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FACTORS THAT FACILITATE OR LIMIT THE INCORPORATION OF EMERGING TECHNOLOGIES IN THE CLASSROOM

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FACTORS THAT FACILITATE OR LIMIT THE INCORPORATION OF EMERGING TECHNOLOGIES IN THE CLASSROOM[1]

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Abstract

This study explores the perceptions of the teachers from the District Education Secretariat (Bogotá-Colombia) on the factors that facilitate or limit the incorporation of Emerging Technologies in the classroom. The sample used for this research was based on 241 teachers from different educational institutions. The data were collected through an anonymous survey with quantitative and qualitative questions. Open and axial coding was used to identify the different factors in contextual levels, such as microsystem, mesosystem, exosystem and macrosystem. It was found that sociodemographic variables do not influence the incorporation of technology in the classroom, in addition, there are three necessary and basic conditions for teachers to begin to incorporate technology in the classroom: motivation, infrastructure and information and communication technologies skills, but for any processes to be successful the teacher must be aware of what he is doing but any attempt to incorporate technology will fail. On the other hand, government entities must be responsible to generate policies or strategies in order to improve infrastructure, as well as design training plans according to the needs of each teacher and each institution.

Keywords: Emerging technologies, teacher perceptions, technology incorporation, contextual levels.

1. Introduction

Emerging Technologies (ETs) in the classroom have become an important subject of conversation between different educational actors, which covers topics related to the conceptualization and incorporation of ETs in schools or universities, aiming to improve various educational processes that contribute to strengthen the skills of the 21st century in students. For this article, the Emerging Technologies refers to "resources, artifacts, tools, concepts and innovations associated with digital, that have a disruptive potential to transform or generate changes in the processes where they are used, regardless of whether these are new or old technologies." (Sosa, Salinas & De Benito, 2017, p.129). This definition applies to any branch of study, and in the educational field, the main objective of these technologies is to transform both teaching and learning which requires new practices and strategies for teachers and students to use of technology in the classroom. (Pöntinen, Dillon, & Väisänen, 2017).

[1] This work is part of a larger study, which consists of the "Design of a Model of Incorporation of Emerging Technologies in the classroom (MIETC) for Bogotá public school teachers to generate strategies or learning activities.

Thus, different countries have generated policies and strategies, such as improving infrastructure, designing initial and ongoing training programs related to Information and Communication Technology (ICT) among others, (Kafyulilo, Fisser, & Voogt, 2016; Potolea & Toma, 2015), aiming to incorporate technology efficiently and effectively in educational processes. However, Singh and Chan (2014) point out that the success of these strategies is directly related to teachers, who are regarded as the main transformers and innovative agents, in charge of deciding whether or not to incorporate ICT in the classroom.

Nonetheless, there are different factors that can facilitate or limit the incorporation of ETs in the classroom, at the different contextual levels: microsystem, mesosystem, exosystem and macrosystem (Claro, 2010; Kirkland & Sutch; 2009). The microsystem refers to the factors associated with teachers and their competences to incorporate technology. Ertmer (1999) calls them second-order barriers, Losada, Karrera and Jimenez (2012) refer to them as the endogenous factors and Jimoyiannis (2008) and Kafyulilo et al., (2016) as personal factors. The mesosystem are factors related at the local level such as the institution and the community, the exosystem are the factors linked to the opinion of third parties, the experience and satisfaction of other people and the macrosystem are identified as factors related to national policies and curricula. For Ertmer (1999) the latter three factors are called first-order barriers, Losada et al. (2012), define them as exogenous factors and kafyulilo et al., (2016) as institutional and technological factors.

Regardless of the classification, previous authors agree that teachers need different strategies to deal with both facilitating and limiting factors at each of the contextual levels to make significant use of ETs in the classroom. However, to be able to design strategies of incorporation of technology it is necessary to know from the teachers themselves those factors that affect the incorporation of technology in their educational practice.

According to the above, this study answered the following questions: Is there a relationship or association between sociodemographic variables and the incorporation of emerging technologies in the classroom? What factors facilitate or limit the teachers from the District Education Secretariat (Bogotá-Colombia) to incorporate Emerging Technologies in their educational processes at the contextual levels (microsystem, mesosystem, exosystem and macrosystem)?

2. Literature review

When reviewing the scientific literature in several databases such as Scopus, Web of Science, Google Scholar and Science Direct, it was found that there are several studies that determine the different factors that affect the incorporation of technology in the classroom. For this reason, this article shows the facilitating and limiting factors found and classified according to the contextual levels.

2.1. Microsystem level

Within the internal factors related to the teachers that facilitate the incorporation of technology in the classroom are: the positive beliefs and necessary competences to integrate them, (Mumtaz, 2000; kafyulilo et al., 2016) Self-motivation to want to do things (Mumtaz, 2000; Park & Ertmer, 2008); have a high level of confidence in the use of ICT (Dawes, 2000; Jimoyiannis, 2008; Andrew, 2004; Mumtaz, 2000); the perceived utility of technology in the teaching and learning processes (Yuen & Ma, 2002; Zyand, 2016; Mumtaz, 2000); have positive feelings towards ICT that generate some kind of emotional bond (Losada, et al., 2015; Zyand, 2016); use metacognitive skills needed to decide which tools to use (Barnes & Kennewell, 2016) and the ease of use of technology (Collis & Moonen, 2001).

As for the factors that limit the incorporation in this level, it was found: lack of motivation and interest (Kafyulilo et al., 2016; Villalba, González-Rivera, & Díaz-Pulido, 2017); the resistance to change by teachers in their educational practices (Villalba et al., 2007, Jones, 2004b; Abarzúa & Cerda, 2011; Ertmer, 1999); the beliefs and negative attitudes of teachers about the incorporation of technology (Abarzúa & Cerda, 2011; Walker & Shepard, 2011); not having a perception about the benefits or advantages of incorporating technology in the classroom (Carver, 2016, Jones, 2004b, Cartelli & Palma, 2008) and lack of skills in the management of technology in the classroom. (Villalba et al., 2017; Carver, 2016).

2.2. Mesosystem level

Within the institutional factors that facilitate the incorporation of technology in the classroom are: adequate and sufficient access to digital infrastructure and resources (Claro, 2010; Mumtaz, 2000); having a person for technical support (Claro, 2010, Jones, 2004a, Mumtaz, 2000); carry out an ICT plan for the educational institution that allows a vision of how to integrate ICT (Jones, 2004a); provide teachers with the necessary time to design their classes (Andrew, 2004) and the students' own challenge to use the technology (Kafyulilo et al., 2016).

