# A Framework for ICT Usage Classification of Higher Education Institutions

*Completed Research*

**Guillermo Rodríguez-Abitia**
Universidad Nacional Autónoma de México
grdrz@unam.mx

**Marina Kriscautzky-Laxague**
Universidad Nacional Autónoma de México
mkriscau@unam.mx

## Abstract

Information and Communication Technology (ICT) usage in educational institutions has undergone a significant evolution from its inception to the present time. ICTs have moved from simply facilitating administrative tasks to being an important aid for class management, and then on to becoming an important part of the learning process itself. Nonetheless, undergoing a heavy investment on technology does not deliver the desired outcomes on students' performance automatically. It is important to ensure that the ICT deployment objective is a good fit with the adopting institution. This paper aims at identifying the aspects that are relevant in the adoption of ICT in higher education institutions, both from the technology, and the educational points of view. Furthermore, a classification framework is proposed to map the current status of any school and understand the nature of the adoption inhibitors, whether they are environmental or intentional. Several groups are defined, as well as described.

**Keywords**

ICT usage, higher education, classification framework.

## Introduction

The evolution of the application of ICT in educational institutions has been complex and it has undergone several paths, depending on particularities of each context. Thus, factors like educational level and intention, accessibility to technology, digital fluency of teachers and students, and many others can be considered candidates to explain the level and nature of ICT adoption. However, institutions often make big investments in technology with unclear results, yet a great demand for ICT application to foster learning lingers (Buabeng-Andoh, 2012). Therefore it is paramount to learn the path for effective ICT usage, in alignment with the educational objectives and strategies of the school. Creating systems to enable the faculty's quest to adopt and use ICT in the teaching and learning processes is of great relevance by University administrators (Keengwe, Kidd & Kyei-Blankson, 2009).

Our aim is to review the ways into which many higher-education institutions have undertaken the challenge of ICT adoption and its application to the educational process, in order to shed light about the different factors that influence the choice and availability of ICT usage. For that, we undertook a qualitative study, observing universities of all sizes and natures, across 7 countries.

The following section makes and review of the relevant existing body of knowledge that guided the observation principles applied to the study. Next, we describe our methodology, consisting on several stages, as well as a description of the instruments created, and of how data was analyzed.

Furthermore, we present the results of the interpretation of the data collected, and a discussion of their potential implications for higher-education institutions, potentially allowing them to identify where they stand, and what needs to be addressed to fulfill their ICT for education vision, based on a classification framework that is proposed. Finally, we address the study limitations and suggest directions for future research.

# Literature Review

The use of ICT to support educational purposes has evolved enormously in the past decades, varying significantly in the scope and orientation of the ICT implementation effort. Education technology is defined by Wendler, Stumpf-Wollersheim, and Welper (2017, p.1) as "...the use of any technology to facilitate learning and to improve the performance of students in higher education". Koh and Lim (2006), undertook a general review of the use of ICT in education, describing that the first applications were directly related to video production and class transmission via television channels. They also mention that then the micro-computers came to be, allowing the generation of specific applications for what was then known as computer-aided instruction (CAI). Such applications were mainly complements to support traditional teaching. The advent of the Internet and web technologies, as well as virtual reality, provided benefits of greater potential, and open a great number of possibilities never imagined before, like higher-end learning, problem resolution, creativity, and the development of integrated skills. In a similar manner, the use of online education was promoted greatly. Omarova & Ivanova (2016) affirm that modern education systems are largely based on information-based environments, which in turn use emerging information technologies to solve pedagogical problems.

In the Education field's body of knowledge, a majority of the work that deals with the integration of ICT in schools, does it from the basic education standpoint. However, the general guidelines published by organizations like United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Organization of Ibero-American States (OEI), constitute valid referential points for higher education. Thus, we draw from the studies published by the UNESCO, the OEI, and the Organization for Economic Co-Operation and Development (OECD), as well as from the standards set by the International Society for Technology in Education (ISTE), and the Ministries of Education of Chile and Colombia, to gain perspective in the identification of the important dimensions for an effective integration of technology in a higher education environment.

