Integration of ICT into the higher education process: The case of Colombia

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ABSTRACT

This paper has as its aim to establish a pedagogical strategy aimed at supporting the integration of ICTs (Information and Communication Technologies) into the higher education process. A survey was carried out aiming focus on the analysis of teachers' practices so that competences in ICT use at university education in Colombia could be enlarged. 81 universities answered the survey questionnaire: 51 private and 30 public, and a total of 423 lecturers from different academic disciplines. Our findings show the degree of attention paid by teachers to strengthening ICT skills in their training tasks. This research is complemented with Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis performed with 50 professionals experienced in ICT use in higher education.

Introduction

Demands in the field of education as a whole, and more precisely in university education, are increasingly high because social development largely depends on education. In this respect, ICTs play an essential role in the mediation of the teaching-learning process to conceive the future. For example, in relationship with entrepreneurial careers, Garrido, Hilton, Cagle, and Wright (2018), Schenkel, D'Souza, Cornwall, and Matthews (2015), and Smith, Sardeshmukh, and Syed (2019) recognized this. At the same time, as highlighted by Hilty and Huber (2018), and Zane, Yamada, and Kurokawa (2014), ICT constitutes an example of a transformational and to a certain extent disruptive technology.

Concerning lecturers' perception profiles, they can be categorized into two according to Riascos, Quintero, and Ávila (2009); those who are reluctant to use ICTs as an innovative strategy under the excuse that the methods which they have utilized for so long have worked well; and those willing to adopt the role of an innovative lecturer seeking to improve the teaching-learning process. The new demands make it necessary to train lecturers so that they can reflect on technological contents, their use in teacher training, and the advantages that it brings (Soto, Serna & Neira, 2009). The OIS (2010) points out that, despite the great efforts made in aspects linked to training and raising awareness about teachers' roles, those efforts are still insufficient, since they have mostly focused on providing lecturers with the basic notions needed to make an instrumental use of ICTs, neglecting the training aimed to achieve the skills required for the joint utilization of innovative didactic methodologies and sophisticated ICTs through which teachers can apply such methodologies to real world problems in their university classrooms. So much so that the project la Ciencia y la Cultura (OEI) (2010) states that training teachers in the skills needed to teach the new generations perhaps constitutes the most important dimension when it comes to generating educational change.

For Gascó and Melo (2017), ICT incorporation into educational systems has required modifications in their projects, to such an extent that they eventually rethought the goal and feasibility of different means, available resources, and relevant infrastructures. This comes as no surprise either, considering —as highlighted by Alhabeeb and Rowley (2018) too— that the way in which students and students approach these themes usually differs.

In turn, Nakano, Morla, Garret, Vásquez, and Lozada (2012) see ICTs as a valuable tool for the educational community which has been validated in terms of both mass media and communication equipment and regarding programs and new solutions for users.

Therefore, skills are arguably fundamental to teach about context and culture diversity, to help students join the knowledge society, and to ensure the existence of multicultural and solidarity-oriented citizens.

Thus, Lion (2012) points out that digital competence refers to the specific use of knowledge, capabilities, and skills associated with the development of elements and processes which allow for an effective, efficient, and innovative use of technological instruments and resources. Garrido et al. (2918), Prado, Quintanilla and Pérez (2017), and Digan, Kerrick, Cumberland, and Garret, (2017), also sustained this.

As for Colombia, the studies carried out by Barrera, Hernández, and Luna (2018) and Lugo (2010) describe it as a country which finds itself at an integration stage, and where universities not only have technological resources at their disposal but have also started working on professional teacher training and the integration of ICTs both into education and into the teaching-training process.

The design of a strategic pedagogical methodology makes it possible to integrate ICTs into Colombian higher education, in accordance with the ideas provided by Cabero (2015). Integrating ICTs into higher education implies using them as a tool which facilitates learning as well as the dissemination of knowledge, thus permitting to reach the goal of learning in a more significant and excellent way.