The limiting factors found during this research are: the lack of infrastructure associated to the scarce computer equipment and programs in the educational institution (Villalba et al., 2017, Carver, 2016, Zyand, 2016, Abarzúa & Cerda, 2011, Mumtaz, 2000); teacher's lack of time to plan classes with technology (Carver, 2016, Zyand, 2016, Abarzúa & Cerda, 2011, Jordan, 2004b, Mumtaz, 2000); the lack of support staff (Villalba et al., 2017, Carver, 2016, Abarzúa & Cerda, 2011, Mumtaz, 2000); the lack of training and, in some cases, the low quality of this in pedagogical, didactic and technical aspects (Jones, 2004b; Zyand, 2016; Wedman & Diggs, 2001; Ertmer, 1999); the lack of a clear and shared vision on the use of ICT in school through curricula or institutional educational projects (Park & Ertmer, 2008, Zyand, 2016, Wedman & Diggs, 2001, Mumtaz, 2000) and lack of an ICT coordinator or an ICT mentor (Kumar & Kumar, 2003) in the institution to support the processes of teachers.

2.3. Exosystem level

At the exosystem level, the factors that facilitate the incorporation of technology is to work with other educational institutions so that the teachers can share their experiences and learn of the successful practices (Jones, 2004a); to provide spaces within the institution for peer-to-peer work, this works as an instance of dissemination of good practices (Jones, 2004a, Eickelmann, 2011) and to generate communities of practice and learning within and outside the institution (Trucano, 2005). The lack of communities of practice and the lack of collaboration between teachers (Zyand, 2016) are factors that have limited the non-incorporation of technology in the classroom.

2.4. Macrosystem level

In the macrosystem the national, international and political context is a conditioning factor to incorporate technology in the classroom, because it is responsible for generating training processes where teachers can design strategies for incorporating ICT in a comprehensive way (Jones, 2004a) ; to generate extrinsic motivation which encourages teachers to incorporate technology (Kafyulilo, 2016, Losada et al., 2015, Park & Ertmer, 2008) and to design policies to equip institutions with the necessary infrastructure. On the other hand the lack of incentives (Zyand, 2016), the lack of technology incorporation models in the classroom (Wedman & Diggs, 2001) and the rapid change of technology (Birk, Nygaard, Pedersen, & Saifuddin, 2017) become the main factors limiting the incorporation of technology in this level.

As can be seen, there is a great diversity of economic, social, political and psychological factors (Butler & Sellbon, 2002), in each of the contextual levels that affect the incorporation of ETs in the classroom, however, the reviewed studies coincide in pointing out teachers as main agent of change (Claro, 2010), since the incorporation responds to a personal and not to an institutional act (Abarzúa & Cerda, 2011), considering that the factors of the microsystem contextual level are those that finally condition the use of ETs and as Ertmer expressed (1999) those factors are the most difficult to change because they require a change in teachers' beliefs which make them more complex to address.

3. Method

For the research an anonymous survey was made based on sociodemographic and other questions related to the incorporation of technology. Those questions corresponding to the sociodemographic information part were composed of quantitative variables (age and years of teaching experience) and qualitative dichotomous, polytomous and ordinal variables (gender, seminars or diplomas in ICT, locality where teachers work, areas of education, level where they teach, initial training, studies achieved and their relationship with ICT). The questions related to the incorporation of technology in the classroom were qualitative and adapted according to the answer of the question "Have you incorporated emerging technologies into your educational processes? When answering YES, teachers were suggested to respond what prompted you to incorporate emerging technologies in the classroom? Which drawbacks did you experience when incorporating Emerging Technologies in the classroom? What impact did the incorporation of Emerging Technologies have on your teaching practice and the learning process of their students? And what factors do you think are key to incorporating Emerging Technologies into the classroom? When answering NO, teachers were told to respond: why haven't you incorporated Emerging Technologies in the classroom? And what factors do you think are key to incorporating Emerging Technologies into the classroom? The above questions were open questions.

After the survey was designed, it was placed online using the Google Forms service for 3 months and the teachers from the official schools in Bogota-Colombia were invited through the email and the social network of Facebook to answer the survey. Additionally, physical formats were distributed in meetings with teachers, to be completed and subsequently transcribed to the form, in total 245 records were obtained. The collected data was downloaded in Excel and debugged, 4 records were found repeated, in total the sample for this study was of 241 teachers.

For the analysis of the data, it was used a univariate statistical analysis of the sociodemographic part with the purpose of describing the sample. The program R x64 3.4.0 and Excel 2013 were used. Then, a bivariate analysis was also performed with R to study the independence or dependence between sociodemographic variables and the dichotomous variable (The teacher has incorporated emerging technologies in the classroom). The analyzes were performed taking into account the following conditions:

- If the variables are nominal categorical (dichotomous and polytomous,) or ordinal, the contingency tables and non-parametric Chi square test are used (Arriaza, 2006; Berlanga Silvente & Rubio Hurtado 2012). Additionally, Cramer's V is used to measure the strength or degree of association or relationship. The rank of this index is 0 to 1, where 0 indicates that there is no association between the variables and 1 there is a strong association between the two variables (Kearney, 2017).
- If at least one of the variables is metric or quantitative and the other is nominal categorical, the normality test must be performed through the Shapiro-Wilk and Lilliefors tests Kolmogorov-Smirnov, if the quantitative variable has a normal distribution, the

student's t-test is used and if the distribution is not normal, the Mann-Whitney U test or Wilcoxon rank sum is used (Arriaza, 2006; Chan, 2003). In addition, to measure the size or magnitude of the effect between the two variables, the r index between 0 and 1 (Fritz, Morris, & Richler, 2012) was used and interpreted according to the ranges proposed by Cohen (1988): between 0.1 to 0.3 small effect; between 0.3 and 0.5 intermediate effect and 0.5 and higher a strong effect.

As for the analysis of the open questions, the Atlas.ti version 8.0 program was used to encode the data in an open and axial way, performing a content analysis on each response of the teachers and identifying the categories that allowed responding to the second research question. After the data were segmented, assigned a code, the categories were described and finally they were related to each other with the univariate, bivariate and theory data to conduct the discussion and draw conclusions from the study.

4. Results

The results begin with the univariate analysis, then with the bivariate analysis and finally with the content analysis of the open questions.

