ISSN: 2765-8252
Vol. 4. Nro. 4.
Recepción: 15-07-2021 Aprobación: 14-10-2021

# The cyber-learning paradox: facts, myths and expectations about the impact of digital technologies on learning and cognition

# La paradoja del ciberaprendizaje: hechos, mitos y expectativas sobre el impacto de las tecnologías digitales en el aprendizaje y la cognición

Libert Alonso Vergara Novoa[1] (olvergaran@unal.edu.co) (https://orcid.org/0000-0003-3842-1321)

Dany Andrey Latorre Mendez[2] (dlatorre@uan.edu.co) (https://orcid.org/0000-0003-2735-0353)

## Abstract

The impact of Information and Communication Technologies (ICTs) on learning remains one of the most controversial topics among scholars. There are experts who see them as the cornerstone of a revolution in education but others consider that ICTs have been overrated, as it was the case with radio and television in the twentieth century. This study attempted to analyze the potential and actual value of ICTs on learning and cognition, based on a qualitative content analysis that allowed to contrast the results of 150 research articles published between 2006 and 2021, with international reports and scholars' contributions to the topic in discussion.

**Key words**: Information and Communication technologies, digital technologies, cyber-learning, cognition, qualitative content analysis.

## Resumen

El impacto de las Tecnologías de la Información y la Comunicación (TIC) en el aprendizaje sigue siendo uno de los temas más controvertidos entre los académicos. Hay expertos que las ven como la piedra angular de una revolución en la educación, pero otros consideran que han sido sobrevaloradas, como ocurrió con la radio y la televisión en el siglo XX. Este estudio tiene como objetivo analizar el valor potencial y real de las TIC en el aprendizaje y la cognición, a partir de un análisis de contenido cualitativo que permitió contrastar los resultados de 150 artículos de investigación publicados entre 2006 y 2021, con los informes internacionales y las aportaciones de los académicos al tema en discusión.

[1] Licenciado en Filología e Idiomas. Master en Educación. Docente en la Universidad Antonio Nariño y en la Universidad Nacional de Colombia. Bogotá, Colombia.

[2] Licenciado en Educación Básica con Énfasis en Humanidades e inglés. Especialización en Gerencia y Proyección Social de la Educación. Master en Educación. Doctorando en Educación. Docente en la Universidad Antonio Nariño-Bogotá, Colombia.

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

**Palabras clave**: Tecnologías de la información y la comunicación, tecnologías digitales, ciber-aprendizaje, cognición, análisis de contenido cualitativo.

## Introduction

Access to information has been democratized as never before in history, due to the use of information and communication technologies (ICTs), giving rise to the Digital Knowledge Age (Logan, 2013), also called the Second Machine Age by Brynjolfsson and McAfee, (2014). These technologies have had an impact that far transcends the circulation and access to information as they have revolutionized every aspect of human life (Schwab, 2016; Sternberg, & Preiss, 2005).

Interpersonal relationships, work, purchasing of goods and services, communication and learning are just some of the fields that have been altered, for better or worse, by ICTs. Although time and research are required to determine the large-scale consequences of this hyper-technological stimulation in human behavior and in society, it is clear that digital technologies are already imbricated into the texture of daily life and they have become essential resources to forge the upcoming future (Rifkin, 2014; Pozo, 2016).

If in the industrial age, mechanical tools replaced physical force at work, in the age of knowledge, ICTs are called upon to overcome the limitations of human cognition (Brynjolfsson and McAfee, 2014). In this sense, they can be classified as cognitive technologies or material tools, using the Vygostskian terminology, which have the potential to enhance intellectual performance (Kozulin, 2000; Pea, 1985).

In regard to education, digital technologies undoubtedly play a very important role. In fact, a significant number of enthusiastic advocates of these devices in schools and universities see them not only as valuable resources for teaching and learning but as the fundamental tools to promote a radical change in the educational paradigm (Diamandis, 2020; Gee, 2017, 2011; Prensky, 2014; Hertz, 2019; Fullan, 2012; Thomas & Knezek, 2008). As a consequence, an increasing number of contemporary pedagogical approaches use ICTs as their cornerstone.

