resources from their homes.	0.13	0.16	0.23	-0.05	**0.67**

The first factor, which we called *utility and educational setting of ICT*, comprises 6 items. This factor covers two complementary aspects. First, it reflects the teachers' perception of the usefulness of ICT for learning, either to improve its quality (item 15) or to obtain better school results (item 22). At the same time, it highlights the usefulness of ICT for the teacher's teaching in terms of improved achievement of their educational goals (item 12), adapting well to the type of teaching undertaken by the teacher (item 19), to the type of educational communication between the teacher and the students (item 18), and to the type of information to which access is desired (item 14).

The second factor, which we called *support for the teacher in the use of ICT*, also includes 6 items. These are the aid received in carrying out their teaching with ICT, in pedagogical (item 08), technological (item 03), and teacher training terms (items 11 and 17). This factor also reflects the support and recognition they receive from the managers of the school (item 04) and the education authorities (item 10).

The third factor identified is related to the *teacher's self-perceived expertise in the educational use of ICT*, and includes two items. It is related to both the use of computer programs and applications (item 09) and to the educational use of these ICT (item 13). It also includes is the training available for learning to use ICT (item 11), which is logically related to the development of expertise of this nature.

The fourth factor, designated as *availability and access to ICT in the classroom*, covers five items. It includes three complementary aspects: availability, access and technical support. The first aspect includes the availability of computers connected to the Internet in the school (item 01) and in the classroom (item 05), and the distribution and use of spaces (item 07). Two aspects are clearly important for teachers in terms of access: the speed and quality of Internet connection (item 06) and ease of access to software that is useful for their subject

(item 02). Finally, this factor also encompasses technical support for the configuration and updating of ICT (item 03).

Lastly, the fifth factor identified, called *access to ICT outside the classroom*, consists of three items. This factor includes a series of needs related to the teacher's ability to communicate with students through ICT at school (item 16), students having access to materials and contents outside of class hours (item 20), and access to the Internet and other digital resources at home (item 21).

Differences in the factors affecting the educational use of ICT between educational levels in IE-TIC schools

Table 5 shows the significant differences in some of these five factors in a comparison of the responses from teachers grouped according to the educational level of their workplace (kindergarten, primary or secondary education).

Table 5. Differences in the perception of factors depending on the level of education: Kindergarten (KE), primary (PE) and secondary education (SE) (n = 278)

Factors	KE (n=93) Mean (SD)	PE (n=89) Mean (SD)	SE (n=96) Mean (SD)	Levene's test	ANOVA
Factor 1: Utility and educational setting of the ICT.	3.62 (0.43)	3.67 (0.56)	3.71 (0.69)	8.656*	W = 0.640
Factor 2: Teacher support in the use of ICT.	4.15 (0.55)	4.17 (0.51)	4.01 (0.67)	2.497	F=2.298
Factor 3: Teacher's self-perceived expertise in the educational use of ICT.	3.97 (0.66)	3.89 (0.65)	3.88 (0.67)	0.178	F=0.518
Factor 4: Availability and access to ICT in the classroom.	4.57 (0.40)	4.48 (0.44)	4.25 (0.64)	13.007*	W = 8.109*

Factor 5: Access to ICT outside the classroom.	3.16 (0.88)	3.40 (0.86)	3.99 (0.77)	0.915	F=22.266*
Total	3.93 (0.40)	3.98 (0.42)	3.97 (0.46)	2.312	F=0.348

*, $p = 0.000$

As can be seen, there are significant differences between the three educational levels in factors 4 and 5. First, teachers place significant value on factor 4 (availability and access to ICT in the classroom): kindergarten teachers place most value on this factor, followed by primary teachers. Second, there were also significant differences in teachers' responses to factor 5 (access to ICT outside the classroom), but in this case the order is reversed: secondary education teachers give responses with significantly higher scores than those of primary teachers, who give higher scores than kindergarten teachers.

Discussion and Conclusions

In technology-rich school environments, where the teaching staff has advanced digital expertise and with relatively easy access, the issues that appear to have the most influence on the educational use of ICT are not those of a strictly technological nature. Teachers particularly appreciate the usefulness of the technology for their objectives. This factor makes by far the biggest contribution to explaining the variance. In their decision-making, teachers value first, the extent to which technology acts as a lever to improve their students' quality of learning, and to what extent its use fits in with the teaching methods and curricular skills they want to develop.