4.1. Univariate analysis results

As mentioned above the survey was answered by 241 teachers, 61% were women and 39% men, the age range was between 23 and 64, the mean age was 41.84 with a standard deviation of 8.40 and interquartile range (IQR) of 11. The data related to years of work experience, it was found new teachers with very few years of teaching practice and others with 41 years of experience, the mean was 16.86 with a standard deviation of 8.29 and interquartile range (IQR) of 12.

Figure 1 shows the geographical distribution of the teachers who answered the survey, teachers from 18 localities participated and only 2 localities were not represented in this study.

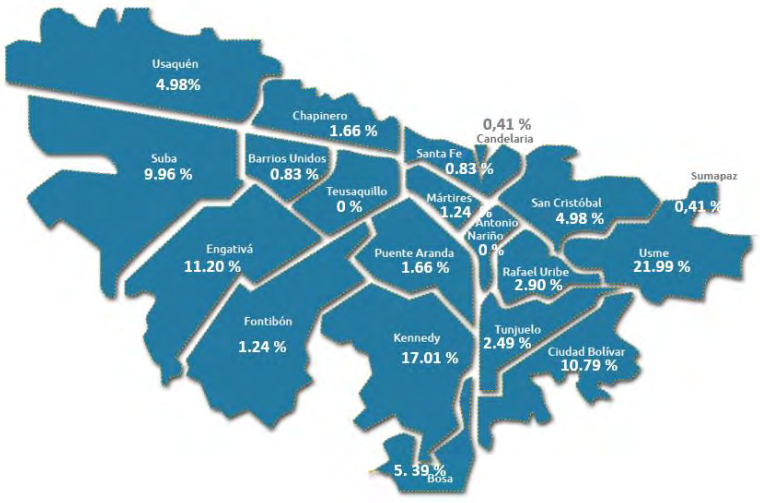

Figure 1. Geographical distribution of the teachers who answered the survey

At the level of initial training to be a teacher, the classification of Colombian legislation was taken into account, law 115 of 1994, decree 1278 of 2002, which stipulates the persons who can practice teaching are the higher normalist teachers (teachers who have received their pedagogical and didactic training in normal schools, as a complement to their secondary and secondary education), licensed teachers (they are teachers who obtained their university

degree and accredit them to practice teaching) and unlicensed professionals (those who obtain their university degree but in their training have no pedagogical or didactic foundation) that accredit pedagogical studies. The results were: 76% are licensed teachers; 19% are unlicensed professionals and 5% are normalist teachers. It is important to clarify that 5% of the normalist teachers 64% already got a degree, 18% a professional career and 18% only got the title of normalist teachers.

In relation to the level of maximum training attained: 47.72% are magister, 15.7% of these population are currently advancing their doctoral studies; 21.99% are specialists and 32% of them are studying a master's degree; 1.24% are doctors and 29.05% have not done any postgraduate study, but 54.23% of these y teachers are studying a postgraduate, Additionally, it was found that 30.29% of all respondents are pursuing a postgraduate study in order to improve their professional development. Finally, 38.17% of the teachers who studied or studied some kind of postgraduate said that this was related to ICT.

In the variables related to the area of education and the teaching level of teacher, the total does not correspond to the 241 respondents because in some cases, teachers are in charge of not only one class but several and in different levels. For example, a primary teacher can teach different subjects and a mathematics teacher can be in charge of secondary and primary. This varies depending on the context and the needs of each institution, just as at the level of training these were classified according to the Colombian legislation.

Table 1 shows the percentage of respondents in each of the areas of education, noting that in other areas the teachers support institutional educational projects and the attention of students and parents.

Table 1. *Teaching area*

Areas	Percentage
Natural Science and environmental education.	14.84%
Social Science: history, geography and political constitution.	12.14%
Artistic education.	9.11%
Ethical education and human values.	8.94%
Physical education recreation and sports.	6.75%
Religious education.	8.09%
Humanities, Spanish language and foreign language (English).	13.83%
Mathematics.	12.82%
Technology and Informatics.	9.78%
Other areas.	3.71%

In the level of action of the teachers it was found that: 6% of respondents teach class at pre-school level; 21% primary level; 37% secondary level and 36% middle level. Pre-school refers to transition levels; primary involves first, second, third, fourth and fifth grades; secondary are sixth, seventh, eighth and ninth levels and middle grades are tenth and eleventh levels. Finally, it was found in this univariate analysis that 66% of teachers have taken courses, seminars or degrees in ICT and 85% of those surveyed said that they have incorporated emerging technologies in the classroom.

4.2. Results of bivariate analysis

The bivariate analysis was used to determine the independence or dependence between sociodemographic variables and the dichotomous variable (the teacher has incorporated emerging technology in the classroom) for this, contingency tables, parametric and non-parametric tests were used according to the criteria previously established in the method, in

addition, for all the analyzes, it was used the null hypothesis H0: The two variables are independent or there is no relationship or association between the variables and the alternative hypothesis was HA: the two variables are dependent or are related or associated with each other, they were worked with a level of significance of 5%. It is important to note that, depending on the nature of the variable, the means or medians were compared. The results of the analysis between each of the variables are shown below:

Variable Gender Vs. Variable Incorporation of Technology in the classroom: being the dichotomous variables was used the test of Chi-square of Pearson, according to the results obtained in the program R (X-squared = 1.734, df = 1, p-value = 0.1879). H0 was accepted because the p-value obtained in the test was greater than 0.05 that is to say that the incorporation of technology is not related to the gender. Additionally, the Crammer V (0.084823468) is close to zero which indicates that there is no relation or association between the two variables.

Variable doing courses, seminars or degrees in ICT Vs. Variable Incorporation of Technology in the classroom: being the dichotomous variables was used the test of Chi-square of Pearson, according to the results obtained in the program R (X-squared = 11.848, df = 1, p-value = 0.0005772). H0 was rejected because the p-value obtained in the test was less than 0.05, meaning that the incorporation of technology is related to the realization of courses, seminars and graduates ICT, but, the Crammer V (0.221727843) calculated indicated that the degree of association is very low among the variables.