It is important to recognize that higher-education institutions have particular conditions and characteristics that require attention, and differentiate them in nature from those of basic education. The educational objectives, for instance, are very different, since higher-education thrives to build work competencies, whereas basic education attempts to build a knowledge foundation for later use. Thus, the type of technology devices and applications required for higher education is normally much more complex and specialized than what is required for basic education. Additionally, some universities have a strong research component, requiring an ICT infrastructure different to what is used for teaching purposes. Hence, we reviewed studies that were directly related to such schools, standing out a study about the state of ICT in Mexican higher-education institutions (Ponce López, 2016), derived from the UniversiTIC study that has been undertaken but the Council of Rectors of Spanish Universities (CRUE) since 2006. This study emphasizes the importance for universities to count on a governance and management model for ICT.

## *ICT Usage Perspectives*

From the referenced works, we defined two main axis that reflected two different perspectives for the subject under study: the first one was the technological, and referred to all the factors that lead to an optimum ICT infrastructure, governance, management, and leverage; the second one referred to the pedagogical or educational perspective, relating especially to three factors, that were professors, curriculum, and educational resources. The existence of these two perspectives or axis is paramount and very recognized in the literature review, particularly by OEI (2010).

It is important to recognize, however, that there are positions that state that technology trends, such as bring-your-own-device (BYOD), will be able to overcome access and skills limitations (Adhikari, Mathrani, Scogins & Sofat, 2017). Nonetheless, we believe access and skills are unavoidable requirements for technology trends diffusion and for digital literacy (Oye, Iahad & Rabin, 2011).

## *Technological Axis*

One of the main determinants of ICT integration in schools is the type and quality of technological infrastructure in place in each institution. Without an appropriate infrastructure available, ICT

integration is impossible (OECD, 2016; CEPAL, 2013; ENLACES, 2013; OEI, 2011; OEI, 2010; UNESCO, 2009; Chigona & Chigona, 2010; Oye, Iahad & Rabin, 2011). We define infrastructure as the computing and networking services available for academic, and academic administration activities realized by professors, researchers, and students.

Within the technological axis we also defined the institutional commitment with ICT as a fundamental dimension based on the management and governance of ICT, visible in the planning and allocation of computing and networking resources, and based on academic needs. This dimension includes the presence of an institutional development plan that comprises ICT as a substantial part of institutional improvement (Ponce López, 2016), as well as the establishment of ICT units that manage ICT, also with the explicit reference to educational models that guide the integration of technology in each institution (OEI, 2011).

Table 1 provides detail on the components that comprise each one of the dimensions within the technological axis.

| Dimension | Institutional Commitment with ICT | ICT Infrastructure |
|---|---|---|
| Components | • A plan exists for the integration of ICT in academic and administrative activities<br>• The plan has evaluation mechanisms<br>• A plan exists for integrating ICT in the teaching process<br>• An organizational unit exists for undertaking the plan<br>• If there is no plan: There are certain initiatives, and activities for integration ICT with educational models<br>• There is an online educational offering, and inhibitors and promoters have been identified | • WiFi is available for students and professors<br>• Wired connectivity is available for students and professors<br>• Nature of classroom equipment available<br>• Availability of spaces where students can work with computers<br>• Loan system of computing devices<br>• Online and other ICT services (LMS, administrative tasks, institutional personal pages, institutional e-mail) |

**Table 1. Technological Axis Components**

## *Pedagogical Axis*

Along with the availability of ICT, other factors are deemed crucial for a successful integration of technology in education, related mainly to the attitudes of people. The level of usefulness of an information system for daily, strategic and decision-making activities is a function of the closeness of the relationship between people and technology (Nolasco Vázquez & Ojeda Ramirez, 2016). The human factor is, to a great extent, responsible for the degree of technological integration. Some believe that the sole level of digital literacy has a direct effect on self-regulated learning by the students (Perera & Gardner, 2017). Such new outcomes in behavior cannot be ignored, and should be capitalized.

