The Use of ICT in Educational Institutions in Paraguay and the Factors That Intervene

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Abstract—Research in education has produced vast information about the use of technology for the development of classes around the world. In Paraguay, there have been initiatives that promote the use of technology in schools to enhance the teaching and learning process. The objective of this study is to examine the use and scope of ICT in the classroom and to better understand teaching experiences in secondary education in Paraguay. The methodology used was quantitative and qualitative by means of an online questionnaire with closed and open-ended questions consisting of 30 questions on access to and use of technology in the classroom, teacher skills and training, and level of institutional support. Results include three factors associated with the professional perception of ICTs and 7 factors associated with the degree of appropriation of ICT as well as factors related to teachers' competency levels and differences between rural and urban areas. These findings call for first of all a stronger emphasis on universal access from the public policy point of view in order for the affordances of ICT to be available to all.

Keywords—ICT, factors, Paraguay, secondary education, teachers

1 Introduction

Technology implementation has gained a primary role in education in the last decades. ICT or Information and Communication Technologies entail using technological tools to communicate, disseminate, store and manage information [1] [2]. However, considering the field of education, several authors have referred to ICT as the tools used to "store, retrieve, manipulate, or transmit information electronically in digital form" [3] as well as technology having the potential to improve learning and teaching methods [4] thus focusing on student-centered rather than teacher-centered learning [5]. Such integration of ICT within the field of education entails not only adding machines to the learning process and expecting a positive change in education [6], it rather involves integrating new pedagogies within instruction [3].

Hence, integrating technology into the classroom requires a much more orchestrated effort by stakeholders, school administrators, and teachers alike for it to have a positive impact on students' learning as its mere adoption is not sufficient for the digital trans-

formation [7]. In other words "integration is defined not by the amount or type of technology used, but by how and why it is used" [8]. Teaching with technology is a complicated task and there is no single solution for proper implementation, as it can vary depending on the type of institution, in addition to being constantly evolving, which is a challenge for its application [9][10]. For technology to be properly implemented, it needs to be integrated within classrooms, become part of the curriculum for students and future teachers, and teachers must keep up with technological innovations [11] [12] [2] [5].

To begin with, there are several factors that come into play when considering the adoption of ICT in education, including contextual as well as individual factors [13] [14] [7] [15] [16]. First and foremost, the digital divide remains a major problem for the implementation of technology challenging education systems to adopt new ways of technology implementation and to engage in constant research for the better use of available resources [17] [18] [19] [20][21]. Such a problem represents an opportunity to better understand the role of technology in schools and also the various problems teachers face whenever implementing ICT into their classrooms. McKnight et al. [16] identified five positive roles ICT plays in education as these relate to instructional strategies, contextual factors, perceived impact on learning, and supporting research. Inan and Lowther [22] found that teachers' years of teaching and age negatively affect computer proficiency. On the other hand, computer proficiency, teacher readiness, and beliefs positively affect technology integration. Other factors related to the availability of computers and overall support positively influence beliefs and readiness [22].

As the use of technology gains prevalence in the education field, it is also vital to understand how teachers can be classified based on their ICT use to provide schools with valuable information on common trends and challenges faced to better address these problems. Graves and Bowers [23] sought to expand on two models of teacher typology, namely Mama and Hennessy [24] and Donnelly, McGarr, and O'Reilly [25]. The former classified teachers into four distinct groups considering their technology use as well as other contextual factors: dexterous, evaders, assessors, and presenters. This classification relies on technology's purpose such as its use for instruction, for productivity, use of technology for specific student activities, and for hands-on activities [23].

This model also considers possible roles of ICT in education as well as types of teachers who make use of technology based on the school type, availability of technology, experience, and the purpose of technology in their everyday practice [23]. Hence, technology implementation entails much more than simply using computers in the classroom to achieve positive outcomes. Research on teacher beliefs and perspectives on the use of technology and how it is related to the values assigned to this tool in relation to the levels of implementation is ample [26][27][28][29][30]. For example, Wozney, Venkatesh, and Abrami [31] considered levels of ICT integration using the Expectancy-Value theory of motivation focusing on the internal and external attributions affecting ICT use as well as the value assigned to ICT use as a worthwhile tool. They provided a self-assessment section for teachers to indicate their stages of technology integration, namely: awareness, learning, understanding, familiarity, adaptation,

and creative application. They found that there is also a strong correlation between student-centered styles of teaching and high computer proficiency as well as personal use of computers and their use in the classroom. Moreover, teachers in their studies reported the need for more training in the use of technology to better address their students' needs [31].

