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Factors influencing the adoption of ICT by universities from the technological infrastructure dimension

Factores que influyen en la adopción de las TIC por parte de las universidades desde la dimensión tecnológica

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Abstract

Given the need for the Higher Education Institutions (HEI) to adopt, adapt and appropriate the Information and Communication Technology (ICT) to transform their process of teaching – learning, this study was conducted to identify the factors that influence this process, from the technological dimension. For the study it was necessary to perform a conceptual theoretical review of the past 10 years based on various literature sources. The results show a better theoretical understanding of the elements from this dimension that must be taken into account when incorporating ICT by the HEI. The factors found are related to: Personnel, Infrastructure and Strategic Management. These, in turn, are divided into sub-factors. The first group consists of: ICT management (technical support) and users support and competency (teacher training). The second group consists of: hardware, software and networks. Finally, the third and final factor is composed of: technological prevention and technological improvement.

Key words *- factors, ICT appropriation, university, education, technological infrastructure.*

Resumen

Dada la necesidad que tienen las Instituciones de Educación Superior (IES) de adoptar, adaptar y apropiarse de las Tecnologías de Información y Comunicación (TIC) para transformar sus procesos de enseñanza – aprendizaje, se realizó este estudio a fin de identificar los factores que influyen en este proceso, desde la dimensión tecnológica. Para el estudio fue necesario realizar una revisión teórica conceptual de los últimos 10 años, basándose en diversas fuentes bibliográficas. Los resultados encontrados evidencian una mejor comprensión teórica de los elementos que, desde esta dimensión, deben tenerse en cuenta al momento de incorporar las TIC por parte de las IES. Los factores encontrados se refieren a: Personal, Infraestructura y Gestión Estratégica. Estos a su vez se dividen en sub-factores: el primer grupo se compone de Gestión de TIC (soporte técnico), usuarios y alfabetización (formación docente). El segundo grupo se compone de: hardware, software y redes. Finalmente el tercer y último factor se compone de prevención tecnológica y mejoramiento tecnológico.

Palabras clave: *factores, apropiación TIC, universidad, educación, infraestructura tecnológica.*

INTRODUCTION

The exponential growth of ICT has created new and unimaginable opportunities and educational alternatives that provide ubiquitous features and continuous accessibility and flexibility of interactivity to the learning, allowing in turn improving the teaching - learning process. These potentials and qualities are recognized by the international community (Sandia Saldivia, 2015). However, the responsiveness of Higher Education Institutions (HEIs) and flexibility against the momentous changes is a complex problem, because the challenge goes far beyond the simple addition of technologies. This represents a redefinition,

reorganization and planning of educational processes, and therefore the HEIs themselves.

It is important to clarify a number of quality factors that must be present in the process of appropriation of ICT in higher education institutions. These factors can be grouped into three broad areas: organizational, related to the management and organization of the institution; academics, referring to all the elements that include the teaching - learning process; and technology, which involves everything that relates to the operational and functional part (Sandia Saldivia, 2012).

This paper presents a documental review of the theoretical and conceptual elements that are part of the process of adoption and appropriation of ICT from the technological dimension. The study was based on a documentary research, in which a rigorous classification of information, considering the ideas, theories, concepts or proposals of the authors, taking into account the principles of reliability, objectivity, consistency, relevance, completeness and representativeness was conducted, in order to generate a conceptual framework to form a body of ideas on the factors and sub-factors technology.

METHODOLOGY

According to Arias (2012), documentary research is a process that is based on the search, retrieval, analysis, criticism and interpretation of data and information obtained and recorded by other researchers in various documentary sources, in order to generate new knowledge.

The organization of the information collected consisted of a division by categories, under the criteria of objectivity and relevance of the factors that were considered most important in the documents found. These help out to generate a theoretical construction on the main factors affecting the adoption of ICT in the HEI, based on inference and interpretation of this information, which ultimately led to the results, that clearly explain each of these factors. It is worth noting that parallel to this, there have been two similar works, focused on the organizational and teaching – learning dimensions, respectively.

