ICT Skills in University Teachers, the Knowledge, Use and Pedagogical Appropriation of These Technologies

Ángela Patricia Manrique Barrera[1(✉)],
Ariel Adolfo Rodríguez Hernández[1],
and Jorge Enrique Otalora Luna[2]

[1] Grupo de Investigación en Tecnología,
Investigación y Ciencia Aplicada (TICA),
Universidad Pedagógica y Tecnológica de Colombia, Tunja, Colombia
{angela.manrique,ariel.rodriguez}@uptc.edu.co
[2] Grupo de Investigación en Software (GIS),
Universidad Pedagógica y Tecnológica de Colombia, Tunja, Colombia
jorge.otalora@uptc.edu.co

Abstract. The main objective of this research work was to identify the ICT skills that teachers have in knowledge use and pedagogical appropriation of these technologies in the educational practice, for a university in the city, Duitama (Boyacá-Colombia), based on a diagnosis made to the teachers of one of their undergraduate programs. The instrument used was a questionnaire designed based on three documents alluding to ICT competencies for teachers, the participants of the study had provision and recognition of the need to have sufficient skills that allow them to appropriate ICT in a didactic way. It is concluded that it is important to provide teachers with spaces that enable them to improve their skills in the digital era, with strategies that train teachers, including ICT in the teaching processes, facilitating students to improve their learning, helping them acquire specific skills that contribute to making them digitally competent, taking into account that they are elements to be taken into account by the university professors, interested in providing a quality education according to the latest development.

Keywords: ICT skills · Teacher training · Training · Educational practice

1 Introduction

Even in the current era of digital endemics, it can be verified that in some contexts the appropriation of ICT can be complicated and create a digital divide by establishing a factor of inequality to the community involved. This leads to reflect on how ICT should be leveraged to be implemented in favour of that community and not against it (Del Vasto 2015). The level of competences of teachers in higher education has been a cause of studied because of its importance for the performance of their work, and especially for its impact on student learning (Valenzuela et al. 2013).

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The importance of the teaching role to the impact of ICT requires constant updating, they must rethink their work and learn to use new means and resources to implement them in the classroom (Arista 2014).

To guide the integration of ICT in teaching practice, some authors such as Mishra and Koehler (2006) propose the concept of TPACK, corresponding to the acronym of the expression "Technological PedAgogical Content Knowledge". Being a model that identifies the types of knowledge that a teacher needs to master the integration of ICT in an effective way in the teaching that imparts.

Some teachers seeking to transform their teaching practices incorporate different ICT within the classroom, but these attempts often fail, because they do not count as indicated by the TPACK model with the pedagogical and technological knowledge needed to integrate ICT pedagogically into the training process (Schmidt et al. 2009 cited by Boude and Sarmiento 2016).

After 30 years of research in the field of integration of Information Technology and Communication (ICT) in education, we understand that ICTs are tools to provide content and implement best educational practices (Rodriguez et al. 2012; Crook 2012; Draxler 2008; Jones 2004; Law and Chow 2008; Losada Iglesias et al. 2012; Wastiau et al. 2013, cited by Melgarejo and Rodríguez 2017).

Depending on how ICT is used, these can generate changes in pedagogical models, as well as new learning concepts and methodologies in teachers and their unification with the educational system, which conceives policies and strategies for training teachers to improve their teaching work and contribute to the improvement of the quality of education (Montero 2010).

According to the research of Melgarejo (2016) who describes seven frameworks, identified as being of an international character. Organizations such as UNESCO and countries such as South Africa, Australia, the United States and the Netherlands, among others, have designed frameworks to establish a reference point for the skills necessary for their effective inclusion, use and appropriation in educational environments (Melgarejo and Rodríguez 2017). Melgarejo (2016), states that each framework clearly conceives different stages of evolution over time, additionally these stages of evolution change their denomination in each framework. However, they can be interrelated as shown in Table 1:

From the list it is important to highlight the Framework designed by UNESCO since it demonstrate how several frameworks take it as a reference for its construction and development, such as that proposed by Colombia, that is ICT Competencies for Professional Development of a Teacher, also the one proposed by ISTE National Standards (USA) of Information and Communication Technologies (ICT).

