



Trends of Digital Transformation in University Education During Pandemic and Post-Pandemic

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Key words: Digital transformation, education, engineering, pandemic, post-pandemic

Abstract: The parsimonious progress towards the digital transformation of education has been one of the edges of the educational crisis experienced in Latin America whose reality became more evident with the abrupt pandemic situation where the conditions of inequality and poverty take on a more significant harmful impact to the less privileged social classes being flagrantly violated the human right to education. In the case of higher education, this problem is exacerbated by the bias of particular interests, traditionalist governance, rigid curricula, teachers with little or no training in pedagogies with the use of technology and students with minimal or no opportunities to access a computer and internet. In conclusion, we can indicate that the contribution made by professionals in Computer Science and engineering is abysmal, however, no effort will be enough if students are not allowed access to information and communication technologies in an equal way, declaring this as a violation of first-generation constitutional rights such as equality and others such as access to quality education. Considering the circumstances will the digital transformation be able to support universities in the resilient action they must adopt to safeguard engineering education or will it increase the gap during the pandemic and post-pandemic?

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Page No.: 3759-3764
Volume: 15, Issue 24, 2020
ISSN: 1816-949x
Journal of Engineering and Applied Sciences
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INTRODUCTION

The current confinement has made it possible to open contact with the whole world through virtuality, changing the way of living, social and cultural interaction becomes closer, new work modalities emerge with more force, electronic commercial relations increase and therefore, of course, higher education must be at the forefront offering

training that prepares the future professional. In this way, the agility of digital transformation, robotics, artificial intelligence and automation requires continuous learning of constant updating, coupled with the fourth industrial revolution.

Rethinking educational policies and modifying the paradigm that decisions are made from up in a massive way, ignoring the reality of the great diversity of

populations with diverse needs can be mitigated with greater active participation of all sectors that can be easily convened through digital tools.

Failure to support higher education institutions towards a digital transformation will inevitably slow down the learning process, since, the solutions to control the pandemic are not close and the options to return to normality are far away; in this way, digital tools are a decisive factor in contributing to the quality and coverage of education.

CONTENT DEVELOPMENT

Defining digital transformation: Digital transformation includes an evolution of thought, uses, customs of the human being which will impact companies by requiring diverse factors like for example, leaders with a futuristic vision and a team of collaborators invested with skills appropriate to a new organizational structure whose competitive banner will be based on technology.

In this regard, the OCDE.^[1] has stated: (...) Digital transformation does not only refer to adopting digital technologies. It is also related to the transformation within society and the business world required to turn the new technology into an economic and social opportunity. This requires investments that complement the technology itself, in skills, in organizational change, in new business models and processes as well as in the intellectual assets that help create value from new technologies.

There are also other authors such as Menendez *et al.*^[2] that consider it “a necessary process of profound technological and cultural change that every organization must implement to ‘keep up’ with its digital customers”).

Meaning, digital transformation involves that all the members of the organization modify their mental structures, the acquisition of an evolved culture, visionary leaders, work teams with digital skills, allowing them to adapt in a flexible, fast and innovative way; on the contrary, they would become pachydermic companies, parked in their comfort zone with management models lacking competitive advantages in the market in a globalized world.

Computer Science and its contribution to digital transformation: Computational Sciences is the name attributed to the use of algorithms that allow transforming information through a cyclical process composed of: analysis, design, implementation and tests; in simpler terms, we could assert that these sciences allow solving problems through algorithms defined according to the problems presented^[3].

In the world, Computer Science is divided into various professions ranging from software engineering, computer engineering, among others. Our country is

unique, given that we have systems engineering as an undergraduate program, a profession that covers topics such as application development (software), software architecture, systems auditing, among other disciplines, hence its importance and contribution to the technological evolution.

From its conception, the term engineer comes from the Latin *Ingenium* equivalent to producing, hence, systems engineers generate solutions to problems of daily life through the principle of abstraction which its closest definition from the edge of systems is: taking things from the real world and transforming them into a programming code through an integrated development environment, generating a program^[4].