First, some international models for the adoption of ICT from the technological perspective were conceptualized. These models allow, in a methodical way, navigate through the different phases of the way of the adoption of ICT in higher education institutions.Following is a brief overview of each model.

ACL SPLA model *(e-learning positioning statement).* This model aims to diagnose the maturity of the institution regarding the incorporation of ICT. It was designed as an aid for institutional strategic planning and as a support for the process of improving institutional quality. It is used for the management and leadership of the e-learning courses at NIACE *(National Institute of Adult Continuing Education).* (NIACE, 2007).

Among the reference models in terms of appropriation of ICTs, it is also the EFMD –CEL *(European Foundation for Management Development)* model. This model is recognized as a reference in quality certification processes aimed to the management of programs that incorporate education learning based on ICT. It allows to evaluate what is happening in the organization from the perspective of the program, pedagogy, economics, technology, organization and culture, using criteria, indicators and standards, in order to improve the quality of the programs offered supported by educational technology (EFMD CEL-Accredited, 2006).

On the other hand, it is the CAPEODL model *(Comprehensive Approach to Program Evaluation in Open and Distributed Learning)* proposed by Badrul Khan (2004), which combines the knowledge proposed in his model P3 *(People-Process-Product Continuum in e-learning),* presenting a procedurally lists of several products for the seven stages of *e-learning.* In a second part, it refers to the framework of virtual learning serving as a diagnostic tool to develop a comprehensive approach to the assessment of learning programs (Morrison, 2003).

Finally, there is presented the Proposed Methodology for Transformation Presence to Virtual or *e-learning* Programs, of the Ministry of National Education of Colombia (MEN) (Ministerio de Educación, 2010), which allows higher education institutions to implement virtualization projects carried out by the *e-learning* 2.0 association agreements.

This model is basically aimed at the transformation of classroom to *e-learning* programs, and describes three dimensions: organizational, technological infrastructure and teaching - learning (Castillo et al, 2007).

Organizational dimension. This dimension indicates the need to implement structural changes to prepare and condition the organization towards the incorporation of ICT. It requires a diagnosis for classifying at what level the institution is, and then proceeds to the analysis of the environment in which e-learning will take place. For this dimension, the MEN methodology says that it is also necessary to consider strategies and lines of work to allow concrete actions to provide high quality programs (Castillo et al, 2007).

Technological infrastructure dimension. In this dimension it is considered that the appropriate technological infrastructure is a fundamental requirement for technology-based instruction. This means having networks, hardware and software, and technology support staff appropriate for faculty members. The technology infrastructure must also deal with administrative and academic needs (Bates, 2001).

Teaching-learning dimension. In this dimension, the MEN methodology perceives ICT in education as an essential component of the teaching, learning and assessment processes. It indicates that the formative intent is expressed in the methodological diversity of teaching and learning and in the innovative teaching, outside the traditional standards. Thus, ICTs allow a key dimension for any domain of personalized learning (Castillo et al, 2007).

To transform classrooms to virtual or e-learning programs, from the perspective of the technological infrastructure, the methodology of MEN proposes a procedure in which the first step should be to make a diagnosis to determine the requirements of the institution (physical facilities, network services, and personnel support) (Castillo et al, 2007).

As a second step, it should consider the Learning Management System or LMS to facilitate *e-learning* services. These LMS platforms offer integrated learning environments that provide functionality, usability, use of standards, scalability, security and reliability (Castillo et al, 2007). Then, it must move to quality assurance and service delivery systems that support various processes within the institution. It requires offer to the virtual students the facility to access their course materials anytime, anywhere safely (Castillo et al, 2007). Finally, it is required document the preparation of the technology infrastructure where the requirements of today's server infrastructure, telecommunication and technological model for *e-learning* are specified and describe technological support systems (Castillo et al, 2007).