In this sense, this research has taken up mainly three documents, which are mentioned below:

In January 2008, UNESCO published ICT competency standards for teachers, which seek to serve as a guide to teacher training institutions (training programs). This document sets out the competencies for the development of educational innovation supported by ICT, which are research, technological, pedagogical, communicative and management.

Table 1. Evolution states of the frameworks

Framework	Evolution states			
	Inclusion	Use	Appropriation	
1. UNESCO ICT competency standards for teachers	*Approaches to teaching*			
	Technology literacy	Knowledge deepening	Knowlegde creation	
2. ICT-enhanced teacher standards for Africa	*Stages*			
	Emerging	Applying	Infusing	Transforming
3. ISTE: National Educational Technology Standards for Teachers (NETS-T)	*Rubrics*			
	Beginner	Medium	Expert	Transformer
4. Australia: ICT competency framework for teachers	*Phases*			
	Phases 1	Phases 2	Phases 3	
5. ICT- tools for a balanced use of ICT in the Netherlands	Expertise/Vision			
	Teacher-driven learning	Autonomous learning	Self-organized learning	
7. Competencias TIC para el Desarrollo Profesional Docente	*Levels*			
	Exploration	Integration	Innovation	

Source: Melgarejo (2014).

Finally, the document "ISTE National Standards (USA) of Information and Communication Technologies (ICT) for teachers (2008)" apply the standards, design, implement and evaluate learning experiences to engage students and improve their learning, enrich professional practice and serve as a positive example for students, colleagues and the community.

The previous documents were taken into account for the elaboration of a cross-sectional survey, where the objective was to identify the ICT competences that teachers should possess in the knowledge, use and pedagogical appropriation of these technologies in educational practice, for teachers of undergraduate programs in regional universities of Colombia. A sample was obtained from a faculty of a recognized University in a small populated city, in this case the city selected was Duitama.

This article is structured through five sections. Section 1 introduction; Sect. 2: methodological approach, where the most significant aspects are collected; Sect. 3: compilation of the results of the survey according to the ICT competencies and as a result a proposal to develop ICT competencies for the selected Faculty; Sect. 3: results of the survey applied to the teachers of the Program; Sect. 4: discussion and finally, the Sect. 5: conclusions.

2 Method

The research is a cross-sectional study that followed a methodological approach of quantitative type and a non-experimental design in order to address the research objectives. The data were contrasted through descriptive and correlational studies, the sample is non-probabilistic and followed the accessibility criteria and sample availability. For the collection of information, an instrument was used designed in the Seminar on Teacher Training in ICT within the framework of the academic activities of the Master's Degree in Applied ICT to the Education Sciences in the second semester of 2016. The bibliographical revision was carried out for the construction of the instrument through three main texts that present ICT competencies for teachers:

ICT competencies for teacher professional development of MEN (2013), ISTE National Standards (USA) of Information and Communication Technologies (ICT) for teachers (2008), ICT Competencies Standards for teachers (UNESCO 2008).

The statistics of the use of the virtual platform within the University were reviewed and an Undergraduate Program was chosen that had an average use to which the questionnaire was applied. After the review, the instrument was structured taking the most relevant items from each document, the questionnaire was sent to the twenty (20) teachers of the program, of which 13 were completed. From the total, 8 are men (62%) and 5 women (38%), their range of teaching experience ranges from 1 to 33 years, 69% have master's degree, 16% have specialization degree and 15% doctorate.

The instrument used is composed of 20 questions, through which you can identify the greater or lesser degree of ICT competencies that teachers have in the knowledge, use and pedagogical appropriation of these technologies in educational practice.