The first significant contribution of Computer Science was introduced by the mathematician and computer scientist Alan Turing who thanks to the development of the enigma machine or Turing machine, allowed to tip the balance for the allies, deciphering the codes of the Nazi forces which would lead to the culmination of World War II and the end of the Adolf Hitler's regime.

Since, predecessor decades, in the evolution of the world, systems have played a preponderant role in the development of humanity, long ago the idea of having a computer was not conceived because it was a privilege of professionals in the area, today we find computer equipment in homes and is fundamental in the development of professions such as medicine, this is one of the great contributions, promoted by Steve Paul Jobs who before founding Apple, devised in his ingenious mind the possibility that each person had a computer, term that we know today as personal computing and from where it derives the acronym of PC (Personal Computer).

Establishing a chronology for the contributions of computational sciences, in modern computing technological emerge tools or computer applications that in the beginning were conceived as a method of communication and approach between people, the so-called social networks became the applications with the most significant number of users around the world and even its power has transcended from having contact with celebrities and public figure seven influencing political decisions of global relevance. Jan Koum (WhatsApp) and Mark Zuckerberg (Facebook), creators of the main social networks did not measure their power when conceiving this idea, since, the first of those mentioned idealized it as a smart agenda to know who is online and thus be able to chat^[5]; on the other hand, Zuckerberg designed a tool to know and learn about different aspects of people linked as friends.

These two technological tools generated a great acceptance in the community, to the point of increasing the lucrative profits for their creators, however, the

situation triggered by the virus that affects the world population changed their use, going from being only as a means of knowledge and chatting with friends in being one of the main tools for teachers and students in the development of their classes mediated by information and communication technologies.

Other social networks that have been very useful for the triad of academic training (teachers, students and parents) are: Skype, Telegram, Zoom and Meet, platforms that allow synchronous meetings for teachers to transmit their knowledge to students and they can actively participate in their training process in different areas and levels.

These, like several tools available on the internet, allow teachers to exercise this training function but we cannot ignore the problems that this has triggered, it is not a secret that teachers, students and educational institutions did not forecast the situation like the one the world is going through, finding the following problems:

Digital ignorance: A term that groups together all the people who lack that domain of information and communication technologies, both teachers and students have shown difficulties in the use of social networks and applications to advance in their classes, this is derived from various factors among which we can highlight the difficult access to technology in Colombia, the deficiency in training in these areas and the little investment by the state in technological infrastructure, wherein the XX Ist century there are populations without internet coverage.

Deficient technological infrastructure: Despite not having exact figures that demonstrate inadequate internet coverage and tools (computers, tablets or smartphone), we can infer that approximately 50% of Colombians (25 million according to the DANE population census) have a stable internet connection, figures that denote that large gap between the inhabitants of the national territory^[6]. On the other hand, in the technical bulletin of the National Department of Statistics DANE in 2018, only 41.6% of Colombian households have a computer, a fundamental tool for access to the virtual classes that must be carried out due to the confinement decreed by the national government^[7].

This, without considering the rural sectors who are the most affected in all this situation because many areas of the country do not have a stable mobile phone signal.

Digital transformation in higher education: Based on the concept of digital transformation when it is transported to universities and adding the pandemic ingredient VUCA (Volatility, Uncertainty, Complexity, Ambiguity) that, in a disruptive and vertiginous way, accelerated this change, pressures institutions to rethink

an organizational model appropriate to face the pandemic and post-pandemic, that is, a reformulation of the existing paradigms at all internal and external levels.

Internally, the university as an organization requires a digital transformation of all its strategic, missionary and support processes. For example, in the support processes, it would be less complex and would make the student's academic trajectory data, diplomas reliable if the blockchain is used by automating their information. Regarding this:

In theory, BC would allow accrediting the elements of a CV prepared by the user, preventing the manipulation or alteration of data disseminated through a distributed system without storing the data in a center subject to attacks or violations of its integrity^[8].