In the meantime, the number of skeptics has grown: from those who believe that there is an overvaluation of their impact on education as it already happened with television and radio in the twentieth century (Cobo and Moravec, 2011; Tedesco, 2008), to the ones who argue that new technologies not only alienate and dehumanize people but also deteriorate physical, emotional and cognitive health (Desmurget, 2019).

These views and beliefs seem to have hardened during the pandemic emergency. According to a United Nations report released in 2020, approximately 1.6 billion people around the world have been affected with the largest crisis of education systems in

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

history, triggered by COVID-19 (United Nations, 2020), and the need for an urgent solution has inevitably led to the expansion of ICTs in education in the form of remote teaching and online learning.

It has been a temporary response to the crisis and there is no certainty of the results yet. Nevertheless, for some digital expansion advocates it is the golden opportunity to accelerate the Screen New Deal, as Naomi Klein calls it, and implement a “smarter education system” among other radical changes (Klein, 2020).

Indeed, the way people conceive education is going to change after the pandemic but, is the escalation of ICTs really transforming teaching and learning for the better? What evidence validates its effectiveness? This article seeks to generate reflection on the actual impact of digital technologies on learning and cognition based on a qualitative content analysis of the following sources: research papers published on Scopus databases between 2006 And 2021 about this matter; international reports; and critical views stated by scholars.

## Literature review

### Education and ICTs

Information and Communication Technologies or ICTs have occupied a prominent place for debate on human education and training since the nineteen sixties (Higgins, Xiao and Katsipataki, 2012). At the present moment, such discussions have become even more relevant because the current educational paradigm is in a crisis (Gerber, 2010, Robinson & Aronica, 2016; Pozo, 2016; Zubiría, 2013, 2006), and most of the alternatives for change imply the use of technologies in a higher or lower degree.

In general, traditional methodologies and curricula centered on the transmission and reproduction of information were considered to be meaningful in the context of the industrial society but they do not seem to be functional to meet the expectations of the knowledge age and the youngest generations. ICTs are valued as tools with a high potential to facilitate learning and cognitive development because of the easy access to enormous sources of information and their multimedia versatility, intertextuality and interactivity, (Prensky, 2009; Pletka, 2007; Siemens, 2005; Resnick, 2002).

However, although computers, tablets and cell phones connected to the internet in conjunction with the wide variety of applications and software, allow people to access all kinds of data anywhere and anytime, it is not a proven fact that technologies enhance learning or cognitive performance (Luri, 2020; Romero & Vergara, 2014).

In this regard, the results of international tests such as PISA, PIRLS and TIMSS in recent years, have called into doubt the benefits of ICTs but at the same time, they confirm that the current educational system is unable to properly develop the skills

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

required in the 21st century, characterized by complexity, uncertainty and constant change; so, its reconfiguration becomes an urgent issue. But, how is it possible to rethink education? What role should ICTs play in this scenario? The answers crucially depend on the actual and factual contributions of new technologies to learning and the development of cognition.

In order to have a clear view of this phenomenon, some specific characteristics of learning, cognition and new information and communication technologies are to be reviewed; in addition, cyber-learning or digital learning, broadly understood as learning mediated by technologies, will be analyzed as an emergent notion.

Learning and cognition

If it is accepted that the raison d'être of education is the development of the whole human being, it is necessary to have a clear understanding of the different factors involved in learning: the cognitive factors with the different mental processes and representations; the affective factors, which refer to emotional and motivational characteristics; and, the social and contextual factors, it is to say, the interactions among human beings, symbolic instruments, and technological artifacts.

According to Dehaene (2019), learning consists of grasping a fragment of reality in order to form an internal model of the world. It is therefore a dynamic and complex process that not only involves acquiring long-lasting and transferable knowledge, skills and behaviors, but also modifying them according to new experiences (Schunk, 2012).