The first nine items focus on obtaining accurate information on knowledge, use and attitudes towards the different ICT, compared to the competition, research, technology, pedagogy, communication and management. The next five items seek to highlight the knowledge between the curriculum and the role of the teacher in the program, as a leader in the training of their colleagues and their own professional development through ICT. The last six items allow the analysing of the usefulness that they give in their academic training and in their personal life as research strategies and for answers, the scale based on Likert was applied: Always, Sometimes, Never.

3 Results

Table 2 shows the results of the questionnaire applied to identify the competences in ICT that teachers should possess in the knowledge, use and pedagogical appropriation of these technologies in educational practice. 13 teachers from the Faculty were surveyed. The research revealed figures on the proficiency of teachers in ICT, identifying the areas that require further training for the appropriation of these technologies in the classroom.

Table 2. ICT competencies of teachers.

Document	Item	Questions:	Always	Sometimes	Never
ICT competencies for teacher professional development (MEN 2013)	Investigative competence	1. Do you filter and analyse the information available on the Internet?	77%	15%	8%
	Investigative competence	2. Do you contrast and analyse information from multiple digital sources with your students?	38%	46%	15%
	Investigative competence	3. Do you use the information available on the Internet with a critical and reflective attitude?	69%	23%	8%
	Technological competence	4. Do you design and publish digital content or virtual learning objects through the appropriate use of technology tools?	38%	31%	31%
	Technological competence	5. Do you use technological tools to help your students build meaningful learning and develop critical thinking?	38%	46%	15%
	Pedagogical competence	6. Do you implement ICT-mediated didactic strategies to strengthen your students' learning to solve real-life problems?	38%	46%	15%
	Communicative competence	7. Do you evaluate the relevance of sharing information through public and mass channels, respecting the rules of intellectual property and licensing?	62%	38%	0%
	Communicative competence	8. Do you contribute your knowledge and those of your students to human repositories on the internet, with texts of different nature?	0%	77%	23%
	Management competence	9. Do you raise ICT-related educational policies to make students aware of the good use of information?	23%	54%	23%
ICT competencies standards for teachers UNESCO (2008)	Curriculum	10. Do you pose problems to measure the degree of understanding of students integrating the use of the ICT?	38%	31%	31%
	Pedagogy	11. Do you develop and monitor collaborative projects where students apply their ICT skills?	38%	31%	31%
	ICT	12. Do you use ICT to create and supervise class projects done individually or by group of students?	38%	31%	31%

(*continued*)

Table 2. (*continued*)

Document	Item	Questions:	Always	Sometimes	Never
	Organization and administration	13. Do you play a leadership role in the training of your colleagues, as well as in the development and implementation of the vision of your educational institution, enriched by ICT?	23%	62%	15%
	Teacher professional development	14. Do you participate in any projects with other teachers and experts through the use of networks to access information, in order to support your own professional training?	8%	69%	23%
ISTE national standards (USA) of ICT for teachers (2008) (NETS•T)	Facilitate and inspire students' learning and creativity	15. Do you pose situations involving students in investigating real-life problems and situations, and evaluating solutions using digital tools and resources?	31%	62%	8%
	Design and develop learning experiences and evaluations of the digital age	16. Do you adapt ICT-based materials to individually address student learning styles?	38%	46%	15%
	Model the work and learning characteristic of the digital age	17. Do you explain the use of digital tools in order to support and disseminate research and learning strategies in students?	38%	54%	8%
	Promote and exemplify digital citizenship and responsibility	18. Do you propose activities for students to use communication technology resources to interact with students or experts from other communities and other countries?	23%	54%	23%
	Technological competence	19. Do you create learning activities using applications, content, computer tools and audio-visual media?	38%	54%	8%
		20. Do you use the virtual classroom of the University for the development of your classes?	8%	69%	23%

The research shows that teachers do not use the virtual classroom of the university to support their classes, insufficient use of the repositories on the internet to publish their work and participation is minimal in some projects with other teachers and experts through the use of networks to access to information, in order to support their own professional training.