In Paraguay, measures have been implemented by the Ministry of Education and Culture (MEC) since 1995. These include ICT incorporation programs in conjunction with national and international entities such as Itaipú Binacional, the Inter-American Development Bank, and the European Union. These are aimed at providing equipment to institutions, as well as training teachers in their use [32]. However, according to Costa Bordón [33], the measures taken by the MEC "denote a slow evolution and a long and disjointed "road traveled" with scattered proposals, isolated experiences, and disjointed from those developed by private sector organizations".The same proposes that in addition to what has already been done, it is necessary to provide opportunities for ICTs to offer transformations in the classroom and in educational processes in line with the needs of today's society.

Likewise, the MEC [32] indicates that "the scarce incorporation of information and communication technologies in pedagogical and administrative processes in officially managed educational institutions constitutes a limitation for the improvement of learning conditions and efficiency in administrative processes in the Paraguayan educational system". To counteract this situation and avoid further increasing the digital divide and at the same time promote the pedagogical use of ICT, currently, the MEC through FONACIDE has implemented a program for the "Improvement of learning conditions through the incorporation of ICT in educational institutions and educational management units in Paraguay, 2015-2019". Its main objective is to "improve learning conditions in the Paraguayan educational system by incorporating Information and Communication Technologies in pedagogical and administrative processes". [32]. Considering this project, Aquino et al. [34] report on teacher training in the use of ICT, available resources, difficulties encountered, as well as the frequency of ICT use and areas for improvement. However, research on education in Paraguay is scarce and thus more information is needed to complement the literature on the implementation of ICT in the educational system. Accordingly, the objective of this paper is to provide information on the use and scope of ICT in secondary educational institutions in Paraguay by analyzing and describing the scope of the use that Secondary Education teachers of the national education system give to ICTs in the teaching-learning process. It specifically aims at identifying the main factors involved in the implementation of ICT in officially managed educational institutions.

2 Methods

This article is part of a study following a triangulation CUAN-CUAL convergent mixed methods design [35]. It had an exploratory phase and an implementation phase. In the exploratory phase, focus groups with in-depth interviews and a pilot survey of non-probabilistically selected teachers were used as data collection tools so that the

results would help validate and contextualize the instruments for use in the implementation phase [36][37]. Based on this pilot study, the questionnaire was adjusted and applied to teachers from officially managed secondary schools throughout the country, with the official probabilistic sample considered for this research.

For the implementation phase, the universe of the study includes Paraguayan officially managed secondary education institutions throughout the country. Taking into account technical requirements for the selection of the sample recommended by Hernández Sampieri et al. [38], a probabilistic sampling strategy was used, with the application of random methods so that all the institutions have the same probabilities of being included in the sample, stratified according to the political distribution by departments of the country. Thus, out of a universe of 2032 institutions, 98 were selected; the samples corresponding to the seventeen departments and the capital city were selected by stratification proportional to the number of secondary education institutions in each area. Thus, The sample design included 98 officially managed high schools that offer secondary education and 9 institutions that were considered for their high density of students enrolled in secondary education during the year 2020, according to data provided by the Ministry of Education and Science.

The 98 institutions were visited and contacted and 93 of them responded, which represents an approximate coverage of 95%, and of the 9 referential institutions, 8 of them responded. Responses were obtained for 16 of the country's 17 Departments (Alto Paraguay was not considered because the surveys collected did not meet the inclusion criteria) and for the capital city, Asunción. A total of 736 responses were recorded but following the criteria of inclusion of complete and verifiable information, 12 were discarded and a total of 724 completed surveys were retained from the country's officially managed secondary school teachers who completed the teacher questionnaire regarding the perception and incorporation of ICTs in classroom processes.