According to the MEN model, the technological dimension becomes a keystone for the institution; it undertakes to ensure the appropriate and relevant tools and technologies to respond to e-learning teaching process raised. This must force to promptly provide the intellectual, technical and technological capital needed to enable the organization, monitoring and measurements required by the communicative and educational dimensions and ensure interactivity, mobility, connectivity and interaction between different people and various elements of the learning environment (Universitaria Virtual Internacional, 2013, p. 52).

RESULTS AND DISCUSSION

Upon the review of the theoretical and conceptual elements, present in the different models studied and specifically in the MEN proposal, and the analysis of the criteria raised by them, focusing on technological infrastructure dimension, there were identified the factors and sub-factors that may conform this dimension. The major factors found are: personnel, infrastructure and strategic management. Below is presented a description of each factor and their respective sub-factors, which were determined according to the authors studied.

Personal factor

This factor aims to be a teaching support from the technological dimension, where an organizational structure, that
combines a mixture of centralized and decentralized strategies with individual faculties and departments are recommended (Bates, 2001).

Bates (2001) further states that "…to teach with technology a degree of skill is required, and this requires training not only on technical issues, but also in educational practice. Training should be integrated into the course development process, and this may help the project management model" (p. 03). For this reason, Sancho Gil (2011) notes that it is important to have, not only an infrastructure required to carry out learning experiences worthwhile, but provide to teachers the tools to have optimum working conditions.

The importance of this factor can be seen in the proposal for the incorporation of ICT at the University of Nariño, where it considers the human talent available to use, adopt and develop IT tools; In addition it must organize the work of human talent to achieve significant work

in the field of implementation of the ICT educational processes (Eraso, Walls, & Insuasty, 2009).

Also, it is observed that the Regional Conference on Education United Nations Organization for Educational, Scientific and Cultural, cited by Torres Velandia, Garcia Ponce de Leon & Barona Ríos (2009), states that "one of the aspects linked to the recommendations to enhance the opportunities offered by ICT, demands that commitments must be taken from the governments and the higher education institutions to ensure the appropriate training of all the people, who make possible the efficient functioning of the services they provide by the telecommunication and-information systems" (p. 109).

Clearly, it is necessary as a result of the introduction of technological infrastructure at the university, hiring or promoting people to positions or jobs newly created, with different and innovative profiles (Duart & Lupiáñez, 2005). As it can be seen, for these authors, the working staff play an important role in educational institutions, because from their different perspectives. We must stress that it is necessary to train the people who make the university organizations up to obtain the expected results during the process and development of the action to be executed, taking into account the needs of each institution. This factor considers the following sub-factors: information technology management (technical support) and users (teaching literacy).

a) Information technologies management (technical support). This is an important factor. Teachers need technical assistance to operate and maintain the technology so they can feel safe when using them in their classes. The lack of adequate infrastructure, technical support and technology competition may baulk the access and user confidence, causing the lost of opportunities for learning and increasing frustration on teachers. Therefore, it is recommended to make available additional support or technical training, depending on local circumstances (UNESCO, 2004, p. 82). On the other hand, it is important to consider that an institutional support for educational innovation consisting of giving technical assistance in situ and continuous training, it is valuable to teachers (Badia, A., Meneses, J. & Sigalés, C.,2013). Given the importance of ensuring the appropriate and relevant tools and technologies to respond to the teaching virtual learning processes it must be assumed the technological dimension as the fundamental pillar for the HEI. The institution must provide timely the intellectual, technical and technological capital needed for all processes required in a virtual learning environment. Also, this dimension should provide a operational system of technical sustain, which meets the requirements in the use of ICT, to support the work of teachers, tutors, facilitators and researchers (Universitaria Virtual Internacional, 2013, p. 52).