This priority seems to make sense in the kind of schools we are analyzing, and places us at a new frontier in the analysis of the factors favouring the school integration of ICT. Having overcome the barrier of resource availability and basic digital training for teachers, the keys to understanding progress in the processes of integration of ICT lie in the nature of teaching and learning activities. These activities often present difficulties in terms of reconciling ICT with more widespread educational practices (Coll, Rochera & Colomina, 2010; Ertmer, 2005; Zhao & Frank 2003).

The second most well-positioned factor in the explanation of the variance is related to the perception of support received. Having technological resources and an advanced level of digital expertise does not detract from the need for support. Teachers value the importance of receiving technical assistance *in situ* and continuous training, within a context of institutional support for educational innovation. The incorporation of digital technologies into educational practice requires long and complex processes that demand high levels of energy (Brinkerhoff, 2006; Zhao & Frank 2003). Moreover, even though the teachers in the segment of schools analyzed have high levels of digital expertise and are equipped with extensive technological resources, they still believe that these factors influence decision-making, albeit to a lesser extent.

In a technology-rich environment, the ratios of students per available computer or the mere availability of a connection are not sufficient parameters. Teachers increasingly tend to rate the functional availability of these resources more highly. Qualitative aspects therefore become more important: the quality and speed of connections, the mobility and suitability of digital resources for educational needs, and the availability of software and other specific resources for the various areas or subjects.

Something similar is true of with digital expertise. Most of the teachers in the population analyzed believe that they have sufficient techno-pedagogical expertise to manage the resources available in their schools. However, as mentioned above, they still consider it essential to receive support. This apparent contradiction suggests that these teachers are considering innovative challenges with ICT that have not yet arisen in their schools, and for which they do not feel that they have sufficient training.

Finally, it appears that the possibility of students' access to digital content and contact with teaching staff outside the classroom students is the least influential factor of those analyzed. The opening up of classrooms by means of digital technologies to transcend barriers of space and time is one of the key innovative factors in the incorporation of ICT in education. Its limited importance in the teachers' perceptions suggests that the use of the technologies for this purpose will be very restricted. This is perhaps because the physical barriers of schools are still very powerful, even when they have enough digital resources.

An analysis of the factors perceived as important for decision-making as regards the use of ICT in the schools participating in this research is of great interest. What the teachers at these schools do and perceive gives us some idea of the evolutionary trends in the system as a whole, to the extent that the availability of digital resources is becoming widespread and teachers are becoming competent in their use. In this new context, the educational use of ICT depends more on the educational projects and purposes pursued than the digital resources. A review of the curriculum and educational goals appears to be necessary in order to adapt them to new social demands, and further research on the processes of training and support for educational innovation by means of ICT is also required.

Our research has several limitations and recommendations for further study. It is important to note that it is a descriptive research, as it was limited to collect data from eight schools and 278 teachers. It also is an exploratory research, since participants derive from all curricular areas and from all three school levels: kindergarten, primary and secondary education. We also want to emphasize that, although the factorial exploratory analysis has been useful for identifying specific factors that influence teachers' use of technologies for teaching and learning in technology-rich classrooms, these identified factors cannot be applied in general to any kind of scholar teachers.

Beyond of the limits of this study, further research with a larger sample of teachers would be desirable in order to obtain data of a wider range of participants. First, a more in-depth characterization of the factors affecting the educational use of ICT could be possible in each education level and each subject area. Second, further research would allow us to better understand the factors that influence the adoption and use of particular types of learning technologies by school teachers. Such technologies could be computer-supported learning environments, computer-supported collaborative learning environments, or virtual classrooms, among others. Third, obtaining a larger sample of teachers could make possible conducting more robust statistical analysis, such as a factorial confirmatory analysis. Finally, we believe that is necessary to consider a new area of research that identifies not only the factors related to the frequency of use of technology, but also the factors that influence the way in which technology is used for teaching and learning purposes, particularly in order to build and maintain constructivist learning environments. Indeed, obtaining more specific information about these factors may contribute to promote more innovative learning contexts in classrooms.

Acknowledgements

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