To approach this issue we identified key components that are of vital importance, such as students, professors, curriculum design, and digital educational resources. From these components, perhaps the most important is the formation of skills in the faculty to apply technology creatively, providing significant learning environments (ISTE, 2017; Ramírez Martinell & Casillas, 2017; INTEF, 2017; UNESCO, 2013; Ministerio de Educación Nacional de Colombia, 2013; OEI, 2011; OEI, 2010; Chigona & Chigona, 2010).

Oye, Iahad & Rabin (2011) assert that, without the proper access to, and training on the target technology, adoption by professors will be low, regardless of being or not mandatory, and they recommend making training mandatory itself.

The components that comprise the three dimensions within the pedagogical axis are presented in table 2.

| Dimension | Faculty Formation | ICT Curricular Integration | Digital Educational Resources |
|---|---|---|---|
| Components | • Programs and projects are in place for developing ICT skills in faculty members<br>• An organizational unit exists for that purpose<br>• Diagnostic instruments exist for identifying the faculty profiles related to their use and domain of ICT<br>• Challenges for ICT integration for teaching | • A virtual campus or platform for course delivery exists<br>• ICT are explicitly integrated in the curriculum<br>• ICT are used for teaching activities in blended or distance models<br>• Diagnostic instruments are in place for identifying students' ICT skills | • Initiatives are in place for the development of Open Educational Resources (OER)<br>• An organizational unit exists that is responsible for developing educational resources<br>• Nature of the digital educational resources used<br>• Existence of repositories |

**Table 2. Pedagogical Axis Components**

## Methodology

Based on a thorough review of literature, both for research and practitioners' publications, as well as information published in relevant organizational websites, the main trends on the application of ICTs for educational purposes were identified. These trends were classified into dimensions, which were in turn validated by the research team members by iterations of focus groups. Thus, an interview and observation guide was developed to be applied directly on the field.

A strategic sample of universities, from different countries, mainly in Latin America, the U.S., and Spain, was drawn. This sample was also convenient, based on personal contacts and willingness to participate by the local administrators. It was sought, however, to cover differences in size (mega, large, medium, or small), source of funding (private or public), and with a certain variation in national context, as well as in the vocation of the institution (general vs. specialized). Thus, universities from important economies in Latin America were included, as well as some universities from the United States, and Spain. The idea for including only American and Spanish universities relied on the fact that American models are commonly copied in Latin America, but Spain is also the most influential country in the region in terms of educational practices. It is important to note that, for the case of U.S. universities, it was only the case of small private schools what was intended to provide contrast to the study. As for Spain, private universities have little or no weight, so only public institutions were considered. Since the main country of interest was Mexico, universities from this country are the most numerous. Table 1 shows the distribution of universities in the sample, with a total of 22 institutions.

| | Funding | | Size | | | | Vocation | |
|---|---|---|---|---|---|---|---|---|
| Country | Private | Public | Mega | Large | Medium | Small | General | Specialized |
| Mexico | 7 | 3 | 6 | 2 | | 2 | 10 | |
| Peru | 1 | | | | 1 | | | 1 |
| Chile | 1 | 1 | | 2 | | | 2 | |
| Argentina | | 2 | 1 | | | 1 | 1 | 1 |
| Brazil | 1 | 1 | 1 | 1 | | | 1 | 1 |
| U.S.A. | 2 | | | | 2 | | | 2 |
| Spain | | 3 | 1 | 2 | | | 3 | |
| Total | 12 | 10 | 9 | 7 | 3 | 3 | 17 | 5 |

**Table 3. Sample Distribution**

Interviewers/observers were sent to each institution, and meetings were set up with teams or people responsible for technology infrastructure, as well as for educational strategy, and with professors. Direct observations on physical implementations of technology were conducted. All interviews were recorded and transcribed. Later on, they were all coded based on a rubric that was prepared especially for that purpose, and that included the five main dimensions identified as a result of the literature review. Due to space restrictions, the details of the rubric cannot be included in this paper. Nonetheless, it is important to note that there were specific observations related to each of the possible five values to be assigned for each university in each dimension. The scores obtained by all universities are presented in the results section.