Additionally, learning can take place implicitly or explicitly. In the first case, knowledge is acquired randomly and without conscious attention. It is the product of constant interaction with the environment and the assimilation of perceived regularities. A good example of this is the acquisition of the mother tongue. In the second case, learning happens in a deliberate and organized way, it involves determining goals and requires cognitive and metacognitive strategies, as it happens when learning to read and write or when studying a foreign language (Pozo, 2016).

Learning depends on cognition, which according to the computational representational understanding of mind (CRUM), is assumed as the set of computational procedures that operate on the representational structures of the mind allowing to process the information received through perception and giving origin to thinking (Thagard, 2005, 2006). Experimental designs and simulations with artificial intelligence have been the main means by which cognitive psychology seeks to understand how subjects perceive, remember, understand, produce new ideas, solve problems, and make decisions (Sternberg, Sternberg & Mio, 2012).

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

In this sense, it is relevant to say that although the underlying mental processes involved in learning are the same for all humans, it does not mean that everyone learns in the exact same manner. There are individual differences related to age, cognitive style, learning pace, previous knowledge, and motivation, among others, which in turn require specific types of sensory stimuli and learning strategies. The current educational paradigm does not effectively satisfy these differences since it tends to promote a homogeneous teaching process designed for groups of students with similar cognitive, affective, and social traits.

Distributed cognition and cognitive technology

The contributions of cognitive psychology have been essential to understand how learning happens and therefore to improve classroom practices. However, the classical approach to cognition has restrictions as it is mainly concerned with the individual mind and its reasoning processes.

Consequently, it has tended to neglect emotional and social dimensions, which play a significant role in the development of thinking skills and learning. Besides, the mind has limitations in memorizing, retrieving, and processing information, as well as in problem solving and then, humans appeal to different types of cognitive technologies, work collaboratively to achieve common goals, and design special learning settings.

This interaction between subjects, artifacts, and the environment has been called distributed cognition; its conceptual value lies in the fact that it enables understanding the role that technological tools, semiotic instruments, and human scaffolding play in cognitive development (Hutchins, 1994; Salomon, 1996; Vergara and Perdomo, 2016).

According to Thagard, (2005), this theory has a high potential to research and to improve the human and computer interaction. It is from this perspective that the use of ICTs, seems to be highly relevant to learning, they operate as a cognitive prosthesis that supports processes such as analysis, synthesis and decision making, and allows humans to simplify a wide variety of tasks by overcoming the fallibility of memory.

Macluhan understood technologies as extensions of the mind and body (Logan, 2013) and some contemporary scholars who have aligned with this idea, consider that ICTs enhance intellectual performance at such a level that the process can be understood as cognitively distributed (Salomon, Perkins, and Globerson, 1992), or as an extended mind process (Clark, 2008; Estany & Sturm, 2014; Menary, 2010; Logan, 2007, 2013; Chemero, 2009; Crisafi & Gallagher, 2010).

Cyber-learning

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

Virtual environments and methodologies based on the use of computers and networks have enabled the entry of ICTs into schools, generating a new way of accessing and processing information, which might be generically called cyber-learning or digital learning. Although there is not absolute consensus with regard to its conceptualization, it can be stated that cyber-learning refers to any methodology or educational approach that is mediated by the use of new technologies and that allows students to access the sources of information in many different ways (Montfort & Brown, 2013).

These include pedagogical approaches such as Connectivism (2004); trends like Fully Online Learning, Blended and Hybrid Learning, Massive Open Online Courses (MOOCs), and Open Learning (Bates, 2015); learning models like the Flipped Classroom or Self-Organized Learning Environments (SOLE), as well as strategies based on Gamification or augmented reality. Obviously, all of them depend on the efficient use of networks, software, applications and digital devices in a way that learning opportunities are expanded both inside and outside schools.

Cyber-learning is still in its early stages; for this reason, different institutions around the world such as the National Science Foundation in the United States (NCT, 2013), insist on the need to increase research in order to establish more powerful links between learning and ICTs.