The quantitative analysis began with a descriptive analysis to distinguish responses by departments, areas of influence of the schools, in addition to outlining the profile of the teachers surveyed according to proportion of access to ICT, levels of teaching competence in ICT, stages of ICT implementation, years of teaching and others. For this purpose, the EXCEL spreadsheet and its Data Analysis tool were used to summarize the main statistics using pivot tables. Subsequently, bivariate and multivariate analyses were performed with IBM SPSS 21 statistical software. Mean responses of teachers' professional opinions on ICT, levels of ICT integration in the classroom by subject, area of influence of the schools, ICT competence levels were compared with Student's t-test after verifying the tendency to normality due to the large sample size. Confirmatory factor analyses were carried out with the main variables of ICT access and integration and by means of tree analysis it was possible to identify the most influential factors to classify teachers according to ICT access and integration.

3 Results

The questionnaire has a 30 question-section that corresponds to the professional views of teachers on ICT. With these 30 variables, an exploratory factor analysis was

performed during the validation stage of the instrument, which made it possible to identify three factors that explain 75% of the total variability of the data [36][37]. With the data from the 724 teachers, a confirmatory factor analysis was performed, limiting the results to 3 factors, which resulted in a fairly good overall sample adequacy measure (KMO=0.932) and 57% of total variance explained, as well as statistical significance of the heterogeneous variability to ensure that the multivariate treatment is correct for the data. The 3 factors selected and the highest relationships with the variables are detailed in the following table:

Table 1. Factors associated with teachers' professional opinions on ICTs

Factors	Variance explained	Variables with highest correlation
Factor 1: *Aspects that affect teaching with ICT benefits*	32%	Improves student performance Promotes the development of students' interpersonal skills. Improves student learning. Makes teachers feel more competent. Provides teachers with the opportunity to be guides.
Factor 2 *Difficulties in the use of ICT*	13%	It is difficult because students know more about computers than teachers. It will increase student stress and anxiety. Requires training that takes up too much time. It makes students put books aside.
Factor 3 *Challenges related to access and infrastructure*	12%	It is too expensive It is only successful if the technological tools are available for the development of classes both at school and at home; for students and teachers.

The first factor, which explains 32% of the total variability, is associated with variables that have a direct influence on the teaching and learning process, on classroom actors such as students and teachers, and speaks of the benefits that the incorporation of ICTs in the process will bring to teachers and students.

The second factor explains 13% of the total variability and is mostly associated with the variables that have to do with the technical and emotional difficulties that the ICT-mediated classroom process may bring to students and teachers. It refers to the generational problems between these two educational actors to accommodate to the technologies of the moment and to the class time that should be used for training in the technological tool rather than to the development of the curricular content itself.

The third factor that explains 12% has a higher correlation with the variables that refer to the technological infrastructure required for the effective development of classes. It mentions the high cost required to equip the institutions and provide students and teachers with their own computer tools for follow-up from home.

A confirmatory factor analysis of the 7 factors associated with the degree of integration of ICTs in the teaching processes by teachers was also carried out, which was obtained during the validation of the instrument and explained 70% of total variability. In this case, of the 34 variables of the Questionnaire adjusted to measure the degree of ICT integration, with the 724 teachers surveyed, it was possible to confirm the 7 factors

obtained that explain 66% of the total joint variability with a sample adequacy measure KMO (0.922) sufficient for the validity of the procedure (see Table 2).