Thus, Salinas, J. (2004) proposes to "implement a policy of technical support which is a team that will carry out the project, they must be content experts, who are in charge of instructional design, digital design, etc." To introduce ICT in HEIs, it should be considered among other things, a system of user support to help them solve problems that arise; it should has a worker staff with expertise and available infrastructure needed for the use of technology in academia (Moreno & Mariano, 2002; UNESCO, 2004).

b) *User (teaching literacy).* Salinas, J. (2004) indicates that one of the important aspects to consider when implementing an ICT project is the support system for teachers, who must integrate the actions of the training and retraining plan for teachers regarding the use of ICT in teaching, as well as a system of personal counseling and technical assistance that allows to updated training services of the institution, available resources, technical support, among others.

The proposed incorporation of ICT at the Universidad de Nariño, indicates that when trying to develop skills related to the use of tools for both teachers, students and administrative staff, a permanent training plan must be generated for the responsible units and with the implementation of technical monitoring of the students (Eraso et al 2009). Salinas J. (2000) also states that the introduction of new technologies in universities should be considered a privileged means to achieve the changes brought about the technological evolution. So it is necessary to have skilled and continuously trained workforce, mainly related to these changes. As Almerich, Orellana, Suárez-Rodríguez and Díaz-García (2016) say that ICT literacy teachers must focus on two important areas: technological skills and teaching skills, and this is influenced by personal and contextual factor.

For its part, Duart & Lupiáñez (2005) point to the need of teachers technology training from different types of innovation and use of existing ICT in the processes of educational innovation. This view is complemented by the proposal of giving incentives in different ways (stock, structures, materials, etc.) aimed to promoting the implementation of the technology curriculum by teachers. This stimulus can be the establishment of permanent support and technical and didactic advice (Salinas, M. I., 2010).

Likewise, Heitink et al (2016) has found that the use of technology by teachers shows aspects of the knowledge transfers model of teaching, which means that the use of ICT is intended to support learning activity and strengthen the pedagogy..

According to a study, conducted at the Universidad Autónoma del Estado de Morelos (UAEM), the human resources who work actively in supporting technological infrastructure and in the operation of the telecommunication networks, are rated as specialized and non-specialized personnel; in this regard, there are some full-time professors who say this is insufficient (Torres Velandia et al, 2009).

On the other hand, it is observed that, as noted by Fernández Batanero and Torres Gonzalez (2015), one of the factors that can influence the transformation of teaching performance in the use of ICT in educational practice, is the technological level of teacher training. As Celaya Ramírez, Lozano Martínez, & Ramírez Montoya (2010) says the selection and adoption of a particular resource in its class it is determined by the knowledge and experience that the teacher has in his specialty area as well as the domain in teaching strategies.

Therefore, in the HEIs it is important to find alternatives that lead good literacy teachers to ensure comprehensive training in different areas to perform, depending on the function to be met by each one.

Infrastructure factor

This factor includes both physical and technological infrastructure, as well as human support, financing, the relationship between technological infrastructure and academic planning, and the roles of the authorities in incorporating ICT projects. For technology-based education, an appropriate technological infrastructure is a fundamental requirement (Bates, 2001). The same author, Bates (2001), describes the elements to consider in this factor, including adequate technical support personnel for faculty members, as well as networks, hardware and software. Salinas J. (2004), states that the incorporation of ICT in training, under the concept of flexible learning, generates changes, related to the technological infrastructure, the content and materials, and the access and use of digital resources.

In several studies, it is suggested that in the introduction of ICT in universities it is important to consider the technological infrastructure, which is essential to ensure that learning opportunities are provided (Moreno & Mariano 2002; Torres Velandia, Garcia Ponce de León, Barona & Rivers, 2009). Priority should be given to the needs of expansion and modernization of equipment and technology infrastructure, as ICT become the transversal axis that articulates and consolidates information systems, education and research (Torres Velandia et al, 2009). In this regard, there are conducted studies that support the importance for the institutions having infrastructure to carry out relevant and effective learning experiences (Sancho Gil, 2011). This is corroborated by Garzón Clemente (2015) which states that proposals on infrastructure should include conditions such as open and closed environments for agency collaboration, physical and logical networks, and common standards for telecommunications, among others.