The five dimensions were comprised of (1) political commitment with the university technology adoption, (2) quantity and quality of ICT resources available. (3) teaching training and development, (4) degree of integration of ICT in the curriculum, and ICT access, and (5) integration of ICT-based educational resources in the teaching-learning process. The coding allowed placing each university in one of five levels of maturity for each dimension: absent, incipient, medium, integrated, and consolidated.

After interpreting each one of the dimensions for each university, the differences and similarities were identified, as well, as the most frequent enhancers and inhibitors of ICT usage. Additionally, the dimensions were combined to portray two domains. The first was related to the existence, availability, and quality of the ICT infrastructure, without regard to its application, but rather in the sense of degree of appropriation for everyday activities. The second domain referred to the application of ICT in an educational context, with a specific fit to an educational strategy. This domain was therefore related to proper use of learning and knowledge technologies. Universities were plotted on a chart, based on their scores on each domain, and then grouped based on proximity. The position of each group in each quadrant of the grid helped identify its nature and provide some interpretation, providing the basis for the classification model proposed in this paper.

## Results and Discussion

The findings for each one of the dimensions will be described next, followed by the construction of the chart, and the description of the groups found.

### *Dimension 1: Institutional Commitment with the University Technology Adoption*

All of the universities included in the study had a strategic plan that included the adoption of ICT. In some cases, such plans were derived from public policy reflected in a national educational agenda. However, it is often found that the necessary financial resources do not come in the required amount to support the plan. This is more evident as the university size decreases. It is common to find that large and mega universities have dedicated organizational units for the support of ICT for educational purposes. In Spain, this model is almost identical in all universities, and it is not strange to find many inter-institutional projects. In Chile, the variation between private and public universities is minimal, following also very similar standards of ICT usage and support. Argentina, Brazil, and Mexico, on the other hand, show very considerable variations depending on the nature of each university. In the U.S., the appropriation of technology is already a given, and universities vary only on the focus of its application. In most cases, the existence of several means of delivery (online, blended, or face-to-face) means independent management of ICT.

### *Dimension 2: Quantity and Quality of ICT Resources Available*

One of the main discussion points found in this dimension is the importance that some institutions give to the autonomy of faculties and schools to plan, acquire, and support their own ICT needs, rather that adjusting to a central authority and plan. Regardless of the philosophical grounds that support each position, it was found that centralized control and planning favored an evenly distributed and standard provision of technology resources. Thus, in universities where autonomy was prevalent, it was common to find that schools related to Science and Engineering would generally have higher-quality widespread ICT resources, whereas schools whose vocations were the Social Sciences and Humanities would inevitably lack the provision of robust, and well maintained and supported technology. Interoperability and

integration of administrative systems, networks, and virtual platforms are also favored in centralized structures, not only for ICT management, but also governance.

### Dimension 3: Teaching  Training and Development

Independently of their differences, in all universities the importance of the role of the professor as a determinant of the quality of the education is greatly recognized. In Mexico, all universities have established plans for disciplinary and technological knowledge updating, varying only on the resources available for sustaining the development and training programs. In Chile, Argentina, and Peru, the establishment of formal programs and education tracks for the faculty is paramount. Chile in particular, follows a competency-based approach that is not evenly found in other countries. In the U.S. and Spain, the approach is more geared towards providing individualized aid and training, based on the demand of each professor. Brazil, on the other hand, tends to have independent programs that are generally not sufficient. On occasions, ITC skills and disciplinary knowledge are considered entry requirements, and are loosely strengthened afterwards.

### Dimension 4: Degree of Integration of ICT in the Curriculum, and ICT access

Four levels of ICT integration were identified from the interviews: (1) Scarce or inexistent planning for the use of ICT in the subjects of the curriculum, in order to develop digital skills, (2) Some explicit actions exist, but they are not in harmony with a centralized plan. This is the case of universities that have implemented some learning management systems (LMS) to support blended learning, and also have some specialized tools for the discipline of each major, (3) Strategic plans foster cross-sectional development of digital skills across the curriculum, and (4) Universities that have appropriated the use of technology on a daily basis for almost all activities, where digital skills are currently in use.