It deserves to be mentioned that, according to a study undertaken by Jara, Claro and Martinic (2012), ICTs can favor universal access to education, equality in instruction, the exercise of teaching, and quality learning, including therein teachers' professional development, additionally stressing the perspective oriented to achieve a more efficient educational system management and administration. In this sense, these technologies have helped lecturers enrich their pedagogy and didactics to establish novel exchanges with other lecturers dedicated to the same discipline and even with others who work in different disciplines, ultimately seeking to build collaborative links of a multidisciplinary nature.

Delving deeper into the specific case of Colombia, the Ministerio de Educación Nacional (2013) [Ministry of National Education 2013] explains in the document entitled *"Competencias ICT para el Desarrollo Profesional Docente"* [ICT Skills for Professional Teacher Development] that the existence of a regulatory framework together with other antecedents have made it possible to define essential conditions to strengthen educational innovation policies. That is how the link generated around ICTs, their pedagogical use, and the teacher's skills in this regard, permit to update the classical practices in terms of knowledge transmission. The availability of skills, the essence that underpins the importance of ICTs, requires a systematization effort not only for their diagnosis, intervention, impacts and actions but also for their proper assessment, use, and implementation.

From this perspective, Hernández, Gamboa and Ayala (2014) conclude that a national policy framework for the integration of ICTs into the educational system devised by different public and private institutions must reach students, teachers, and executives/managers/administrators of educational institutions. The words of Cabero (2015, p. 23) in this respect sound quite sensible: "Making ICTs become part of higher education implies their utilization as instruments that help facilitate learning and knowledge dissemination, thus permitting to achieve the goal of learning in a more significant and excellent manner."

In the light of the above, one can say that the suitable use of ICTs for universities arises as a necessary strategy, because they would not only be developing technical and economic resources but also jointly empowering their lecturers, managing to have competent and qualified professionals who fulfill the present-day requirements. According to Rangel (2015), digital teaching skills entail an effective performance based on mobilizing resources of a technological, informational, pedagogical, and communicative nature.

It must be additionally recognized that ICT incorporation into educational systems has required modifications in their projects, even rethinking the aims and viability of using various means, available resources, and relevant infrastructures.

In the opinion of González (2016), the training of an ICT lecturer necessarily involves an organization of contents, an arrangement of educational activities, forms of interaction and communication, as well as constructive evaluation mechanisms. It consequently becomes essential to ensure teacher training following the standards contained in the three approaches to educational change, basic ICT notions, knowledge deepening, and knowledge generation.

Technologies offer multiple chances for the generation of new learning experiences. As many as different variables may influence the design of the educational situation (Mirete, 2016).

We can therefore state, on the basis of the paper written by Lion (2012), that digital competences refer to the specific use of knowledge, capabilities, and skills related to the development of elements and processes thanks to which technical tools and resources can be effectively, efficiently, and innovatively developed.

In view of all the above, this paper has as its aim to carry out a quantitative and qualitative analysis of ICT integration within the context of higher education in Colombia that can serve as the basis for a methodological strategy to achieve that goal.

Method

Seeking to know the state of the art concerning ICT presence in Colombian university teaching, a decision was made to implement a descriptive type of methodology with a qualitative and quantitative study, taking as our primary sources: (a) a survey administered via Google Drive in September 2016 amongst lecturers of small-, medium- and large-sized private and public universities (classified by the Colombian Ministry of National Education) and located in the six natural regions of Colombia, namely: Amazónica; Andina; Caribe; Insular; Orinoquía; and Pacífica; and (b) focused personal interviews via phone to experts in ICT use in higher education: teachers, pedagogues, social communicators with experience in ICT, and systems engineers that were in charge of ICT departments in higher education institutions. The information provided by university websites also served as a secondary source, drawing a comparison between Colombia's Ministry of National Education proposals and the real extent of ICT implementation and use.

A total of 81 Colombian universities (50 private and 31 public) voluntarily took part in the study, with 423 teachers from a variety of disciplines (art and humanities, social and legal sciences, health sciences, engineering, economic and business sciences, and basic sciences). In regards to interviews, we selected 50 professionals characterized by their knowledge and experience in ICT use within higher education environments.