From the above it can be deduced that teachers have a continuous improvement of their skills related to ICT in their application, if they have at their disposal the technological infrastructure and appropriate technical assistance. This is why the UNESCO (2004) states that all students and teachers should have access to new technologies, software, and telecommunications networks, both inside and outside the classroom. It is noted that the ICT infrastructure measures the perceived of the ICT tools availability and suitability, such as hardware, software and peripheral equipment provided. It also refers to the availability of equipment, software, Internet access and other similar resources (Lu, C. Tsai, C.-C., & Wu, D., 2015).

The technological infrastructure not only refers to equipment and tools themselves, but, as mentioned above, it is necessary to have a number of applications, platforms, software, database with specialized tools, networks, among others. Derived from this, the sub-factors related to the infrastructure factor are: hardware, software and networks.

a) *Hardware, software and networks.* The authors considered agree that these three sub-factors are equally important, and are closely related, that is why they will be discussed together.

For Bates (2001), the field of technology infrastructure includes the subcomponents of software and web resources, noting that one of its components are digital resources, which are directly related to the connectivity. Also, Marqués Graells (2000) remarks that the technological infrastructure basically comprises the provision of multipurpose study halls and computer rooms connected to the Internet, for the needs of teachers and for the students free use, and the creation a videoconferencing room and a "virtual campus".

For its part, Duart & Lupiañez (2005) state that "accessibility, connectivity and portability technology for students, faculty and staff management are emerging today as a new scenario of the introduction of technologies in most universities" (p. 13). To do this, it should be keep in mind the points made by the Regional Conference on Education UNESCO 2008, that says that one of the aspects relating to the recommendations to make real the ICTs opportunities, is to ensure the construction of communication networks (Torres Velandia et al, 2009).

Web 2.0 is known as "a social phenomenon in relation to the creation and distribution of content on the Internet, characterized by open communication, decentralization of authority, freedom to share and use within an approach that treats relations human as a conversations" (Ortiz de Zarate, 2008). It is observed that the Web 2.0 or social Web has allowed a collaborative and social approach to educational training, and the absolute possibility of content creation; likewise, the Web 3.0 or Semantic Web, allows to describe content, meaning and value of the data (disruptive technology), incorporating "intelligent agents" (Sandia Saldivia, 2015). Then, for some authors as Peña Ochoa & Peña Ochoa (2007), the Web 2.0 is the tool in the education, since it offers a rich and diverse process of encounters and experiences. It is noted that the HEIs today are supported mostly by dozens of e-learning technologies. This indicates that technology has played and continues to play an important role in the development and expansion of online education (Boa Reena Tok & Marpe Sora, 2013).

On the other hand, network technologies have disruptive effects generated in all organizations, forcing them to drastically restructure their processes and products, resulting in unimaginable social and economic innovations. The network is a profoundly disruptive technology, which requires changes (Anderson, T., & McGreal, R., 2012). Moreover, as Betancourt Franco, M.C., Celaya Ramírez, R. & Ramírez Montoya, M.S. (2014) point out that networks ensure strategies and connective actions important to develop new knowledge. HEIs are not immune to these changes. For these reasons, among others, it is important to promote incentives in different ways to point out to the actual implementation of the technology curriculum by teachers. One of these stimuli may be a subsidy scheme for users to purchase hardware, software, and computer equipment and have free internet access on campus (Rogers & Shoemarker, 1974).

Briefing, Salinas, J. (2004) coincides with previous authors, pointing out that "undoubtedly, little you can do in the field of ICT-based teaching without clear strategic guidelines concerning infrastructure" (p. 11). For him, a technological plan of the institution will be a good foundation for success. However, he remembered that innovation is a human, not a technical activity.