Table 2. Factors associated with the level of incorporation of ICTs in classroom development

Factors	Variance explained	Variables with highest correlation
Factor 1 *Creative integration of ICT*	15%	Has students use 3D modeling software or simulations. Uses painting or drawing software Has students play games Conducts experiments or lab exercises
Factor 2 *ICT adaptation for administrative purposes*	13%	Prepares handouts, quizzes for students Keeps track of attendance or grades Creates lesson plans
Factor 3 *Production of audiovisual materials*	10%	Makes video tutorials Make explanatory audios
Factor 4 *Use of ICT tools*	10%	Uses videos and digital cameras Uses processors and spreadsheets
Factor 5 *ICT integration for communication*	7%	Uses e-mail Uses virtual platforms
Factor 6 *ICT use for self-learning*	6%	Has students use self-study and feedback tutorials
Factor 7 *ICT use as support in the teaching process*	5%	Creates PowerPoint presentations Uses LCD projectors for presentations

Regarding the professional opinion of teachers with respect to ICT, differences between the items analyzed were evaluated according to the level of ICT competencies they stated they had. For all cases, a Student's t-test for independent samples at 95% confidence was performed. Two parameters were established for the test: those teachers who were perceived to have below the average level of competencies and those who at least considered themselves to have the average level of ICT competencies. Table 3 verifies the aspects in which significant differences were found in teachers' opinions by level of competence. The positive difference in the means indicates that those with average or higher levels of competence rated the items described in the table with high scores.

Table 3. Comparison of means - Opinion on ICT by level of ICT competencies

Comparison of mean values - Student's T-test	p-value	Difference of means
It promotes the development of communication skills (e.g., writing and presentation skills).	0.014	0.445
It is only successful if teachers have access to a computer at home.	0.037	0.361
It gives teachers the opportunity to be facilitators of learning rather than providers of information.	0.017	0.323
It requires too much time to be spent on technical problems.	0.000	0.611
It is an effective tool for students of all abilities.	0.006	0.458
It is unnecessary because students will learn computer skills on their own, outside of school.	0.000	0.925

It relieves pressure on me as a teacher.	0.002	0.502
It is effective if teachers are involved in selecting computer technologies to integrate.	0.018	0.336
It helps accommodate students' personal learning styles.	0.018	0.330
It limits my choices of instructional materials.	0.000	0.715
It requires time-consuming software skills training.	0.000	0.689
It promotes the development of students' interpersonal skills (e.g., the ability to relate to or work with others).	0.001	0.557
It will increase the amount of stress and anxiety students experience.	0.000	0.756
It is difficult because some students know more about computers than many teachers.	0.000	0.699
It improves students' learning of critical concepts and ideas.	0.006	0.453

In the integration of ICT to online classes, a significant difference (p-value<5%) has been verified by levels of teacher ICT competence in the items grouped in Table 4. Those teachers who have been indicated as having average or higher levels of competence in the use of ICT differ from the rest of their colleagues in aspects related to communication in virtual learning environments, the actual preparation of the class taking into account technological resources and the selection of the environment itself.

Table 4. Differential aspects of teachers with average or higher ICT competency levels

Differential aspects of teachers with average or higher ICT proficiency level - Significant values in Student's t-test.	**Processes**
Uses e-mail to communicate with other teachers	Communication
Uses e-mail to communicate with students	
Uses an LCD projector (a projector connected to a computer) in class	Classroom planning with ICT
Creates PowerPoint presentations for use in class	
Scans drawings or images	
Uses digital video, digital cameras	
Uses a word processor	
Uses Flash Drive storage	
Uses online storage (Drive, Virtual platform)	
Uses a digital platform for the development of virtual classes (Moodle, Classroom, Teams, etc.)	Classroom form and environment
Has students perform experiments or laboratory exercises	

Of the 7 factors considered in terms of the level of ICT integration mentioned by the teachers surveyed, an analysis was made by classification tree by zone of influence (Figure 1) of the schools included in the sample. The results obtained are detailed below. The multivariate analysis found significance (p-value<5%) between zones of influence, firstly in Factor 5, which involves communication processes between educational actors as a level of ICT integration, is the aspect that distinguishes teachers in urban and rural areas of residence. It can be concluded that the integration of ICT for communication processes; sending messages by e-mail, educational platforms, or monitoring online class processes; is a distinctive aspect between the zones of residence and

is the one that presents the greatest power of discrimination of the groups. From the sample evidence, it is appropriate to indicate that communication among educational actors with technological tools is more widespread in urban areas. The graph also shows that those teachers who use ICTs for communication processes are also those who use them for self-training processes and are the ones who integrate these tools in a creative way. In rural areas we see that the creative applications of ICTs differ significantly from urban areas, with the latter having the highest proportion of teachers who indicate that they use ICTs in various didactic situations, beyond merely administrative aspects. Therefore, the differential factors between rural and urban areas, being in urban areas the greatest application and report of benefits are: The creative application of ICT and communication processes with technological tools.