The importance of research in this field lies on the fact that it would lead to the emergence of a profound synergy between technologies and learning without generating cognitive and emotional dysfunctions, as some scholars claim (Ophira, Nass & Wagner, 2009; Carr, 2011, Greenfield, 2014), and therefore shaping the possibility to design true teaching and learning ecosystems.

Even though it is a recent area of research, the digital learning potential seems promising. In this sense, a variety of increasingly sophisticated resources offered by virtual reality, augmented reality, and gamification will increase learning opportunities inside and outside of schools. In fact, some emergent technologies based on contributions from cognitive psychology, neuroscience and ergonomics, are being developed to enhance the human-machine relationship.

These technologies can get adapted to individual human needs and have the potential to improve performance in areas such as attention, memory and decision making, generating synergies known as augmented cognition and augmented social cognition, which in the future might help to shape powerful virtual learning ecosystems (Ed, 2009; Reeves, Schmorrow & Stanney, 2007).

## Methodology

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

By means of a qualitative content analysis, an evaluation of arguments, perspectives and research data was done in order to determine the impact of ICTs on learning and on the development of cognitive processes. Content analysis is an interpretative technique which deals with quantitative or qualitative procedures, and seeks to understand objectively and systematically, communicative products or written, iconic, sound or verb-iconic texts, using content and context as a frame of cognitive, social, and cultural reference (López, 2009; Piñuel, 2002.

As content analysis is used to describe and infer knowledge from the texts themselves and their relationship with the situational and circumstantial conditions in which they arise, it provides a higher level of interpretability and trustworthiness (Bardin 1996; Krippendorff 1990).

In the current study, a qualitative content analysis was carried out by using a cross-sectional design, in which different postures were examined and some global categories were established. The research process had three general stages:

The first one was devoted to the search, selection, analysis and categorization of the corpus, which in this case was compound by one hundred fifty papers published between 2006 and 2021 in peer-reviewed journals indexed in the Scopus database. This interval of time has been the one with the highest number of publications related to the use of ICTs in education. The reports were selected with no preference for a specific level of education (primary, secondary or tertiary) or a pedagogical approach but assisted by ICTs.

Once the criteria were defined, the articles were selected randomly. Two broad conceptual categories were established according to the specificities of the study: 1. Research reports presenting positive effects of ICTs on learning or cognitive skills; 2. Research reports presenting results with little or no incidence of ICTs on learning or cognitive skills.

During the second stage, the data that resulted from the analysis of the articles was contrasted with the information given by experts and scholars in documents, books and reports, regarding three key points: 1. The scientific findings concerning the impact of new technologies on learning and cognitive performance; 2. Academic views for and against the use of ICTs in education; 3. Information derived from international standardized tests results related to the topic in discussion. In the final stage, some pedagogical insights were drawn based on the inferential process carried out during the analysis of the information.

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

As it has been said, the articles were selected from the Scopus database which belongs to the ELSEVIER platform. This database facilitates the search of academic abstracts from different areas of knowledge. In the same way, this tool allows the measurement, evaluation and impact factor of the scientific production. The criteria taken into account for the search were:

A. Review of the characteristics of the paper: theme addressed, journal where it was published, country, classification quartile according to the ranking developed by Scimago Journal and Country Rank and supported by Scopus.

B. Identification of the articles published in Scopus type journals between 2006 and 2021.

C. Detection of the place of origin or geographical context in which the studies were developed.

D. Recognition of the most frequent indexation databases that support the arbitration of the analyzed magazines.

E. Classification of the articles by educational level in which they were developed.

F. Identification of the fields of study of the articles analyzed.

Subsequently, the Scopus database was accessed and the search was established based on the option "advanced search", generated by the system, with the aim of obtaining publications related to the topic of analysis of this article. In order to do it, the following steps were performed:

First, the words “Information and communication technologies in learning" were typed, to obtain the primary results. Later the order of the filters established in the database was followed, according to the years in which the articles were possibly published. Then, the sub-areas of knowledge "Social Sciences" and “Arts and Humanities" were selected. Finally, the keywords to specify the search were added: teaching, education, learning, cognition"

The first search yielded approximately 470 articles, from which 150 publications were chosen taking into account parameters such as:

- Studies around experiences in the classroom at different educational levels. (Basic, secondary, higher education, among others).