### Dimension 5: Integration of ICT-based Educational Resources in the Teaching-learning Process

Opposite positions were found with regard to the creation and use of open educational resources. These positions were more aligned to the philosophy of the university than to the existence of resources or size issues. The U.S. universities were extreme in the low priority they gave for professors to create open resources, digital resources in general, or even to create resources repositories beyond digital libraries. They had some grants for the development of resources, but it was never with the intention of sharing them with the rest of the world. If they were used, it was solely for their own classes and within the protection of the LMS. On the other hand, the larger Mexican universities had clear initiatives to support the creation and open publication of resources, recognized as academic productivity for the professors' evaluation, thus providing the corresponding repositories as well. In Brazil and Spain, videos of recorded classes were predominant formats of delivery, both for blended and online education. Professors tend to resist sharing the resources they have created or identified from other sources, preventing effective collaboration from taking place.

### Classification Framework

To preserve the identity of the institutions in the study, their labels have been coded in a format: CCN-SFV, where CC are the two letters that identify the country, N is a sequence, in no specific order, for all universities in one country, S refers to size, F identifies type of funding, and finally V means vocation. As an example, we can think of the 9th Mexican University in the list, which is mega-sized, privately funded, and whose vocation is general. The corresponding label should be: MX9-MRG.

The scores, for each institution, can take on values of a scale from 1 to 5, depending on the degree of maturity for each dimension that was observed, based on the criteria set on the rubric. Thus, the possible scores in the scale mean the following: (1) Absent. This means that the components in a particular dimension are inexistent or very poorly developed; (2) Incipient. This level refers to the fact that there are some efforts in place, but the results are still of little impact; (3) Medium. There is a considerable level of development for the components of each dimension, but they are far from reaching ideal status; (4) Integrated. This means that the components have been developed up to a high standard, and there is a

satisfactory deployment of technology, reaching out to the majority of the university community; and (5) Consolidated. This level not only shows a high level of technology usage, but also a great coupling among the dimensions within an axis, and between the two axis. Each level in the rubric sets the necessary criteria of component development to place each dimension evaluated in the appropriate level on the scale. The scores obtained for each dimension as a result of applying the evaluation rubric are presented in table 4.

| | Dimension 1 | Dimension 2 | ICT Infrastructure AVG(D1-D2) | Dimension 3 | Dimension 4 | Dimension 5 | ICT Education AVG(D3-D5) |
|---|---|---|---|---|---|---|---|
| MX1-MPG | 4 | 3.5 | 3.8 | 3.5 | 3 | 4.5 | 3.7 |
| MX2-MPG | 4 | 3.5 | 3.8 | 3 | 3.5 | 3.5 | 3.3 |
| MX3-MPG | 4 | 4 | 4 | 4 | 3.5 | 4 | 3.8 |
| MX4-LPG | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| MX5-MPG | 4 | 4 | 4 | 4 | 3.5 | 3.5 | 3.7 |
| MX6-SPG | 2 | 4 | 3 | 2.5 | 3.5 | 2.5 | 2.8 |
| MX7-MPG | 3.5 | 3.5 | 3.5 | 4 | 3.5 | 4 | 3.8 |
| MX8-LRG | 3 | 5 | 4 | 3 | 4 | 5 | 4 |
| MX9-MRG | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| MX10-SPG | 2.5 | 3.5 | 3 | 3.5 | 2.5 | 2 | 2.7 |
| AR1-SPS | 2.5 | 2.5 | 2.5 | 2.5 | 2 | 2 | 2.2 |
| AR2-MPG | 3.5 | 3.5 | 3.5 | 3 | 3 | 3 | 3 |
| BR1-MPG | 4 | 4 | 4 | 2 | 3.5 | 4 | 3.2 |
| BR2-LRS | 5 | 4.5 | 4.8 | 2.5 | 2.5 | 3 | 2.7 |
| CL1-LRG | 4 | 4.5 | 4.3 | 3 | 3.5 | 3.5 | 3.3 |
| CL2-LPG | 4 | 4.5 | 4.3 | 4.5 | 3.5 | 3 | 3.7 |
| PE1-DRS | 4 | 4.5 | 4.3 | 3 | 3.5 | 3.5 | 3.3 |
| SP1-MPG | 5 | 5 | 5 | 4.5 | 4.5 | 5 | 4.7 |
| SP2-LPG | 5 | 5 | 5 | 3.5 | 4.5 | 5 | 4.3 |
| SP3-LPG | 5 | 5 | 5 | 4.5 | 4.5 | 5 | 4.7 |
| US1-DRS | 5 | 5 | 5 | 4 | 5 | 4 | 4.3 |
| US2-DRS | 5 | 5 | 5 | 4 | 5 | 4 | 4.3 |