Variable Age Vs. Variable Incorporation of Technology in the classroom: as it is a quantitative and a qualitative variable, first the test of normality was made to the quantitative variable where the H0 is: The variable age in the population has a normal distribution and the HA is: The variable age in the population is different from the normal distribution; for this, it was used the Lilliefors test (Kolmogorov-Smirnov), which obtained a p-value of 0.018, this value is less than 0.05 then the null hypothesis was rejected; meaning that the age variable does not have a normal distribution, since it was not a normal distribution, the non-parametric Mann-Whitney U test or sum of Wilcoxon ranges was used to compare the medians and the p-value of 0.06635 was obtained which is greater than 0.05; so the null hypothesis that there is no statistically significant relationship or association between age and the incorporation of technology in the classroom was accepted. Additionally, the effect size (r = 0.1183573385) is close to zero, which means a small effect.

Variable years of teaching experience Vs. Variable Incorporation of Technology in the classroom: as it is a quantitative and a qualitative variable, first the test of normality was made to the quantitative variable where the H0 is: The variable years of teaching experience in the population has a normal distribution and the HA is: The variable years of experience in the population is different from the normal distribution; for this, it was used the Lilliefors test (Kolmogorov-Smirnov), which obtained a p-value of 0.0003999. This value is less than 0.05, so the null hypothesis was rejected, meaning that the variable years of teaching experience does not have a normal distribution, since it was not a normal distribution, the non-parametric U-Mann-Whitney test or sum of Wilcoxon ranges was used, having as a result the p-value value 0.3811,which is greater than 0.05, meaning that the null hypothesis was accepted, the non-existence of a statistically significant relationship or association between the years teaching and the incorporation of technology in the classroom; the effect size (r = 0.056508) is close to zero, i.e. small.

Variable place where for teaching Vs. Variable Incorporation of Technology in the classroom: being a polytomic variable and a dichotomous variable, it was used the test of Chi-square of Pearson. When performing the test in R, we obtained expected frequencies

lower than 1, which made necessary to group the smaller localities and obtain expected frequencies greater than 1 to be able to use the test again. When performing the test was rejected the H0 because the p-value obtained (p-value = 0.02964) in the test was less than 0.05; meaning that the incorporation of technology is associated with the place where it is taught, but the association factor V of Crammer (0.3255063085) shows a weak relationship between the variables.

Variable level of training achieved Vs. Variable Incorporation of Technology in the classroom: being the two categorical variables, the Pearson Chi-square test was used, according to the results obtained in program R (X-squared = 0.54555, df = 1, p-value = 0.4601). Ho was accepted because the p-value obtained in the test was greater than 0.05, that is to say that the incorporation of technology is not associated to the last level of formation, in addition, the V of Crammer (0.047576102) is very close to zero which indicates that there is not a degree of association of dependence between the variables.

Variable postgraduate is or was related to ICT Vs. Variable Incorporation of Technology in the classroom: being the dichotomous variables was used the test of Chi-square of Pearson, according to the results obtained in the program R (X-squared = 1.0047, df = 1, p-value = 0.3162). H0 was accepted because the p-value obtained was greater than 0.05; meaning that the incorporation of technology is not associated with the realization of a postgraduate related to the ICT. Additionally, the calculated Crammer V (0.07665141) indicated that the degree of association is very low among the variables.

Variable area of teaching Vs. Variable Incorporation of Technology in the classroom: being a polytomic variable and a dichotomous one, it was used the test of Chi-square of Pearson. According to the results obtained in program R (X-squared = 6.0949, df = 9, p-value = 0.7304), Ho was accepted because the p-value obtained was greater than 0.05, i.e. the incorporation of technology is not associated with the teaching area. Besides, the calculated Crammer V (0.10138085) indicates that the degree of association is very low among the variables.

Variable level of performance of the teacher Vs. Variable Incorporation of Technology in the classroom: being a polytomic variable and a dichotomous one, it was used the test of Chi-square of Pearson. According to the results obtained in program R (X-squared = 12.07, df = 3, p-value = 0.007149). H0 was rejected because the p-value obtained was less than 0.05 that is to say that the incorporation of technology is associated with the level of performance of the teacher, additionally, V of Crammer (0.183360764) indicated that the degree of association is very low among the variables. Furthermore, V of Crammer (0.183360764) indicated that the degree of association is very low among the variables.

4.3. Content Analysis Results

In this section, there are the teachers' perceptions about the factors that facilitate or limit the incorporation of emerging technologies in the classroom. These are divided into two: the first part refers to the findings found in teachers who have incorporated technology in the classroom that correspond to 85% of the sample and the second part are teachers who do not incorporate technology in their processes e.g. 15%.

4.3.1. Teaching outcomes that have incorporated Emerging Technologies in the classroom (85% of the sample)

The following describes the findings with corresponding to the open survey questions and contextual levels:

4.3.1.1. What encouraged you to incorporate emerging technologies into the classroom?

The factors that motivated teachers to incorporate technology in the classroom are at the microsphere (75.5%), mesosystem (18.7%), macrosystem (4.3%) and exosystem %).

In the *microsystem*, it was found that there are 6 factors that drive the incorporation of ETs in the classroom (see table 2). They are: self-motivation (38%); the benefits for teaching (23%) where teachers perceive that incorporation allows them to transform and innovate the educational practice (D22[2]: 'emerging technologies significantly favor educational practice'; D187: 'innovate educational and training processes'; D220: 'vary the typical masterclass'). Moreover, they consider that they are easy to use and useful for teaching processes (D60: 'allow the presentation and work of certain subjects for their greater understanding', D128: 'reinforce the subjects seen in class', D152: 'Because it is easier to use'),they allow to energize the classes (D25: 'You can perform the explanation dynamically' D96: 'make classes enjoyable' D184: 'help to improve the dynamics of classes') and they are also a resource of support for teachers in their different classes (D62: 'how to support visuals for class topics (games - rounds - stories)'; D63: 'elaborate guides, hear rounds, songs'; D151: 'screening of films and videos'); the benefits for learning (20%) where technologies are able to motivate students (D39: 'get students' attention through technological means, since they are in constant interaction with such devices.' D93: 'motivating students through these resources' D166. 'Is a way of attracting the attention of students'), this enables them to investigate, acquire, appropriate, evaluate and reinforce learning (D25: 'Facilitating appropriation and scaffolding in learning', D48: 'interactively reinforcing these processes'), strengthen skills (D25: 'favors the processes of metacognition', D64: 'allows students to promote and facilitate their participatory, creative and intellectual aptitude'), improve communicative processes between 'learners and teachers and even parents' (D13) where 'more effective and timely communication take place' (D153) and encourages the participation not only of students but parents (D34); apply what was learned in the training processes (10%). This factor refers to the skills acquired by teachers to incorporate technology in the classroom (D43: 'after taking a certificate course in ICT I have continued to do it'; D52 and D98: 'apply what was learned during the masters'); be up to date (5%) where the teacher feels that the context and his own motivations forces him to be in a constant training to acquire the necessary competences and thus apply what he or she has learned (D197: 'require digital skills for both teaching and learning'; D203: 'we can also learn, update and qualify ourselves with the advances in this field') and the affordances of ET (4%) where the benefits of ETs are perceived as: 'accessing novel and attractive material' (D144), 'finding information' (D56) and sharing it with students (D238).