- Studies conducted in various geographical contexts.

- Studies conducted in inclusive classrooms.

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

- The state of the art in relation to ICT.

- Studies conducted on the use and impact of social networks in education.

- Studies on teaching, learning and cognition in relation to ICT.

Results and Discussion

After selecting and analyzing the basic data related to the articles, the information was organized as it is shown in table 1. The period of time of publication of the articles analyzed, as well as the number of authors who took part in the preparation of the articles and the number of journals were established.

**Table 1**

| | |
|---|---|
| PERIOD OF TIME | 2006-2021 |
| NUMBER OF ARTICLES | 150 |
| NUMBER OF AUTHORS | 244 |
| NUMBER OF JOURNALS | 73 |

Some other important details about the journals, the quartiles and the country of origin are shown in table 2.

**Table 2**

| | ***JOURNAL*** | **NUMBER OF ARTICLES SELECTED BY JOURNAL** | **QUARTILE ACCORDING TO SCIMAGO-SCOPUS** | **COUNTRY** |
|---|---|---|---|---|
| 1 | Revista de Investigación Educativa | 3 | Q1 | Spain |
| 2 | Comunicar | 3 | Q1 | Spain |
| 3 | Educación XX1 | 3 | Q1 | Spain |
| 4 | Computers in Human Behavior | 2 | Q1 | United Kingdom |
| 5 | Computers and Education | 22 | Q1 | United Kingdom |
| 6 | British Journal of Educational Technology | 12 | Q1 | United Kingdom |
| 7 | Internet and Higher Education | 1 | Q1 | United Kingdom |
| 8 | International Journal of Educational Development | 2 | Q1 | United Kingdom |
| 9 | Journal of Computer Assisted Learning | 1 | Q1 | United Kingdom |
| 10 | New Library World | 1 | Q1 | United Kingdom |
| 11 | Learning, Media and Technology | 1 | Q1 | United Kingdom |
| 12 | Medical Education | 1 | Q1 | United Kingdom |
| 13 | Journal of Computer Information Systems | 1 | Q1 | United Kingdom |
| 14 | Disasters | 1 | Q1 | United Kingdom |
| 15 | Aslib Proceedings: New Information Perspectives | 1 | Q1 | United Kingdom |
| 16 | Quality Assurance in Education | 2 | Q2 | United Kingdom |