Considering the results of the proficiency level of teachers in ICT, the following proposal is presented that promotes training actions, both initial and continuous, in order to promote research and innovation skills, application of ICT-based strategies and knowledge to develop didactic proposals according to the disciplinary area or the interdisciplinary component of the academic programs, Table 3 presents the proposal for the training of teachers.

Table 3. Proposal for the development of ICT competencies.

Competencies	Proposal	Activities
Technological competencies	Train teachers in the development of learning activities using applications, content, computer tools and audio-visual media	Propose a course where the teacher learns to develop pedagogical contents from the use of the image, audio and video Contemplate within the courses of educational update a diploma or course on computer tools and content development (blog/web)
	Train teachers in the use of the virtual classroom of the University to support the development of their classes	Schedule trainings for teachers of the Faculty in services and the use of virtual classrooms Develop workshops that allow the knowing of the virtual classroom and the different resources and activities that the platform has
Communicative competencies	Train teachers on the use of repositories of humanity on the Internet, and the importance of publications	Develop a course on the development of scientific texts and the importance of publishing in indexed journals The sectional library can offer training in search in specialized databases Develop workshops focused on collaborative works, where literature on topics of interest is shared through forums
Teacher professional development	Train teachers in the use of networks, in order to support their own professional training and participation with other teachers in the development of projects	Training on information networks, in support of research Design a course with the purpose of disseminating the importance of networks and maintaining updated and interesting topics, e.g. the Trello platform

4 Discussion

The Institutions of Higher Education (Instituciones de Educación Superior – IES) are the entities that count, according to the legal norms, with the official recognition as providers of the public service of higher education in the Colombian territory (MEN 2010). Within the didactic component of the disciplines is the incorporation of pedagogical and didactic criterion with the use of the Information and Communication Technologies (ICT) to its educational processes in its sociocultural context (MEN 2016).

At the national level, a number of research and political actions are currently being promoted to improve the quality of the teacher as an important pillar in national education, thus, studies such as those reviewed by the Fundación Compartir in collaboration with the Universidad del Rosario, Universidad de los Andes and organizations such as the Randa Corporation, point to the teacher as a starting point for educational change. In that sense, it seeks to improve the preparation of teachers of undergraduate and graduate programs (Padilla 2015).

In the University, activities should be proposed for students to use communication technology resources to interact with students or experts from other communities and other countries, as well as to implement ICT-mediated teaching strategies to strengthen students' learning that allows them to solve real life problems. In the research, less than 38% and 23% develop or have a notion of these activities.

As discussed in other research, Cózar-Gutiérrez et al. (2016) states that:

> The technological culture, which has been in all educational processes in a short space of time, conditions the way of teaching and learning, as well as the interpersonal relationships among the members of the educational community. The possibilities offered by ICT today through didactic tools, digital resources and virtual learning environments, allow the creation or selection of specific, more motivating and personalized activities, according to the different ways of learning. Being aware of this fact will, undoubtedly, contribute to improving the quality of teaching within the framework of higher education, providing students with new training possibilities and personal enrichment (p. 114).

Incorporating ICT in university campuses and adding a challenge to teachers is not enough to manage these new technologies and their applications in the area of knowledge of each one, they also require discovering the use and attitude of students towards themselves in order to achieve a correct learning (Cózar-Gutiérrez et al. 2016).

Research such as that of Boude and Sarmiento (2016), show that currently higher education teachers go through a particular moment where the technological skills that students have are superior to those of teachers, as well as, the expectations they have about how their training process should be carried out, the resources that should be used and even the role that their teacher should play in this process (Biggs and Catherine 2011; Laurillard 2013, cited by Boude et al. 2016).