[2] From now on D and the number corresponds to the teacher who answered the survey. For example D22 is teacher 22.

Table 2. *Factors that drive or motivate the incorporation of technology at the contextual level Microsystem*

Factors that encourage or motivate: At the contextual level Microsystem (75.5%)		
Self-motivation	38%	
Benefits for teaching	23%	
Transform and innovate educational practice		10%
Ease and utility		7%
Dynamize the classes		4%
Provide support resources		2%
Benefits for learning	20%	
Motivate students		7%
Inquire, acquire, appropriate, evaluate and reinforce learning		6%
Strengthening of competences		3%
Improve communicative process		2%
Other		2%
Apply the learned in the training processes	10%	
To be updated	5%	
Affordances of Emerging Technologies	4%	

In the *mesosystem*, 5 factors were found that encourage the incorporation of ETs in the classroom (see table 3) these are: the demand for context (29%) was the most prominent and it is divided into: the demand of the context of students, where 'young people and children need to make appropriate use of ICT to improve learning processes ' (D55) and 'being in contact with technologies' (D92); the requirement of the institution because several Institutional Educational Projects are related to the use of ICT and ETs (D148; D206) and curricula stipulate the need to incorporate technology (D75); to tackle a problem (23%) both generic and disciplinary using ETs that allow analyzing and solving it in an innovative and different way (D79); the motivation and interest of the students (22%) that generate the TEs (D58, D162, D203); the infrastructure (14%) available in the institution (D174; D241) and the competences of the students (12%) to easily manage the technologies (D41; D98).

Table 3. *Factors that motivate or motivate the incorporation of technology in the contextual level Mesosystem*

Factors that motivate or motivate the incorporation of technology in the contextual level Mesosystem (18,7%)		
Context requirement	29%	
Student		12%
Institution		11%
Area		6%
Addressing a problem	23%	
Motivation and interest of students	22%	
Infrastructure	14%	
Competences of students	12%	

In the *exosystem*, 2 factors that encourage the incorporation of ETs in the classroom were found. The first one is the experience of other teachers (80%) when implementing successful strategies taken from other teachers (D31) and the second one, refers to establishment of

networks (20%) to exchange knowledge and success cases in the incorporation of ETs (D138).

In the *macrosystem,* it was found that the needs and challenges of the current society (80%) encouraged teachers to incorporate ETs into the classroom (D4: 'In today's world (society of knowledge and technology) where technologies are called as they are called (ICT, TAC, ICT, etc.) play a preponderant role in all fields of knowledge and human performance. It is imperative that the field of education and especially in subjects like mine (T & I) keep close to this reality, as we see young people are immersed in these advances'; D44: 'The sociocultural relevance in relation to new technologies'; D163: 'exigency of the present world'), In addition, the evolution of technology (20%) also motivates teachers to incorporate technology into their teaching and learning processes.

4.3.1.2. Which drawbacks did you experienced when incorporating Emerging Technologies in the classroom?

The drawbacks presented during the incorporation of technology are divided into the different contextual levels (see Table 4).

Table 4. *Drawbacks presented during the incorporation of ETs in the classroom*

Drawbacks		
Macrosystem	58,2%	
Lack of infrastructure		56,0%
Other		2,2%
Mesosystem	32,9%	
Institution		14,8%
Home		9,2%
Students		8,9%
Microsystem	8,1%	
Lack of ICT skills of teachers		3,1%
Use of own resources		2,0%
Use of own resources		0,8%
Feelings		0,8%
Other		1,4%
Exosystem	0,8%	
Lack of exchange of experiences		0,6%
There is no work between areas		0,2%

The disadvantages presented at the *macrosystem* contextual level correspond to: the lack of infrastructure (56%) in different educational institutions, that involves the lack or intermittent connectivity (D5: 'related to internet connection which is still deficient'; D13: 'Internet service failure'; D135: 'No internet service in the classroom'; D208: 'the wifi network does not work efficiently'), low availability of resources of both equipment and spaces within the institutions (D2 and D208: 'The tablets did not reach to work individually', D139: 'there are not enough equipment in the school', D214: 'lack of spaces, classrooms, computers, TVs'), old and outdated equipment (D5 and D100: 'some of the computers are obsolete'; D148 and D214: 'Computers not updated'), security imposed by the Ministry of Education and the District Education Secretary which prevents access to different web pages because they are blocked (D13) or download software to devices such as tablets or laptops (D23) and the lack of licensing to use ethically and legally some programs (D18; D234). Besides, in others (2.2%) it was found that: the resources provided by the state agencies are not adaptable to the student's disability conditions (D168; D209); there are no training and updating

processes for teachers (D187; D214) and the high number of students served by the teacher (D15) are disadvantages when incorporating ETs in the classroom.

At the *mesosystem* contextual level, the disadvantages are divided according to the institution, the home and the students (see table 12). In the category institution (14.8%) it was found: logistical problems for the loan of the devices (D2, D37, D65, D89; D241); technical problems such as power failure, cables, batteries, TVs that do not work (D30, D149, D208; D241); limited access to devices due to the lack of resources in the institution, devices are not available for all teachers (D3, D200, D206); lack of institutional support to incorporate ETs (D75, D144; D214) lack of time to request resources and plan classes (D153; D167) and lack of technical support in the institution (D17; D194). In the category home (9.2%) it was found: lack of student resources such as internet connectivity (D17, D69, D101, D235) and not having electronic devices such as computers to carry out activities at home (D25, D59, D147, D211); disadvantages associated with parents such as resistance to the use of the internet (D41; D118) and the lack of interest from parents to participate in the processes of formation of their children (D25). The disadvantages associated with students (8.9%) are: the lack of skills in the use of ICT (D36: 'Some students do not know how to handle them', D68: 'It makes it easier to "copy and paste" when dealing with files in digital media, "D225:" Students were not prepared for blogging "); the lack of commitment (D76; D163) and student attention (D27; D35) to perform the requested activities as they do different things like playing (D96), browsing different pages (D31) using different applications (D52) or social networking (D238) and finally the lack of culture of students to take care of 'computers or even steal them to sell them' (D203).