**Table 4. Scores Obtained for Each Dimension**

Based on the elements identified and coded for each dimension, we proceeded to integrate dimensions one and two as the axis of ICT infrastructure, given its nature of including elements that refer to common management and governance of support technology. Dimensions three, four, and five were consolidated as a second axis, indicated the degree of maturity that one institution has for applying and leveraging ICTs for educational purposes. The values for the axis were obtained as an average calculation of the scores of the corresponding dimensions, and are also shown in table 4. The technological axis was placed as X and the educational axis was, in turn, placed as Y. All institutions were plotted in a dispersion chart, and then grouped based on proximity. The resulting classification graph is presented in figure 1.
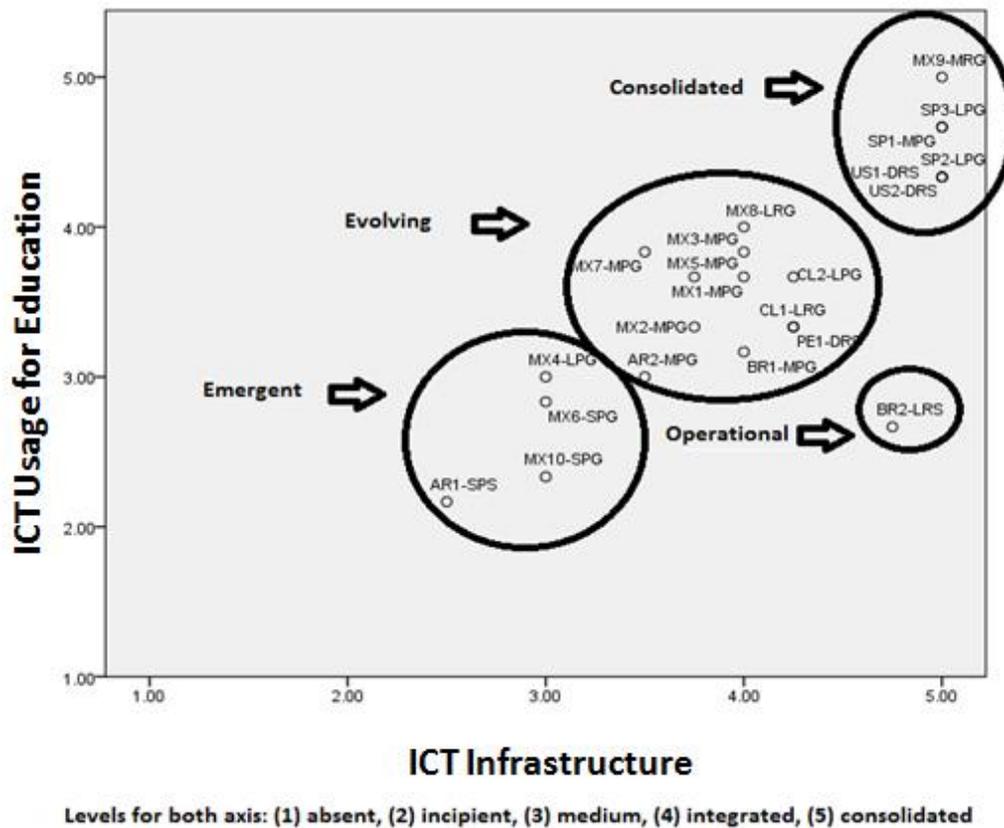
Levels for both axis: (1) absent, (2) incipient, (3) medium, (4) integrated, (5) consolidated