Of course, this would be a way of having the certainty of the documentation when presented in any national or foreign educational institution but of course, it requires implementation and again it returns to the premise of thought evolution. However, this technology would not guarantee the skills acquired but it would facilitate mobility in the continuity of academic training and work activity anywhere in the world.

It is relevant to examine some aspects as mentioned, digital transformation requires changes not only within the university but also compels external agents. In other words, the country's ruling class in charge of the formulation of public policies, regulatory proposals, budget allocation, strategies and all kinds of decisions regarding higher education with a view to DT, require experts in direct contact with the problems with guiding proposals for the future.

It is convenient to have the academy closer with the socialization of its research results, thus, allowing greater university-state interaction and consequently, more appropriate state provisions would be made to the social, political, environmental, cultural, ethnic, religious, economic needs of each Colombian area with educational relevance, taking advantage of new technologies as a learning instrument, extending coverage with quality, preparing students and teachers with the necessary skills in the new era.

Finalizing this aspect, a greater number of universities should tend to participate more closely in the formulation of public educational policies based on the communication to the state authorities of the research on digital transformation and the favorable effects of innovating in the technology-based education, providing solid fundamental arguments in decision-making.

On the other hand, the traditional thinking of university leaders truncates progress, quoting Tom Jaap this type of thinking:

"(...) Encourages organizations to continue basing learning and development on the conviction of the "wisdom tiger curriculum syndrome". This syndrome

emphasizes that skills from the past must be learned and obtained. However much we value this, there is an urgent need to think about today and into the future”.

In this sense, the organization models of the universities to face the pandemic and post-pandemic, it is incumbent on them to reformulate from the foundations; That is, to have visionary leaders, with the ability to adapt quickly to change, aware of how convenient it is for education to assume the Fourth Revolution, placing the student at the center of learning, training teachers, administrative staff, knowledge and skills, care and support, generating a culture around DT, leaving aside the copying of systems that can be successfully developed in other countries or regions but different from their characterization.

As expressed by Peter Drucker, “The foundation of effective leadership is carefully analyzing the mission of the organization, defining it and setting it clearly and visibly^[9]”.

The institutions urge executing leaders to horizontal, participatory governance based on cooperation, collaboration with an approach to the university community, “in the governance process various actors intervene, government, civil society organizations and companies generating a government of networks of interaction between the public, private and civil sectors according to Carrasco cited by Mera *et al.*^[10]. Among its priorities is attention to their particular needs, orienting its strategic objectives to the effective fulfillment of the goals and strengthening alliances with all the intervening actors.

The same authors present the conception of university governance, paraphrasing Brower, they point out “it is related to the procedures that enable the horizontal interaction of different public and private actors. Necessary dynamics in the field of higher education to enable social agreements and fulfill the mission of the university as such”.

The leader is additionally characterized by the knowledge conducive to giving impetus with substantial changes in teaching-learning, together with all the actors involved and the derived processes, settling in the digital transformation as an innovative strategy in the post-pandemic, preventing assuming the use of DT only as a temporary solution for isolation.

UNESCO is carrying out an initiative with a vision for 2050 called the futures of education, “learning to transform itself proposes to reexamine and rethink how education and knowledge can contribute to the global common good” in which the world population participates through its website in various ways.

The way of communication using digital channels allows a constant flow of beneficial information in the management of organizations by the imprint of speed, opening a direct, transparent, friendly communication

channel with the internal and external client, possibilities of increasing alliances with other HEIs or public and private entities, a dominant strategy in the post-pandemic resilient character.

Now, making a transfer to the teaching-learning process, rigid curricula focused exclusively on pedagogical strategies with a thought anchored to the fact that face-to-face education is unsurpassed in quality, requires that this paradigm be overthrown from the thought of the educational community and given a shift towards a broader vision that breaks these limits and allows higher education to advance in flexible environments, hybrids between face-to-face and virtuality.