5 Conclusions

Content dominance, pedagogy and technology alone do not respond to effective teaching integrating ICT. It is necessary to have training and experience in the spaces where these components intervene and condition each other. In addition to mastering the content and the teaching/learning strategies, one must also know which technological tools to use and how they can be applied, taking into account that their use can modify the contents and the dynamics of teaching and learning (Posada 2013).

The impact of Information and Communication Technologies (ICT), has an unprecedented due to the contemporary condition of the information society, thus the educational context and more specific pedagogical processes in Institutions of Higher Education (Instituciones de Educación Superior – IES), have been transformed in order to adopt this ubiquitous condition in their curricula and training processes (Padilla 2015).

This work reflects the importance of the technologies in the learning process and evidences the following scenario by faculty teachers, followed by some assessments:

- Lack of training in the use of ICT and in various pedagogical applications that can be included in the classroom, where scenarios that allow various levels of training are facilitated, according to the teacher's knowledge, as there are teachers with basic level of computer science.
- As the university has several sections, teachers argue that the training should be done in the respective sections and not in the headquarters, in order to have a greater reception.
- Not all teachers use the virtual classroom, as they do not know the benefits of sharing information on this platform.
- The trainings must be scheduled in the weeks of Institutional planning, not in person, so that the teachers do not lose classes.
- Improve the capacity of the University channel for the best quality of virtual courses.

Finally, it is significant to know the degree of knowledge and usefulness that university professors have about ICT in their daily lives, even more so when these technologies are immersed daily on social networks, recreational and leisure spaces. The society of the future requires knowledgeable and trained individuals for a good use of ICT, at all personal, academic, work, and social levels.

References

Arista, J.: Tecnologías de la información y la comunicación (TIC) aplicadas a la docencia. Univ. Autón. Estado Hidalgo **1**(2), 8–15 (2014)

Biggs, J., Catherine, T.: Teaching for Quality Learning at University: What the Student Does, p. 357. McGraw-Hill Education, New York (2011)

Boude Figueredo, O.R., Sarmiento, J.: El reto de formar a profesores universitarios para integrar el aprendizaje móvil. Educ. Médica Superior **31**(1), 61–77 (2016)

Crook, C.: The 'digital native' in context: tensions associated with importing Web 2.0 practices into the school setting. Oxf. Rev. Educ. **38**(1), 63–80 (2012)

Cózar-Gutiérrez, R., Moya-Martínez, D., María, V., Hernández-Bravo, J.A., Hernández-Bravo, J. R.: Conocimiento y Uso de las Tecnologías de la Información y las Comunicaciones (TIC) según el Estilo de Aprendizaje de los Futuros Maestros. Form. Universit. **9**(6), 105–118 (2016)

Competencias TIC para el desarrollo profesional docente: Documento elaborado por la Oficina de Innovación Educativa con Uso de Nuevas Tecnologías. Ministerio de Educación Nacional. Primera Edición - Obra Independiente (2013). www.mineducacion.gov.co. ISBN 978-958-750-762-1

Draxler, A.: New Partnerships for EFA: Building on Experience. UNESCO-IIEP (2008)

Estándares Nacionales (EEUU) de Tecnologías de Información y Comunicación (TIC) para docentes (2008)

UNESCO: Estándares de Competencias en TIC para docentes (2008)

Del Vasto, P.H.: Influencia de las tecnologías de información y comunicación (TIC) en el proceso enseñanza-aprendizaje: una mejora de las competencias digitales. Cient. Gen. José María Córdova **13**(16), 121–132 (2015)

Jones, A.: A Review of the Research Literature on Barriers to the Uptake of ICT by Teachers. BECTA recuperado en, London (2004). http://publications.becta.org.uk/display.cfm

Laurillard, D.: Rethinking University Teaching: A Conversational Framework for the Effective Use of Learning Technologies, p. 260. Routledge, Abingdon (2013)