At the *microsystem* contextual level, the drawbacks associated with teachers' personal factors are: the lack of ICT skills[3] (3.1%) to incorporate Technology in the classroom (D21: 'not know how to handle platforms', D22: 'It takes a lot of time to appropriate and implement them', D106: 'limited knowledge regarding the use of new tools' and D160 'Unknown use'); the use of own resources (2.0%) as providing connectivity from data packets (D151, D159;D181) or using devices that belong to the teacher (D51); resistance to change (0.8%) to break paradigms and innovate educational practices (D141; D214); the feelings (0.8%) associated with 'nervousness and confusion' (D34), 'shame and mistakes' (D93) or fear of damaging them and having to pay them and other inconveniences (1.4%) such as: the continuity of the process (D33); teachers remain in the same comfort zone and do not change their practices (D214); the incorporation of ETs generate more work (D43); some ETs like google translator are a big problem (D31) and sometimes the incorporation does not generate the expected results (D120).

At the *exosystem* contextual level, there are the disadvantages like the lack of exchange of experiences (0.6%) between other institutions (D214) or between the teachers themselves (D216) and a there is no work between areas (0.2%) to generate strategies of incorporation of technologies in the classroom (D214).

[3] ICT skills are "the knowledge, abilities and attitudes of teachers to incorporate technology in the classroom" (Sosa, Salinas, De Benito, 2017)

4.3.1.3. What impact did the incorporation of Emerging Technologies have on your teaching and the learning of their students?

The impact that teachers receive when incorporating technology was positive with 97%, only 3% of teachers say that the impact was negative or none. Table 5 shows positive impacts at each contextual level.

Table 5. *Impacts perceived by teachers when incorporating ETs in the classroom*

Mesosystem (76%)		**Microsystem (22%)**	
Students	*63%*	Teaching support	10,0%
Generates motivation	28%	Transforms educational practice	4,6%
Improves skills	13%	Improves processes	2,6%
Facilitates and enhances the learning process	9%	Be updated and contextualized	2,1%
Improves participation and discussion	4%	Generates motivation	1,8%
Acceptance of the use of technology	2%	Decrease health problems	0,6%
Adaptation to the needs, styles and learning rhythms	2%	Mentality change	0,3%
Generates meaningful learning	2%	**Macrosystem (1%)**	
Arouse curiosity	1%	Democratization of information	0,6%
Generates more commitment	1%	Environmental Protection	0,2%
Improves attention	1%	Allows inclusion	0,2%
Institution	*11%*	**Exosystem (1%)**	
Improves classroom environment	9,8%	Interaction with teachers	1%
Academic improvement	0,8%		
Decreases academic failure	0,2%		
Ease of integrating ICT into the classroom plan	0,2%		
Family	*2%*		
Family integration	2%		

4.3.1.4. What factors do you think are key to incorporating Emerging Technologies in the classroom?

The determinants of incorporating ETs into the classroom at each of the contextual levels are shown in Table 6.

At the *microsystem* contextual level, the factors that are determinant for incorporating ETs in the classroom are: the ICT competences that have the teachers related to the knowledge for

the use and management of the tools (D3; D19; D22; D41; D164); pedagogical knowledge (D28, D88, D102), knowledge of new teaching and learning methodologies and strategies (D30, D91, D121), he ability to perform intentional planning of the educational act (D111; D161) and the constant ability to reflect on the use of technologies in the classroom (D23; D115); the teacher motivation to incorporate ETs in the classroom (D8, D67, D133) commitment and responsibility (D32; D183) to improve educational practice (D16). In addition, there must be a recognition towards the teacher to incorporate it and thus generate interest in them (D60; D150); the benefits for teaching and specifically the support provided by ETs to teachers to innovate in the classroom (D77, D118, D198), to address a problem (D95), to display information in different formats (D49), to display contents and quality topics (D101, D112, D146) to generate dynamic learning environments (D84, D110), moreover, the TEs are easy to use (D65, D115, D190) and useful (D188; (D88) and feedback (D29) and serve to conduct research in the classroom (D110; D134); the teachers' paradigm shift to open their minds to new pedagogies or methodologies (D34, D79, D172) and thus break the monotony in the classroom (D121), also, teachers should lose their fear of using ETs (D143; D171) and thus leave the comfort zone (D198) and health benefits associated with rest (D132) and care of the voice (D186).

Table 6. *Determining factors for incorporating ETs into the classroom*

Microsystem	**32,7%**	**Mesosystem**	**22,5%**
ICT Competences	12,0%	*Institution*	*12,1%*
Teachers' Motivation	10,3%	Institutional support	8,9%
Benefits for teaching	8,1%	Curricular integration	1,3%
Paradigm shift	2,0%	Generate a culture of use and care	1,2%
Health Benefits	0,3%	Motivation	0,7%
Exosystem	**1,6%**	*Students*	*9,4%*
Peer-to-Peer Workspaces	0,7%	Benefits for learning	4,8%
Experiences of other teachers	0,7%	Motivation, interest and disposition	3,1%
Knowledge networks	0,2%	Teacher Training	1,2%
Macrosystem	**43,2%**	Bonding	0,3%
Infrastructure	28,7%	*Family*	*1,0%*
Teacher Training	10,3%	Motivation	0,5%
Context requirement	2,9%	Bonding	0,3%
Support for government entities	1,3%	Family support	0,2%

At the *mesosystem* contextual level, the factors are divided into the institution, the students and the family: The institution includes: institutional support to provide teachers with easy access to resources (D34, D151, D203), the generation of times and spaces to investigate, train, plan and implement activities (D16, D67, D155), provide counseling, technical and

logistical support (D39, D179, D192), generate and update institutional policies for the use of ETs in the classroom of both students and teachers (D47; D198), keep equipment in good conditions (D51, D137, D203) and generate of an ICT plan in the institution (D66; D92); curricular integration in each of the areas (D45, D52) and the institutional educational project (D172); the generation of a culture of use of ETs (D52, D196) and care (D53; D98) and the institutional motivation of wanting to incorporate ETs into educational processes (D45; D180).