It could be concluded that for a successful development of the academic process supported by ICT, there must be a technological complement with free structural availability, allowing teachers to access the material available to them for the methodological development of their educational program, and thus teach properly to the students, who should also have access anytime, anywhere, to execute a consonant process of learning.

Strategic management factor.

Related to this factor, there are a number of studies that defend the importance of strategic management on the implementation of programs ICT based in universities. For example, Duart & Lupiáñez (2005, p. 13) indicate the urgent need for strategic planning and the creation of a policy of alliances for outsourcing management processes and infrastructure maintenance. These authors suggest that "the initial lack of strategic planning decisions on technology infrastructure has led, in some cases, on erratic procurement policy, on the added difficulty in the realization of the processes of technology management, in difficulties not provided on the maintenance and improvement of the equipment and its renewal".

In addition, the proposed incorporation of ICT at the Universidad de Nariño, noted that developments in technology must be designed under professional engineering parameters and obviously all these processes should be articulated with the criteria of strategic planning and should be controlled or regulated (Eraso et al, 2009). Likewise, Mariano & Moreno (2002), point to bear in mind some aspects, which should be a system of user support to help them solve the problems that arise when they are implementing ICT in educational processes.

This factor, as well as everything related to the strategic plan for technology integration, and the teachers' support actions should be evaluated periodically, aiming to establish the degree of efficiency in terms of the planned. This evaluation will define institutional policies and incorporate any improvements that may be necessary (UNESCO, 2004).

All this points to find the adequate guidelines for good performance and operation of the processes required according to every need. In this factor questions and analysis are made to verify and confirm that everything has been properly exploited, providing quality service. Technological prevention and technological improvement are two sub-factors presented on the strategic management factor.

a) Technological prevention. The main objective of the technological dimension must be to ensure the operating conditions of the technology management system components. This involves, among other things, the adequacy of physical space and electrical networks, network installations, computer systems, as well as maintenance of the technological infrastructure and software licensing. It cannot be left out that it should promote ethical, safe and efficient use of technological infrastructure (Universitaria Virtual Internacional, 2013).

In the same vein, all the above "framed in a safe and reliable technical and technological environment to ensure and maintain the integrity, confidentiality, availability, storage, stability, privacy of information; that develop contingency plans, electronic backup systems, monitoring and authenticity of the information and data" (Universitaria Virtual Internacional, 2013, p. 53). In this context, Scott Daniels, J. Jacobsen, M., Varnhagen, S. & Friesen, S. (2013) note that the access is a limiting issue in the effective use of technology factor. This makes that the selection and access to high-quality learning resources for students, can directly affect pedagogy, and therefore decisions about the resources to be used.

From the above it is concluded that it is necessary in HEIs to have electronic backup systems and contingency plans, where they regulate and preview the possible mistakes related to the use of technologies that may arise in the development of programs supported by ICT, in order to provide quick, safe and effective solutions.

b) Technological improvement. This sub-factor is related to the need to constantly evaluate the effectiveness of technology in all instances of teacher training. This will reveal the institutional vision about whether if using technology is going in the right direction. But mostly it will identify the potential problems to change institutional policies and strategies (UNESCO, 2004).

Likewise, for the success in the project, Salinas, J. (2000) says that it is necessary to have "content quality (any service will not have educational value if the materials it contains are not quality; it is obvious that what will prevail will be the contents over the multimedia artifice fires)" (p .18). Moreover, Sahasrabudhe, V y Kanungo, S (2014) has found that the relationship between media choice and its effectiveness is moderated by the learning domain and the learning styles of learners. This means that a big part of the quality of the program would be based on the media selection.

Clearly, if the HEIs want to provide good services need to provide quality programs, not only in the technological infrastructure, but services provided in general. It is important, therefore, to implement periodic evaluations to diagnose the efficient functioning and identify the required improvements.