**Figure 1. Classification Framework**

It can be also identified, from figure 1, that four groups were defined based on the proximity of the dots in the dispersion chart. These groups, at first glance, may also be interpreted as different levels of maturity in the usage of ICT. First, on the left and lower levels of the chart, there is a group of institutions that, having recognized the importance of the application of ICT, and concerned about using it in the best way possible, have not been successful at implementing actions to achieve it. They commonly have plans and initiatives to improve their ICT usage, but these also come without the necessary resources. This group has been named as "Emergent", and it can be expected that, with the right incentives and support, its members will move quickly up the slope.

The second group is called "Evolving", and it includes institutions with scores between medium and integrated on both axis. They are considered in a transition and growing stage, meaning that they have very significant advances in the usage of ICT, but they have not reached a level of virtuosity, probably due to budgetary restrictions, internal politics, or simply because of their great size and complexity. With well-oriented and centralized initiatives, they could move forward to obtain more coverage of technology, and find more sophisticated educational uses of technology, beyond productivity software. Lacking a robust infrastructure prevents them from moving to the next category.

One university constituted a group by itself, a clear outlier. This is a very interesting case of a fully online school, where technology plays a fundamental role for its operation. Thus, it has a robust infrastructure, but its role is mainly oriented to become a strong delivery mechanism. For that reason, this group has been named "Operational". Given its business model, they are not interested in moving forward to more complex educational uses of the technology. It is likely that similar cases could be found elsewhere in the world, and it is certainly worth exploring further this issue.

The last group defined, not surprisingly includes the institutions in the sample that belong to advanced economies. However, one of the most prestigious Mexican private universities is also in that category.

This group is called "Consolidated", provided that they have a very robust ICT infrastructure. However, they are not in this group because of a "perfect" use of ICT both for operation and educational purposes, but they rather have a great coherence among their operational strategy, their educational model, and their technology usage and support.

## Conclusions and Directions for Future Research

Although ICT integration in education has been widely studied, the number of research works that are dedicated to higher education is much smaller. Additionally, the studies that approach the issue of ICT integration, generally do it only from the technological point of view. One of the main benefits of this paper is that it crosses both the technological and pedagogical perspectives, as inseparable and necessary to consider, and to evolve the level of ICT integration to a higher level of maturity.

Identifying the underlying elements that constitute a successful integration process is of paramount importance for institutions that don't want to miss out on the opportunity to serve better the ever more technology-savvy generations of students. An integration effort may be directed and monitored effectively knowing the current status of any organization. Thus, the following steps may be defined, and the resources may be calculated. New delivery models and curriculum design perspectives will be developed, more personalized and demand-based. Thus, it is crucial to be able to leverage the ICT integration to stay in the game.

The framework introduced serves not only as a means for mapping the current status of an institution and classifying it into a group, but rather to place priorities in the continuum of the two axis, and evaluate the desired state of every institution based on their educational and business model.

Higher education institutions have specificities that should not be ignored. These specificities become even more important considering the wide variety of goals and cultures that exist within the universe of educational institutions, even if only one country were considered. However, regardless of nationality of the institutions under study, the elements that constitute the dimensions, and the dimensions that comprise the axis seem to hold very robustly in the proposed model.

Further validation is important to be undertaken, so that the model can increase its external validity and rigor. Thus, it is recommendable to increase the number of institutions and regions, as well as to identify new not considered vocations, and see how the model evolves.

Triangulation of methods is also very desirable, so that the underlying and supporting theory can be augmented, and adjustments to the model can be obtained.

As a final remark, it cannot be denied that integrating ICT in the digital era is not optional anymore for educational institutions. Nonetheless, it can never be oversaw the fact that education is a process, and technology the vehicle for its facilitation. Educational technology products will never be the end, but merely the means. Understanding the new rule of socialization of our time is fundamental for closing the gap between traditional professors, and highly technical students.

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