We must break the mental scheme that greater learning is obtained if the class is only taught in the physical classroom, we must advance towards a mixture of digital tools and therefore the transformation of the educational model which will allow the achievement of the ultimate goal which is the student learning.

Designing institutions that can have a perspective of immediate change prepared for the future with a robust system that can give an immediate and efficient response to eventualities that limit presence. The measures taken in recent months were built on the spot and the HEIs tried to do their best, however, the educational centers were not prepared and theirs a need for a real digital transformation.

Of course, the quality of education is not only provided by using digital tools but it is an excellent contribution to better pedagogical practices that make learning effective. Although, the HEIs due to the pandemic were forced to a crash plan imparting remote education, this does not mean that a digital transformation has already been consolidated.

State-Company-University come to support the entire educational system aligning all possible allies in the achievement of mitigating the abrupt change from classroom to remote education and therefore, prioritizing the creation and implementation of a new pedagogical model based on new technologies, trying to minimize digital gaps, guaranteeing access to computer equipment and internet to the economically disadvantaged population or located in urban or rural areas where technology has not yet reached, in the latter case where community radio or television has a place institutional.

It should be added that when mentioning the digital gap, it should be seen in a broader concept of access and coverage to ICTs but also includes, paraphrasing Westerman^[11], the difference between companies that have learned the true value of ICTs. New digital technologies and their momentum within the organization and among those that omitted the digital domain.

Given the above, teaching also has to evolve and revolutionize static, repetitive thinking to a holistic,

analytical one with the use of new dynamic teaching methodologies, they master digital skills that allow them to use technological instruments, together with didactic and pedagogical training to know how to use this technology.

For Morales Arce, the development of digital teaching skills considers: "From this perspective, teacher training in ICT is one of the priority areas in the current knowledge society as it plays a vital role in the main lines in which it will be framed our educational systems in this new century which will focus on innovation, globalization, the breaking down of cultural and linguistic borders, virtual mobility of students, emigration and continuous training^[12]. The student-teacher interaction with the apprehension of an innovative teaching-learning model will give a new meaning to education.

Digital transformation is taking a step ahead of the hand with Computer Science, this means that the entire educational model should not be eliminated but rather improve it, make it more flexible, expanding the criterion to a hybrid system of presence, combining it with the use of technology.

CONCLUSION

The answer to the initial question is that digital transformation is indisputably an axis on which universities and specifically engineering education must generate a paradigm shift in the face of the challenge of overcoming the crisis produced by the pandemic and the challenge of facing the post-pandemic. Although, in Colombia the availability, accessibility, acceptability and availability of education already had serious effects that, indeed if adequate measures are not taken, there will be a setback and the quality will decrease where this last assertion will be answered in future studies of how it was affected the quality of education with emergency measures where each institution and teacher tried to come out ahead.

The Fourth Industrial Revolution has a transversal effect in all sectors where education has a predominant role and together with its institutions, its action will be with a resilient and innovative approach to face the post-pandemic.

For its part, DT in the teaching-learning processes must be inserted into training the use of technology which does not mean that the teacher should put aside the advances made up to now in the presence but have a conceptual modification in new ways of educating integrating tools given by technology as pedagogical strategies. What is proposed here is a hybrid system not only in the post-pandemic but the insertion of technological advances revolutionizing the experience of learning combined with activity in the classroom, opening more accessible spaces for interaction with a diversity of universities within and outside the country.

The training of teachers in the proper use of technologies must be permanent because inevitably there will be a setback from staying in face-to-face education without the use of ICT and, on the other hand, its use absent from implementation through strategies pedagogical would generate another inconvenience and is the non-fulfillment of the aim of education that is learning. There would be a setback as this shared knowledge would be forgotten, generating gaps in education which can be measured in further research.

We must rethink education as the global health situation inevitably slows down educational processes. The awareness of the improvement of the quality and coverage of higher education with the proper use of ICTs will allow their use not to be taken as a short-term remedy in order to face the pandemic but rather be seen as an innovation in the way of teaching and learning in the post-pandemic.

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