Secondly, significant differences are also found by zones of influence of the school in relation to the variables most correlated with Factors 2 and 4. This indicates that the variables referring to lesson planning, elaboration of materials and the use of digital tools are also very different by urban and rural zones. The result indicates that differences are seen especially by zones in regards to the preparation of PowerPoint presentations and the use of LCD projectors in classes (Factor 7).

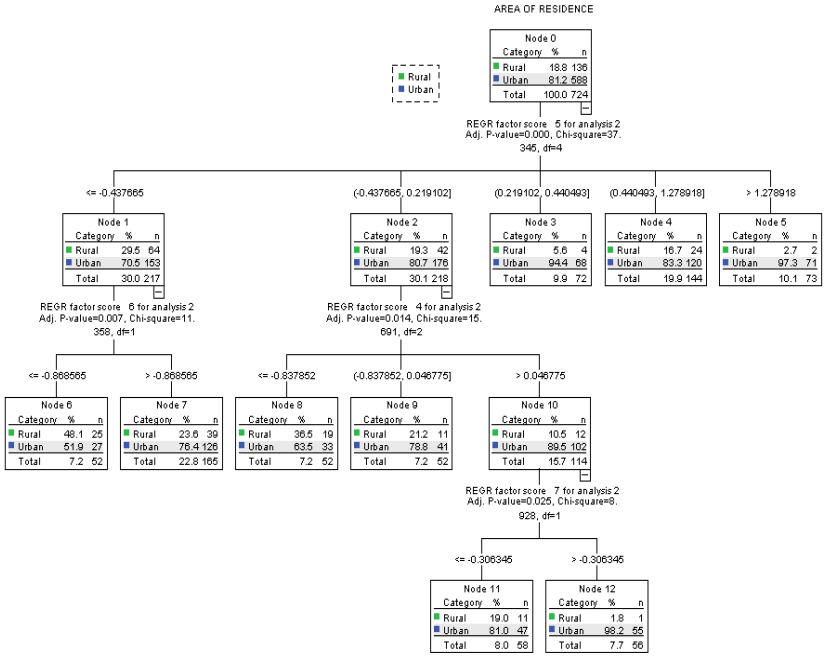

Fig. 1. Factor tree by zones of influence - ICT incorporation

The same analysis was performed by ICT competency level, resulting in significant differences in the first place with factor 4 referring to the use of more specific digital tools such as cameras and accessories. That is, teachers who mentioned having an average or higher level of ICT competencies differed from those with below average ICT

competencies in aspects related to factor 4. Secondly, the differences between both groups of levels are noted in Factor 2 referring to the planning and preparation of didactic materials. (See Figure 2)