Regarding students, it was found: the learning benefits generated by the ETs as the improvement of competences (D38, D81, D106), reinforcement of content (D65), improvement of comprehension (D71), improvement of participation (D23) and better results in the learning process (D101; D130); the motivation, interest, and willingness of students to engage in activities involving technology (D38, D138, D163); the training of students in the use of ETs (D70; D163) and linkage in the planning of activities (D101; D190).

Regarding the family, it was found: the motivation to want their children to incorporate ETs in their processes (D91; D180); parents' involvement in educational processes (D21, D76) and family support for accompaniment (D152) are determining factors for incorporating ETs in the classroom.

At the *exosystem* contextual level, the determining factors for incorporating ETs in the classroom are: the work spaces between pairs to articulate transversal projects (D37) and to perform a teamwork (D32; D182); the experiences of other teachers to appreciate the work of others (D5; D75) and knowledge networks (D48).

At the *macrosystem* contextual level, the factors that are determinant for incorporating ETs into the classroom are: he infrastructure related to the availability of resources in the institutions (D7, D11, D106, D203), connectivity (D10, D83, D197), adequate spaces (D22, D117, D150) , D89, D154) and generate investment in schools (D4, D181); the necessary training for teachers to acquire the ICT skills necessary to incorporate ETs in the classroom (D13; D39; D166) and updated teaching practice (D86); the demands of the context (D122, D149, D201) and the support of government agencies to generate educational policies related to the incorporation of technology (D39; D198) and reduction of students in classes (D28).

4.3.2. Teaching outcomes that have NOT incorporated emerging technologies in the classroom (15% of the sample)

The following describes the findings regarding to open survey questions and contextual levels:

4.3.2.1. Why haven't you incorporated Emerging Technologies in the classroom?

The factors by which teachers have not incorporated ETs are at the macro level (69%), mesosystem (2%) and microsystem (29%) (See Table 7). The lack of infrastructure in the school related to the availability of resources (D72, D157, D207), the lack of connectivity (D130; D175) and the availability of spaces (D12; D176; D237); the lack of training plans (D172; D207) and lack of policies (D176) by government agencies have been limiting factors in incorporating ETs into the classroom.

In the microsystem are: the lack of knowledge on the part of the teachers to integrate the technology to the processes of teaching and learning (D32; D119; D173); teachers do not perceive the usefulness of ETs in areas such as physical education (D136; D158); lack of motivation to train and interest in integrating them (D171; D172); the perception of teachers regarding ease of use is low (D198); there is no change of mind of teachers and they continue to use the same traditional teaching methodologies (D124) .Also, the lack of family

resources in the mesosystem (D177) do not allow teachers to incorporate technology into the classroom.

Table 7. *Why haven't you incorporated Emerging Technologies in the classroom?*

Macrosystem	**69%**	
Lack of infrastructure		62%
Lack of training plans		5%
Lack of policies		2%
Mesosystem	**2%**	
Lack of family resources		2%
Microsystem	**29%**	
Lack of knowledge		11%
Perceived utility		9%
Lack of motivation		4%
Easy to use		2%
There is no change of mind		2%

4.3.2.2. What factors do you think are key to incorporating Emerging Technologies in the classroom?

The determinants of incorporating technology in the classroom are at the macro level (62%), mesosystem (10%) and microsystem (28%), (see Table 8). Within the macrosystem are: infrastructure related to the availability of resources (D72; D131; D202); availability of spaces (D32; D172) and constant Internet connectivity (D202; D207); the generation of teacher training plans (D130; D178; D207); context requirements (D85, D145, D193); creation of national policies (D176) and increased investment (D176; D178).

In the mesosystem the factors are divided into the institution, students and family. In the institution there is a need to generate time (D119; D130) for teachers to design, implement and evaluate their incorporation processes, in addition to providing constant institutional support (D130). In students, their motivation and interest in using technology (D169; D193) and in the family the support they provide to the teaching and learning processes (D164) are determining factors for using technology in the classroom.

Table 8. *Determining factors for incorporating ETs in the classroom perceived by teachers who have not incorporated ETs*

Macrosystem	**62%**	
Infrastructure		38%
Teacher Training		12%
Context requirement		6%
Increased investment		3%
National policies		3%
Mesosystem	**10%**	
Institution		7%
Students		2%
Family		1%
Microsystem	**28%**	
ICT Competencies		11%
Motivation		5%
Perceived utility		5%
Paradigm shift		2%

Planning	2%
Commitment and responsibility	2%
Experience	1%

In the microsystem are: ICT skills to incorporate technologies in the classroom as the knowledge of ETs (D7; D119; D158) and the management and use of ETs (D19; D198); motivation to incorporate ETs (D14; D119); perceived utility in teaching and learning processes (D193; D217); the necessary paradigm shift (D136; D169); commitment and responsibility to incorporate ETs (D145; D171); planning of the processes incorporating ETs (D177; D202) and the teachers' own experience to incorporate ETs (D177).

5. Discussion and conclusion

This research allows the recent examination of teachers' perceptions about the factors that facilitate or impede the incorporation of ETs in the classroom, different factors were found that confirm or refute previous studies and new aspects emerged to be taken into account in the different processes of incorporating technology into educational practice.

The first thing that was found is that the sociodemographic variables of this study are not determinant factors to incorporate ETs in the classroom. This is because there is no dependence, relationship or association between variables. Moreover, in the variables where a dependence was found, its degree of association is very close to zero, meaning that he sociodemographic traits are irrelevant to explain the use of ICT (Gil-Florez, Rodriguez-Santero, & Torres-Gordillo, 2017), which contradicts the studies made by Jimoyiannis (2008) where he states that there is a dependence, relationship or association between the incorporation of technology in the classroom and the variables gender, age, years of teaching and the level of training achieved. This contradiction may be because the demands of the international context, national, local, institutional and the students themselves are forcing teachers to incorporate technology in their teaching and learning processes; something did not happen few decades ago where incorporation of ETs was an option and not a necessity as it is today.

The second finding was regarding the different perceptions that teachers have on the use of ETs in the classroom. For this reason, it was necessary to categorize them according to the contextual levels: microsystem, mesosystem, exosystem and macrosystem (Claro, 2010; Kirkland & Sutch, 2009).