Pursuant to the law, Higher Education Institutions are the entities which enjoy official recognition as the deliverers of the higher education public service throughout the Colombian territory (Law 30 of 1992). Their classification depends on their academic nature and their legal status.

Academic nature appears as the main feature in the constitution (creation) of a Higher Education Institution. It defines and provides the identity in terms of competence (field of action) that gives it academic power to offer and develop higher education programs in one training modality or another. They may adopt a wide range of formats in Colombia: Professional Technical Institutions; Technological Institutions; University Centers; or Technological Schools and Universities.

Legal status defines the most important characteristics that statutorily and administratively distinguish one legal person from another, and it has to do with the origin of its creation. That is how, based on the latter aspect, Higher Education Institutions are private (non-profit, corporations, foundations or solidarity-oriented economy institutions) or public (public establishments and autonomous university entities).

The data collection used two instruments:

a) Questionnaire

Its design was based on the consultation of works which combined ICTs and higher education, such as those by Durán (2014), and Suárez, Almerich, Gallardo, and Aliaga (2013). Attention was also paid to other studies dedicated to the preparation of questionnaires meant to assess lecturers' ICT use skills in education, including those authored by Fernández, Fernández and Cebreiro (2016) and Rangel (2015).

Another important reference to build the questionnaire came from the document published by the Colombian Ministry of National Education (2013) which defines technological competence within the educational context as the capacity to relevantly, responsibly, and efficiently select and utilize a variety of technological tools, understanding the principles by which they are governed, the way to combine them, and the licenses which protect them. Three dimensions are identified for them:

- Exploratory: it identifies the characteristics, uses, and opportunities that technological and audiovisual tools offer in educational processes.
- Integrative: it combines a wide range of technological tools to improve educational practice planning and implementation.
- Innovative: it uses complex or specialized technological tools to design virtual learning environments that favor the development of skills amongst students along with the creation of learning communities and/or networks.

Our intention is to use these dimensions to identify the activities that teachers develop to strengthen their technological skills when it comes to ICT use and integration within the higher education context. And likewise, to find the differences in relation to general and personal aspects of participants concerning their professional tasks and the extent to which they use each one of the questionnaire items.

From the above, and for questionnaire validation purposes, a trial instrument was created for its accreditation by lecturers and pedagogues from different disciplines, and systems engineers dedicated to the ICT use in higher education, from 15 Colombian universities. This made it possible

to introduce the suitable correction and to refine the final questionnaire with close-ended items categorized as dichotomous, order-related, and scale-based that facilitate both systematization and a relevant statistical analysis.

b) Interviews with experts

In accordance with the descriptions provided by Froschauer and Leitrer (2009), and Gonzach, Kluger and Klayman (2006), this kind of interview focuses on the interviewee's relevant knowledge and experience about a specific text. The preparation of the interview starts with a list of the most important aspects to be known in connection with the research aims and the interviewee's profiles. Fifty knowledgeable and experienced ICT professionals working in Higher Education were selected, including: Teachers; Social Communicators; and Systems Engineers in charge of ICT higher education departments linked to small-, medium- and large-sized public and private Colombian universities.

The answers obtained in the interviews were compared to those received about the same topic through the questionnaire administered to teachers.

Results and Discussion

As previously explained, the survey questionnaire was completed by lecturers from small-, medium- and large-sized private and public universities located in the six natural regions of Colombia —Amazónica; Andina; Caribe; Insular; Orinoquía; and Pacífica. The participants belonged to 81 Colombian universities (50 private and 31 public) and comprised 423 lecturers from different disciplines (art and humanities, social and legal sciences, health sciences, engineering, economic and business sciences, and basic sciences).

The Statistical Package for Social Sciences (SPSS), version 20, served to analyze the results obtained for the purpose of identifying the practices followed by teachers to improve their skills in the use of ICTs as a pedagogical support instrument.

As shown in Table 1, 81 universities from Colombia's six (6) geographical regions took part in the survey: 50 = 61.7% private and 31 = 38.3% public. The highest concentration corresponds to the Andina region with 42 = 68.9% private and 19 = 31.1% public —which can be explained because this region is the most populated in Colombia and comprises cities that have a large number of higher education centers.