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

| | | | | |
|---|---|---|---|---|
| 17 | Asian Social Science | 1 | Q2 | Canadá |
| 18 | Computers in the Schools | 5 | Q2 | United States |
| 20 | Technology in Society | 1 | Q2 | Netherlands |
| 21 | Education and Information Technologies | 1 | Q2 | United Kingdom |
| 22 | International Journal of Engineering Education | 1 | Q2 | Ireland |
| 23 | European Journal of Special Needs Education | 1 | Q2 | United Kingdom |
| 24 | Cultura y Educación | 1 | Q2 | United Kingdom |
| 25 | Nurse Educator | 1 | Q2 | United States |
| 26 | Revista Electrónica Educare | 6 | Q3 | Costa Rica |
| 27 | *International Journal of Information and Communication Technology Education* | 4 | Q3 | United States |
| 28 | Journal of Information Technology Education | 2 | Q3 | United States |
| 29 | International Journal of Innovation and Learning | 1 | Q3 | United Kingdom |
| 30 | Scire | 1 | Q3 | Spain |
| 31 | International Journal of Web Based Communities | 1 | Q3 | United Kingdom |
| 32 | Proceedings of the LACCEI International Multi-conference for Engineering, Education and Technology | 2 | Q3 | United States |
| 33 | Historia y Comunicación Social | 1 | Q3 | Spain |
| 34 | Revista Iberoamericana de Tecnologías del Aprendizaje | 2 | Q3 | United States |
| 35 | International Journal of Virtual and Personal Learning Environments | 1 | Q3 | United States |
| 36 | Human Factors and Ergonomics In Manufacturing, | 1 | Q3 | United States |
| 37 | International Journal of Continuing Engineering Education and Life-Long Learning | 1 | Q3 | United Kingdom |
| 38 | Library Philosophy and Practice | 1 | Q3 | United States |
| 39 | Formación Universitaria | 4 | Q3 | Chile |
| 40 | International Journal of Technology Enhanced Learning | 1 | Q3 | Switzerland |
| 42 | Problemos | 1 | Q3 | Lithuania |
| 43 | Información Tecnológica | 1 | Q3 | Chile |
| 44 | Revista Electrónica Interuniversitaria de Formación del Profesorado | 1 | Q3 | Spain |
| 45 | Profesorado. Revista de Curriculum y Formación del Profesorado. | 2 | Q3 | Spain |
| 46 | Revista de Investigación Operacional | 1 | Q4 | Cuba |
| 47 | Ciencia da informacao | 1 | Q4 | Brazil |
| 48 | Revista Ibérica de Sistemas e Tecnologías de Informacao | 2 | Q4 | Portugal |
| 49 | Revista de Psicología (PUCP) | 1 | Q4 | Perú |
| 50 | Revista Lasallista de Investigación | 1 | Q4 | Colombia |
| 52 | Artseduca | 1 | Q4 | Spain |
| 53 | Technics Technologies Education Management | 1 | Q4 | Bosnia and Herzegovina |
| 54 | International Journal of Technologies in Learning | 1 | Q4 | United States |

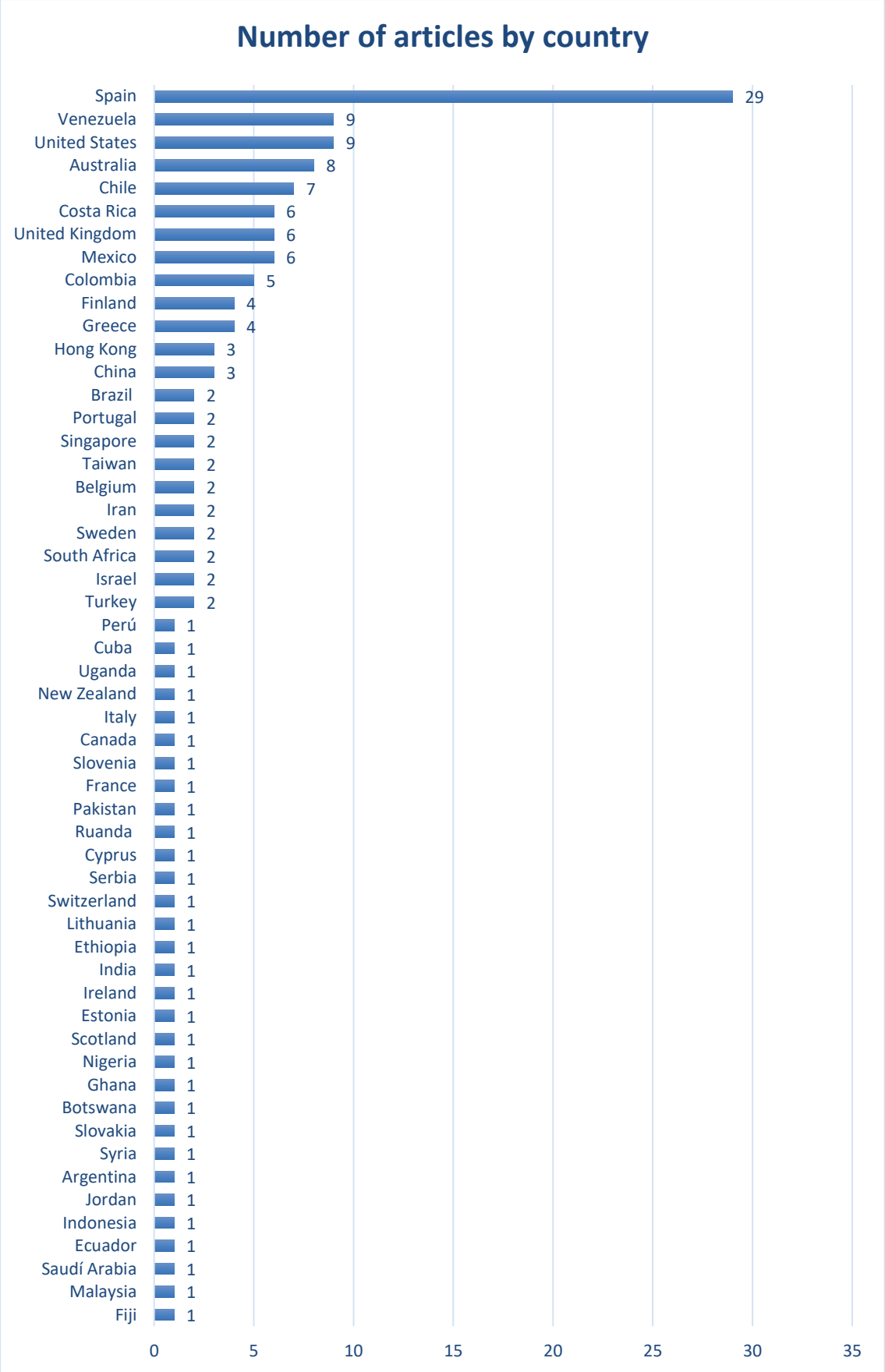
ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