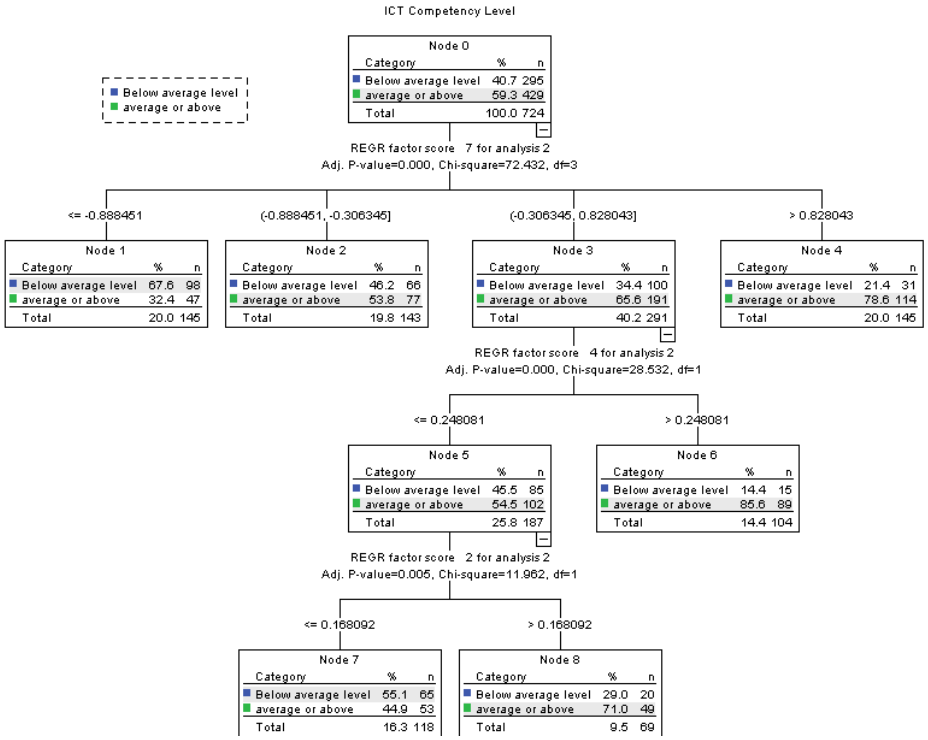

Fig. 2. Factor tree by ICT competency level - ICT incorporation

Regarding the teachers' professional opinion on ICT, the mean value comparison tests indicate that there are no significant differences by zones of influence of the school (p-value>5% - Student's t-test). The Multivariate Classification Tree Analysis with the 3 factors considered for the teachers' professional opinion on ICT with reference to the ICT Competence Level yielded the following results: ICT competence level classified as "below average" or "average or above" have significant differences around factor 2, firstly, referring to the excessive time required for teacher training, the feeling that students know more about ICT than teachers, the idea that ICT generate more anxiety and stress in students. Teachers with average or higher ICT proficiency levels also show significant differences in Factor 3, which mainly refers to the cost of ICT in the classroom, both for students and teachers. The determining factor that defines the level of ICT competence of teachers, according to the factor analysis carried out, is the integration of ICT in the teaching and learning processes. The levels of ICT incorporation in the classroom make it possible to distinguish teachers into two groups according to whether they have an average or above average level of competence and a below average level of competence. The second influential factor in the process of identifying the

level of ICT competence of the surveyed teachers is familiarity with the use of tools, software or technological instruments. Thus, it can be seen that a teacher who has a creative application of ICTs has no problem in using technologies for other aspects of teaching. The level of ICT skills of teachers can therefore be classified as average or above average or below average according to the use of technological tools in classroom and administrative processes mainly.

4 Discussion

Based on the results presented above, in regards to teachers' views on ICT, three main factors were identified. The first one deals with aspects that relate to the benefits of teaching with ICT such as improved student performance, learning, interpersonal skills, as well as teacher self-efficacy. Along similar lines, [16] McKnight et al. (2016) identified five positive roles ICT plays in education such as improved access, communication and feedback, as well as time management. Additionally, they have also noted the benefits of ICT as a way of promoting interaction, multisensory delivery, authentic communication, as well as active learning and critical skills enhancing students' motivation and engagement as it promotes their autonomy and centeredness [39][40][10][5][28].

The second factor identified on teachers' views on ICT relates to the perceived difficulties regarding the use of ICT. In this regard, evidence suggests that the use of technology presents obstacles for educational actors across contexts and researchers have classified barriers considering both external factors such as equipment, time, training, support as well as the teacher's skills and their beliefs about teaching and learning with ICT [41][30][42][43]. These beliefs may include challenges related to external conditions but also to difficulties in commiting and complying schools' regulations regarding ICT adoption which may be overcome by assisted performance and distributed leadership [58].