Table 2 provides a descriptive analysis of the different variables which characterize both the higher education centers and the lecturers that completed the survey, such as, sex, age, type of university, university size, teaching category, scientific level and teaching experience.

One can check a higher participation of men (56.9%) and of under-45s (61.23%). Private universities account for

Table 1

*Interviewed universities by Colombian geographical region*s

Geographical regions	Private Univ.	Public Univ.
Amazónica: Caquetá, Putumayo, Guainía, Guaviare, Amazonas, and Vaupés	0	2
Andina: Cundinamarca, Caldas, Quindío, Antioquia, Tolima, Huila, Boyacá, Santander, Norte de Santander, Risaralda, and Córdoba	42	19
Caribe: Guajira, Magdalena, Atlántico, Córdoba, Bolívar Cesar, and Sucre	4	4
Orinoquía: Arauca, Vichada, Meta, and Casanare	0	2
Pacífica: Chocó, Nariño, Cauca, and Valle del Cauca	4	4
Insular: San Andrés Archipelago in the Atlantic Ocean, and the Malpelo and Gorgona Islands in the Pacific Ocean	0	0
Total of Universities	**50**	**31**

56.7%, large ones reach 53.43%, those with a permanent link as staff amount to 54.37%, master's degrees/technical schools account for 56.50% and those with less than 15 years' experience represent 65.96%. This last finding is in tune with the study by Gyaase, Gyamfi and Kuranchie (2019), where these authors conclude that ICT integration implies that teachers must own the skills and experience required to use them efficiently.

As for gender, the research carried out by Ntuli (2018) did not detect any differences in terms of being prone to use ICTs, an aspect that we have also checked in our study.

In turn, Valtonen, Kikkonen, Kontkanen, Makitalo, and Sointu (2018) paid attention to university lecturers' age and came to the conclusion that newly-arrived lecturers and younger ones were more likely to utilize ICTs.

Within the survey, interviewees were asked about ICT implementation and frequency of use through the following

Table 2
Teachers' general and personal aspects

Sex	Men	%	Women	%										Total
	241	56.97	182	43.03										423
Age	**<45**	**%**	**>45**	**%**										**Total**
	259	61.23	164	38.77										423
Type of University	**Private**	**%**	**Public**	**%**										**Total**
	240	56.74	183	43.26										423
University Size	**Small**	**%**	**Medium**	**%**	**Large**	**%**								**Total**
	101	23.88	96	22.70	226	53.43								423
Teacher's Type of Relationship	**Chair**	**%**	**Occasional**	**%**	**Staff**	**%**								**Total**
	125	29.55	68	16.08	230	54.37								423
Educational Level	**Under-graduate**	**%**	**Specialist**	**%**	**Master's Degree**	**%**	**Docto-rate**	**%**	**Post-doctorate**	**%**				**Total**
	34	8.04	81	19.15	239	56.50	65	15.37	4	0.95				423
Teaching Experience	**<15**	**%**	**>15**	**%**										**Total**
	279	65.96	144	34.04										423

question:

When selecting an ICT resource for the virtual classroom, what degree of importance do you give to the factors listed below according to the following scale, 1 (not important at all), 2 (hardly important), 3 (important) and 4 (very important)?

1. Teachers' knowledge about the use of the resource
2. Time devoted by teachers to using the resources
3. Professional and scientific importance
4. Technological and didactic innovation
5. Accessibility for all students

The data used to perform the descriptive analysis by ICT implementation and frequency of use can be seen in Table 3 and have a mean close to 3.44. The data with the highest score correspond to accessibility for all students ($M = 3.27$, $SD = 0.621$), as opposed to those referred to technological and didactic innovation, the data of which show the lowest scores ($M = 3.69$, $SD = 0.520$).

Table 3 reveals that, when it comes to standard deviation, most data take values from 0.520 onwards but never exceed 0.627, which leads to infer that the values collected are not so far from the averages corresponding to the main variables.