Law, N., Chow, A.: Teacher characteristics, contextual factors, and how these affect the pedagogical use of ICT. In: Law, N., Pelgrum, W.J., Plomp, T. (eds.) Pedagogy and ICT Use in Schools Around the World: Findings from the IEA Sites 2006 Study. CERC, vol. 23, pp. 181–219. Springer, Hong Kong (2008). https://doi.org/10.1007/978-1-4020-8928-2_6

Losada Iglesias, D., Carrera Juarros, I., de Aberasturi Apraiz, E.J.: Factors facilitating successful educational innovation with ICT in schools **17**(1), 113–134 (2012)

Melgarejo, V.: Indicators for monitoring and evaluation of ICT for education: a systematic review. In: 16th Congress of the World Organization of Systems and Cybernetics, WOSC 2014, pp. 117–127. University of Ibagué, Ibagué (2014)

Melgarejo, V.: Esquema de evaluación y monitoreo del estado de inclusión, uso y apropiación de las tic para la educación en las instituciones educativas públicas del municipio de Tunja. (Tesis de Maestría). Universidad Pedagógica y Tecnológica de Colombia, Tunja, Colombia (2016)

Melgarejo, V., Rodríguez, A.: Modelo integral de monitoreo y evaluación para inclusión, uso y apropiación de TIC en educación. Rev. Salud Histor. Sanid. On-Line **10**(3), 60–79 (2015)

Ministerio de Educación Nacional: Instituciones de Educación Superior (2010). https://www.mineducacion.gov.co/portal/Educacion-superior/Sistema-de-Educacion-Superior/231240:Instituciones-de-Educacion-Superior. Accessed 01 Nov 2017

Ministerio de Educación Nacional: Lineamientos de calidad para las Licenciaturas en educación (versión preliminar) (2014). http://www.mineducacion.gov.co/1759/articles-357233_recurso_1.pdf. Accessed 04 Nov 2017

Ministerio de Educación Nacional: Resolución 2041 "Por la cual se establecen las características específicas de calidad de los programas de Licenciatura para la obtención, renovación o modificación del registro calificado" (2016). http://www.mineducacion.gov.co/1759/articles-356982_recurso_1.pdf. Accessed 06 Nov 2017

Mishra, P., Koehler, M.: Technological pedagogical content knowledge: a framework for teacher knowledge. Teach. Coll. Rec. **108**(6), 1017–1054 (2006)

Montero, O.: Estrategia para la introducción de las Tecnologías de la Información y las Comunicaciones. Rev. Latinoam. Tecnol. Educ. **9**(1) (2010)

Padilla, J.: Formación Pedagógica e Investigativa en Tecnologías del Aprendizaje y el Conocimiento para Licenciaturas en Proceso de Acreditación. Universidad Militar Nueva Granada, Cajicá (2015). (Proyecto de Investigación Científica)

Posada, F.: El modelo TPACK (Mensaje en un blog) (2013). https://canaltic.com/blog/?p=1677. Accessed 21 Feb 2018

Rodríguez, P., Nussbaum, M., Dombrovskaia, L.: ICT for education programme: a conceptual framework for the sustainable adoption of technology-enhanced learning environments in schools. Technol. Pedag. Educ. **21**(3), 291–315 (2012)

Schmidt, D., Baran, E., Thompson, A., Mishra, P., Koehler, M., Shin, T.: Technological pedagogical content knowledge (TPACK) the development and validation of an assessment instrument for preservice teachers. J. Res. Technol. Educ. **42**(2), 123–149 (2009)

Valenzuela, B., Guillén, M., Campa, R., Jaime, M., López, M.D.: Evaluación de las competencias docentes del profesorado de la Universidad de Sonora, México. Eur. Sci. J. **9** (2), 55–64 (2013)

Wastiau, P., Blamire, R., Kearney, C., Quittre, V., Van de Gaer, E., Monseur, C.: The use of ICT in education: a survey of schools in Europe. Eur. J. Educ. **48**(1), 11–27 (2013)