The following table shows each one of the factors and sub-factors found to be influential in the process of adoption of ICT, and the authors who points them in their publications.

Table 1. Factors and Sub-factors With the respective authors.

Factor	Authors alluding the factor	Sub-factor	Authors alluding the sub-factor
Personnel	Sancho Gil, 2011. Torres Velándia, García Ponce de León, & Barona Ríos, 2009. Duart & Lupiáñez, 2005. Eraso, Paredes, & Insuasty, 2009. Bates, T., 2001. Celaya Ramírez, Lozano Martínez, & Ramírez Montoya, 2010.	IT management (technical support)	Salinas J. , 2004. Universitaria Virtual Internacional, 2013. Moreno & Mariano, 2002. UNESCO, 2004. Badia, A., Meneses, J. & Sigalés, C.,2013
		User (teaching literacy)	Torres Velándia, García Ponce de León, & Barona Ríos, 2009. Salinas, J., 2004. Salinas, M. I., 2010. Duart & Lupiáñez, 2005. Eraso, Paredes, & Insuasty, 2009. Salinas, J., 2000. Sahasrabudhe, V y Kanungo, S (2014). Heitink et al, 2016. Almerich, Orellana, Suárez-Rodríguez and Díaz-García (2016)
Infrastructure	Sancho Gil, 2011. Torres Velándia, García Ponce de León, & Barona Ríos, 2009. Bates, T., 2001. Salinas, J., 2004. Moreno & Mariano, 2002. Salinas, J., 1997. Duart & Lupiáñez, 2005. UNESCO, 2004. Boa Reena Tok & Marpe Sora, 2013. Lu, C., Tsai, C.-C., & Wu, D., 2015. Anderson, T., & McGreal, R., 2012. Garzón Clemente, 2015.	Hardware	Salinas, J., 2004. Rogers & Shoemarker, 1974. Marqués Graells, 2000. Bates, T., 2001.
		Software	Salinas, J., 2004. Rogers & Shoemarker, 1974. Marqués Graells, 2000. Bates, T., 2001
		Networks	Salinas, J., 2004. Rogers & Shoemarker, 1974. Bates, T, 2001. Peña Ochoa & Peña Ochoa, 2007. Torres Velándia, García Ponce de León, & Barona Ríos, 2009. Duart & Lupiáñez, 2005. . Betancourt Franco, M.C., Celaya Ramírez, R. & Ramírez Montoya, M.S., 2014
Strategic management	Moreno & Mariano, 2002. UNESCO, 2004. Duart & Lupiáñez, 2005. Eraso, Paredes, & Insuasty, 2009.	Technological prevention	Universitaria Virtual Internacional, 2013. Scott Daniels, J., Jacobsen, M., Varnhagen, S. & Friesen, S., 2013.
		Technological improvement	UNESCO, 2004. Salinas, J., 2000.

Source: Self prepared, based on the authors.

CONCLUSIONS

In the research process, object of this work, a theoretical-conceptual review of the main factors influencing the adoption of ICT in universities, regarding the organizational, technological and teaching-learning dimensions, present in the different models studied and specifically in the MEN proposal, and from the analysis of the criteria raised by them, focusing on technological infrastructure dimension, was made. The information obtained was classified and organized by a theoretical mesh, in which the different elements that each of the authors found were reflected, as necessary, to model the adoption of ICT. This allowed, at the end of the process, to unify and establish the factors and sub-factors that were defined as the research product

It is important to consider a technological infrastructure that include conditions such as open and closed environments for agency collaboration, physical and logical networks, and common standards for telecommunications.

The major factors found are: personnel, infrastructure and strategic management. In turn, each factor derived a number of sub-factors, namely: the personnel factor, which implies IT management (technical support) and user (teaching literacy); the second factor is the infrastructure, in which there are presented the sub-factors hardware, software and networks; for the third and final factor, the sub-factors are technological prevention and technological improvement.