The third factor identified relates to issues concerning the digital divide as access to technology has remained one of the most important barriers to the implementation of ICT in schools. That is to say, implementing or knowing how to use technology relies on the assumption that education actors have access to technological tools. In the previous phase of the study, teachers noted that the scarce availability of infrastructure as well as the lack of access to a reliable internet signal is a major obstacle for both teachers and students. This problem coincides with results of previous studies on the use of ICT in times before the pandemic and during the pandemic. While teachers may acquire better tools to cope with the school year, this is not the case for students. Such a situation may affect educational quality as it represents an access gap that affects some educational actors [43][44][45][46][47].

Van Dijk [39] explains that access in the narrow sense refers to the physical access of technology whereas in the broader sense of "second-level" access, refers to the "attitude, and expectation of getting physical access" (p. 2). This concept of access to technology revolves around the idea of appropriation of technology; which entails physical access and attitudes that allow for the adoption of technology as well as the

constant use of new versions, software, hardware, and equipment [48][49][50]. Similarly, Prensky [51] discusses digital wisdom as the "wisdom arising from the use of digital technology to access cognitive power beyond our innate capacity and to wisdom in the prudent use of technology to enhance our capabilities" (p. 1). That is, access and know-how should go hand in hand when it comes to the efficient use of ICT tools. Such skills should be part of the curriculum for the benefit of the teaching-learning process and as preparation for possible challenges that may appear in the future [52]. These findings are related to the factors identified in our study with the level of incorporation and appropriation of ICT by teachers. Along similar lines, our results indicate a relationship between the level of technology implementation along with the level of intensity of computer use and also their current instructional practices. However, these do not always correspond with the integration stage as they remain in the mechanical stage to use for administrative purposes and to support classes [31][53].

In relation to the differences found in teachers' views in relation to their area of residence, our study reflects a trend throughout the world which shows a decreased access and therefore use in rural areas creating what is known as the digital divide between the residents of urban regions who have a much more universal access and therefore opportunities for adoption and integration than those in rural areas whose access is limited and sometimes non-existent. Both teachers and students in these areas cannot integrate ICT in their teaching and learning simply because they do not have sufficient access to both infrastructure and connectivity [54][55][56][57]. Chinapah & Odero [57] call for the reengineering of education towards building a more practical and realistic approach that can address this digital divide. Finally, our results follow a similar trend that those presented by [7] who found that performance expectancy and ICT compatibility have a greater significant positive influence on the motivation and involvement of teachers. The study also clarifies that teachers intend to use ICT and that they see in them a different didactic tool that allows different approaches, thus increasing the quality of teaching and learning.

5 Conclusion

Teachers' knowledge of ICT and the level of ICT integration in the classroom made it possible to identify different teacher profiles according to the areas of influence of the educational institutions where they work. These teacher profiles are determined according to their access to technological tools, as well as their access to quality internet and the technical and pedagogical training they received in the process of including technological tools in the classroom processes. The findings in this study coincide with the other studies on the use of ICT in educational settings around the world. Moreover, it adds to the growing literature on this topic providing information about how teachers in different settings and with different resources approach the use of ICT for the development of the teaching-learning process.

There is evidence of teachers in urban areas who have access to technological infrastructure and quality internet that show creative applications in the teaching processes, while in rural areas it is scarce to find teaching profiles with these characteristics. There

are teachers who perceive themselves as having a high level of ICT competence but who nevertheless use technological tools only for administrative purposes. However, the predominant factor that defines the level of ICT competence of teachers lies in the possibility of using these tools for more dynamic and experiential classroom processes that promote meaningful learning, according to the results obtained in the factor analysis carried out with the answers given by the respondents to the activities that incorporate ICT.

This disjunction between the teachers' perception of having a high level of ICT competence and not using it for creative purposes may be associated with the restricted access to internet and technological infrastructure in the educational institutions or families where students develop the classroom process. Teachers are identified as having the necessary tools and materials for the virtual development of classes, but not the availability of student resources to follow up on them. These findings call for first of all a stronger emphasis on universal access from the public policy point of view in order for the affordances of ICT to be available to all. Once this fundamental requirement has been fulfilled, then the emphasis should be on ways to promote the creative uses of ICT through assisted performance, the sharing of ideas and distributed leadership [58][15], which will provide teachers and students the ICT self-efficacy necessary for life long learning.

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