Table 3
Descriptive analysis by ICT implementation and frequency of use

Component	No. of Interv.	*M*	*SD*
Knowledge about the use of the resource	423	3.47	0.603
Time devoted to using the resources	423	3.33	0.627
Accessibility for all students	423	3.27	0.621
Professional and scientific importance	423	3.43	0.600
Technological and didactic innovation	423	3.69	0.520

A factor analysis about ICT implementation and frequency of use can be found in Table 4 below.

The Kaiser-Meyer-Olkin (KMO) test value in Table 4 —0.701— allows us to accept the analysis as being satisfactory.

Table 4

Validity of the ICT implementation and frequency of use factors

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy		0.701
Bartlett's Sphericity Test	Approx. Chi-square	527.510
	Freedom degrees	10
	Significance	0.000

The components in Table 5 tend to provide better explanations for the answers given to this question: When selecting an ICT resource, what degree of importance do you give to the following factors? In this case referred to ICT implementation and frequency of use, it is the values for the rotation sum of squared loadings that tell us how the components "knowledge about the use of the resource" and "time devoted to using the resources" are the ones which best describe the problem jointly accounting for 70% of all components.

Table 6 shows the rotated factor matrix. In the component referred to as "direct operational applicability" stand out the aspects of knowledge, time, and student accessibil-

Table 5

Analysis by components for ICT implementation and frequency of use

Component	Initial Eigenvalues			Rotation Sum of Square Loadings			Rotation Sum of Square Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
Knowledge about the use of the resource	2.487	49.742	49.742	2.487	49.742	49.742	1.950	38.994	38.994
Time devoted to using the resources	1.015	20.310	70.052	1.015	20.310	70.052	1.553	31.058	70.052
Professional and scientific importance	0.691	13.821	83.873						
Technological and didactic innovation	0.414	8.273	92.146						
Accessibility for all students	0.393	7.854	100.000						

ity, which entails being able to utilize ICTs immediately — because they own the technical knowledge required for that purpose— to do it in a reasonably time-efficient way, and to place them at the disposal of students. These aspects were also detected by Islam, Mok, Gu, Spector, and Hai-Leng (2019) in Malaysian universities and by Sang, Liang, Chai, Dong, and Tsai (2018) in Chinese ones.

As for the second component, that we termed as "strategic relevance," one can easily see professional and scientific importance along with technological and didactic innovation, grouping them together in a strategic aspect when dealing with ICT implementation use. Unlike what happened in the first component, immediacy does not prevail here; it is actually the innovative nature (both techno-

logically and didactically) as well as the scientific, academic, and professional relevance that matter most. A similar line of argument is followed by Reyes, Reading, Doyle, and Gregory (2017).

In short, two teacher typologies appear depending on whether we pursue an immediate applicability of ICTs or rather their consolidation as a key strategic element in teaching and learning relationships.

With regard to this, the proposal made by Khoo (2019) to additionally check employers' views about ICT requirements would also be relevant for these issues not to rely exclusively on what lecturers think but also on market needs.

In parallel, the research undertaken by Buabeng-Andoh, Yaokumah and Tarhini (2019) verified the absence of

Table 6

Rotated factor matrix for ICT implementation and frequency of use

Factor	Component	
	Direct Operational Applicability	Strategic Relevance
Knowledge about the use of the resource	0.858	0.088
Time devoted to using the resources	0.824	0.153
Accessibility for all students	0.637	0.272
Professional and scientific importance	0.059	0.903
Technological and didactic innovation	0.353	0.795

significant differences between teachers' behavior concerning ICTs in western countries compared to others.

There are some studies, amongst them that authored by Cubeles and Riu (2018), in which it is even stated that universities' investments in ICTs have a clearly incremental nature within teaching and learning processes, although their effective results are not so evident.

On the contrary, Aboudahr, Mohamed and Musiban (2018) actually reach the conclusion that a direct relationship exists between the investment made in ICTs for university teaching and learning purposes and students' academic performance.

With a view to complete our work, Table 7 reproduces the SWOT analysis with its most important findings, so that the reader can understand the perception of the 50 interviewees about teaching practices aimed to enlarge ICT use skills.