Among the most significant aspects pointed by the authors, there is the importance of having qualified personnel, capable of performing the tasks associated with each academic program, and in turn they should have access to technological equipment for developing, effectively and efficiently, the process of adoption of ICT in the HEI. In Addition, it must have strategic plans that help to improve, solve and fix troubleshoot and problems that may be faced in carrying out this process. To do this, it is suggested to make periodically an evaluative analysis of all mentioned above, it should determine the progress in order to provide high quality services.

From the related factors found, one of the aspects most mentioned by authors is the technological infrastructure, indicating the relevance of that in teaching based on technology; the appropriate technological infrastructure is a key requirement. Perhaps, because when talking about e-learning, a key supporting factor is the technological platform in which the programs lie. It is essential to carry out the teaching and learning processes, as well as to innovate and optimize methodologies taught by universities today. Related to the previous factor, there is the sub-factor networks, where most of the authors noted that accessibility and portability of technology is necessary in terms of bandwidth, network services and web sites for both, academic and administrative staff, anytime, anywhere.

Also, almost all authors have suggested that the sub-factor user, specifically with regard to teaching literacy is vital for the success of the process of adoption of ICT. They indicate that teachers must have related skills with the knowledge, selection and use of technology to be reliable to use it as a tool for teaching innovation. In addition, teachers must understand the challenges of the knowledge society, and act accordingly. For teachers it is necessary to consider that an institutional support for educational innovation consisting of giving technical assistance in situ and continuous training. In conclusion, practically all the authors indicated that for the e-learning process is essential to train teachers in all matters relating to the use and knowledge of new technologies; and the need to motivate and create incentives on the HEI, that will provide new opportunities for teachers. Likewise, to ensure that HEI provide good services and quality programs, it is important to implement periodic evaluations to diagnose the efficient functioning and identify the required improvements.

The consolidation of the factors involved in the appropriation of ICT from a technological perspective, as a result of this study, concludes that it is of great interest and valuable importance to analyze the different variables that influence this appropriation, to ensure that they work as generating educational innovations in teaching practice. In this sense, the document presents to the HEI valuable elements that can ensure better results when starting ICT adoption processes. Also note, that these results can serve as inputs to define institutional policies aimed at the training of teachers and the appropriation of ICT at universities.

Complementing this work it is significant doing like studies to gain a better understanding of the other two dimensions proposed by the MEN methodology, which are pedagogical and organizational dimension, in order to reach a full understanding of the adoption of ICT process in the HEI.

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Analysis of scientific content on labels and their educational implications: the case of clothing

Análisis del contenido científico de las etiquetas y sus implicaciones educativas: el caso de la ropa

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Abstract

This paper presents the results of the analysis of scientific content on labels of dress clothes. The study is focused on classifying information, determining the cognitive demands involved and evaluating the basic knowledge to which citizens of any country have to face in a daily process: the choice of clothes. The results indicate that there are many scientific-technical concepts around clothing, which seem to demand an increasingly specific training. Finally, we discuss the implications of these results for citizens' education as well as in its possible use as a reference for formal education.

Key words: *science literacy, science in everyday life, buying process, citizens' education, labeling.*

Resumen

En este trabajo se presentan los resultados del análisis del contenido científico de las etiquetas de prendas de vestir. El estudio se centra en la clasificación de la información, la determinación de las demandas cognitivas involucradas y la evaluación de los conocimientos básicos a los que los ciudadanos de cualquier país tienen que enfrentarse en un proceso cotidiano: la elección de la ropa. Los resultados indican que hay muchos conceptos científico-técnicos alrededor de la ropa, que parecen exigir un entrenamiento cada vez más específico. Finalmente, discutimos las implicaciones de estos resultados para la educación de los ciudadanos, así como en su posible uso como referencia para la educación formal.

Palabras clave: *alfabetización científica, ciencia en la vida cotidiana, proceso de compra, educación ciudadana, etiquetado.*