In the microsystem, the factors that motivate and impel teachers to incorporate ETs in the classroom is the motivation itself, which means the teachers themselves decide whether or not to incorporate technology into their processes. It is a personal and non-institutional act (Abarzúa & Cerda , 2011). Additionally, their beliefs about the benefits about teaching and learning, the need to apply what is learned in training processes, and the benefits of ETs are important factors as well. These results confirm what was found in other studies by Mumtaz (2000), Park and Ertmert (2008), Yuen and Ma (2002) and Zyaan (2016). On the other hand, this study also reaffirms the results found by Villalba et al. (2017), Carver (2016), Jones (2004b) regarding the factors that limit the incorporation of ETs in the classroom, which are the lack of ICT skills in teachers and resistance to change. However, this study differs from these authors as it was not found neither beliefs nor negative attitudes about the incorporation of technology on the contrary teachers have a positive beliefs and attitudes to incorporate ETs into their teaching and learning processes. Additionally, something that was not found in the consulted investigations were the feelings as the nervousness and confusion produced when incorporating technology in the classroom which can generate in the apathy teachers towards the use of the ETs and decide not incorporate them in their practice.

In the mesosystem, one of the factors that facilitate the incorporation of ETs is the demand of the context, which allows the teachers to recognize the importance of using them in the various training processes and especially the students themselves to use the technology (Kafyulilo et al., 2016). Moreover, the motivations, interests and competences of students to manage ETs become an ally for teachers to use these technologies. Regarding the factors that limit the use of ETs, they are divided into three aspects, the institution, the home and the students. In institutional constraints, no new factor was found to those found in the literature review; i.e. logistical problems, technical problems, limited access to institutional resources, support, lack of time to plan classes and lack of support or ICT mentors have been historical factors that limit the incorporation of technology. Limitations of the home are emerging factors; however, no research was found related to these limitations. This entails thinking that the ETs can be a mediation tool to include the family in the student training processes, but due to the social and economic conditions it has not been possible to use them for lack of resources at home to have internet connectivity or rely on electronic devices such as computers or tablets. In addition, there is a resistance of parents to the use of technologies, such as the internet, because they have negative beliefs about the use of students on them. Finally, within the limitations associated with students, it was found the lack of skills of students to make an effective and appropriate use of the ETs, also the lack of commitment to develop the learning activities and the lack of care of the students for the electronic devices.

The factors that foster incorporation of ETs in the exosystem contextual level are consistent with the findings of Jones (2004a), Eickelman (2011), Trucano (2005) and Zyand (2016) where the generation of spaces for the exchange of experiences and establishment of networks and communities of practice allows the teacher to learn how to incorporate technology into their processes. This way, the limiting factors are the opposite of the driving factors. Something that was not found in the investigations consulted is the lack of spaces in the institutions for the teachers to work together and to carry out projects where the ETs are articulated.

In the macrosystem, the factors that drive the incorporation of ETs are the needs, challenges and requirements of the current society, in other words the demand of the context imposed by international, national and by the same society is a conditioning factor to use technology in the classroom. This result follows line of studies by Jones (2004a), and the main limitations for the incorporation of technology not only in this study but also in studies such as Villalba et al. (2017), Carver (2016), Zyand (2016), Abarzúa and Cerda (2011) and Mumtaz (2000) who discuss the lack of infrastructure associated with scarce resources, lack of connectivity, and the lack of training plans for the permanent teacher training which do not allow to propose strategies for the incorporation of ETs in the classroom (Jones, 2004a) that allows teachers to transform and reflect constantly on their teaching practices and develop ICT skills "(UNESCO, 2008, cited by Boude, 2013).

Regarding the impacts perceived by teachers when incorporating ETs, it is worth noting: at the microsystem level, support for teaching; in the mesosystem level related to students and motivation allows them to become active and participative people throughout the process (Moral, Martinez, & Piñeiro, 2014), improving their skills, their classroom environment, making it more dynamic and attractive for students and thus; reduce the problems of coexistence and in the family the integration of ETs brings the advantage of strengthening the commitment of parents in the processes of training of their children (Osorio & López, 2016). Besides, the family can observe the benefits of incorporating the technology in the learning processes and thus allow their children to connect to the internet which is a limiting factor in the use of technology in the exosystem, the possibility of interacting with other teachers and

in the macro system the possibility of democratizing information and knowledge for the benefit of society in solving problems.

As recommendations based on of this study, it is suggested to generate strategies at each of the contextual levels: in the macrosystem it is necessary to improve the infrastructure of the schools from the acquisition of equipment, update those that are obsolete and improve the connectivity. Furthermore, training processes should be designed to provide effective advice and support for teachers and take into account the previous knowledge of the participants to generate training plans a little more individualized and thus avoiding dropout and rejection of teachers to these processes. Regarding the exosystem, there must be generated both synchronous and asynchronous spaces so that teachers can exchange experiences. In the mesosystem, it is necessary to integrate the ETs to the curricula and to the diverse projects of the institution aiming to improve competences of the students. Consequently, in the microsystem, processes of self-reflection on the necessity to incorporate the ETs must be done in order to be in permanent training and acquire the necessary ICT competences to use the ETs in the educational processes.

Finally, there are a variety of factors at each of the contextual levels that determine the use of ETs in the classroom, but when performing the analysis in a global way it is found that there are three necessary and basic conditions for beginning to incorporate technology in the classroom: motivation, that implies confidence for teachers to rely on their skills and be understand that success depends on factors that may be under control (Parker & Martin, 2011); infrastructure needed to incorporate ETs as the different services, spaces and resources that allow the development of different educational activities (García, Benitez, Huerta, Medina, & Ruiz, 2007) and the ICT competences that allow the design, development, implementation and evaluation of learning environments supported by significant ICTs that contribute to the integral training of students (Valencia-Molina, Serna-Collazos, Ochoa-Angrino, Montes-González, & Chávez- Vescance, 2016). These constraints are dependent on each other, that is, if strategies are generated to promote them, transformations can occur within the classroom, for example, if an effort is made by governments to generate training processes and provide institutions, teachers acquire the necessary skills in ICT (knowledge, skills, attitudes) to use the equipment of the institution, however, for any process to be successful teachers must believe in what they are doing; otherwise, any attempt to incorporate ETs would fail.

6. Limitations and Prospects

The main limitation of this study is that it was carried out in a specific context and its results could not be generalized to all teachers. On the other hand, due to the evolution of technology and the new challenges and challenges imposed by the society of information and knowledge, it becomes necessary to continue exploring the factors that facilitate or limit the incorporation of ETs, and use what has been found to propose strategies or methodologies for teachers to incorporate technology into their processes in an efficient and efficient way. This way, research not only on the perceptions of teachers, but also to investigate their own practice and determine if the incorporation of ETs in educational processes improve the educational quality of countries.

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