It follows from this SWOT analysis that the availability of teachers specialized in ICT areas together with the fact that a considerable offer of applicable technologies already exists stand out as strengths. As for weaknesses, it is worth highlighting that teachers can choose whether to implement and use ICTs or not —and they do not necessarily have to adapt to this new reality. An outstanding opportunity lies in the fact that ICTs favor the exchange of experiences as well as the participation in professional and teaching networks. Finally, teachers' reluctance and aversion to change deserve to be highlighted as threats for the implementation of new ICTs.

Conclusions

The results obtained in the interview tell us that the threats for ICT implementation and frequency of use can be found in such aspects as the vertiginous technological advances which make new tools available to us every day

Table 7

SWOT analysis

Weaknesses	Strengths
Lack of teaching practice in ICTs. Not enough time to use ICTs. Teachers are the decision-makers when it comes to ICT implementation and frequency of use.	Some teachers are experts in the field of ICTs and use them to broaden their ICT use skills. Many valuable resources are currently available on the Net; it is up to the lecturer to use them, since many applications and software programs are free. It becomes necessary to adopt a strategic approach to work in technologies that are essential for pedagogical and academic tasks and not according to cutting-edge technology.

Threats	Opportunities
Many teachers are reluctant to use technologies, whether because they do not like those technologies or because they lack the proper training. ICT use has improved lately, but a much stronger commitment of teachers is needed. Frequency of use is relative, even though it must be permanent in the interviewee's opinion.	Constant exploration in new technologies. Remaining up to date in teaching practices and competences related to ICT use becomes fundamental. Some lecturers are motivated to use ICTs. ICTs act as tools for the exchange of experiences and the participation in professional or teaching networks.

and the time needed by the institution to be able to acquire and update such ICT devices in a more versatile and pertinent way.

Two teacher typologies appear based on the outcomes of the factor analysis performed, depending on whether one seeks immediate ICT applicability or rather the consolidation of ICTs as a key strategic element when it comes to teaching and learning relationships.

All in all, it turns out that the financial investments made by institutions should especially focus on the availability of technological equipment, leaving aside the coverage and adoption of ICTs by the whole academic population. The idea is to try and implement them gradually, beginning with the most prone teachers (because they are not only knowledgeable in ICT skills but also motivated to utilize them).

It also becomes relevant to design and provide permanent, ongoing training in ICTs and their implementation in the educational context. This is a scenario that requires a co-responsibility of all the actors involved in the training process: teachers, students, managers, and academic support staff.

In view of all the above, and taking into account both the survey performed and the SWOT analysis, we can say that the experiences described have not only proved that it is important to lay emphasis on the technical use of devices or applications or on teaching lecturers about that, but also that it becomes essential to ensure that lecturers can understand and later consciously exploit the real possibilities of interrelating —and consistently using— ICTs on the basis of an improved pedagogy.

We can thus summarize that this is a process which permits to efficiently construct knowledge within the framework of pedagogy —where ICTs come to form part of the didactic action. Proper ICT use appears as an essential strategy for universities, since they would not only be enhancing technical and economic resources but also jointly developing their teachers in an overall manner. The positive outcome would be the availability of competent, well-trained professionals able to face the present-day requirements.

The improvement of these teaching practices related to ICT use will be possible through training and a planned and oriented updating of visual and interactive activities.

Lecturers need to be digitally competent in order to cope with their pedagogic work, taking advantage of an ICT mediation suited to students' skills. This will only be feasible if training centers have the necessary resources and technology. Institutional success depends on a well-trained human capital.

As for future research lines, it is worth highlighting the possibility to apply a longitudinal study that will make it possible over time to compare the findings of this paper with those that may be eventually obtained after a significant period of time has elapsed.

The comparison of the results obtained in Colombia with other countries —especially those situated in nearby geographical regions— constitutes another future research line which seems worth developing.

Checking employers' opinion about the use of ICTs in university learning could also be an interesting research aim for subsequent works.

As for the limitations faced in this paper, it must be recognized that, although the number of surveys administered is significant, more responses would have probably reinforced the conclusions drawn. This same argument applies to the number of interviews.

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