| | | | | |
|---|---|---|---|---|
| 55 | Multicultural Education & Technology Journal | 2 | Q4 | United Kingdom |
| 56 | Bulletin of the Technical Committee on Learning Technology | 1 | Q4 | Taiwan |
| 57 | International Journal of Metadata, Semantics and Ontologies | 1 | Q4 | United Kingdom |
| 58 | Computers in Education Journal | 1 | Q4 | United States |
| 58 | PIXEL-BIT. Revista de Medios y Educación | 3 | Q2 | Spain |
| 59 | Utopía y praxis Latinoamericana | 1 | Q3 | Venezuela |
| 60 | Revista electrónica de investigación educativa | 5 | Q2 | México |
| 61 | Revista Educar | 1 | Q3 | Spain |
| 62 | Revista Espacios | 8 | Q3 | Venezuela |
| 63 | Educação & Sociedade | 1 | Q3 | Brasil |
| 64 | Campus Virtuales | 1 | Q3 | Spain |
| 65 | Journal of Educational Research | 1 | Q1 | United States |
| 66 | Ikala | 1 | Q3 | Colombia |
| 67 | International Journal of Emerging Technologies in Learning | 6 | Q2 | Germany |
| 68 | World Transactions on Engineering and Technology Education | 1 | Q3 | Australia |
| 69 | Revista Opción | 1 | Q3 | Venezuela |
| 71 | Estudios Pedagógicos | 1 | Q3 | Chile |
| 72 | Mediterranean Journal of Social Sciences | 1 | Q4 | Italy |
| 73 | Educación Química | 1 | Q4 | México |

In terms of the countries where the articles came from, the highest number was found in Spain (29), The United States and Venezuela with the same number of publications (9), Australia (8), Chile (7); Costa Rica, The United Kingdom and Mexico (6) and Colombia (5). More detailed data is shown in figure 1. The levels and fields of education that the articles dealt with are shown in figure 2 and figure 3, respectively.

**Figure 1**

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021



ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

Figure 2 below, shows the articles that have been published by level of education, according to the different organizations of the educational system in the world. 64 articles dealt with higher or tertiary education were found, being the level with the highest number of publications. 51 were related with primary and secondary education, 26 papers dealt with teacher training, and the lowest number of items (9) were detected in a category which did not specify the educational level but discussed the impact of digital technologies in education. It was identified as nonspecific level of education. There were no publications related with Pre-primary.

**Figure 2**

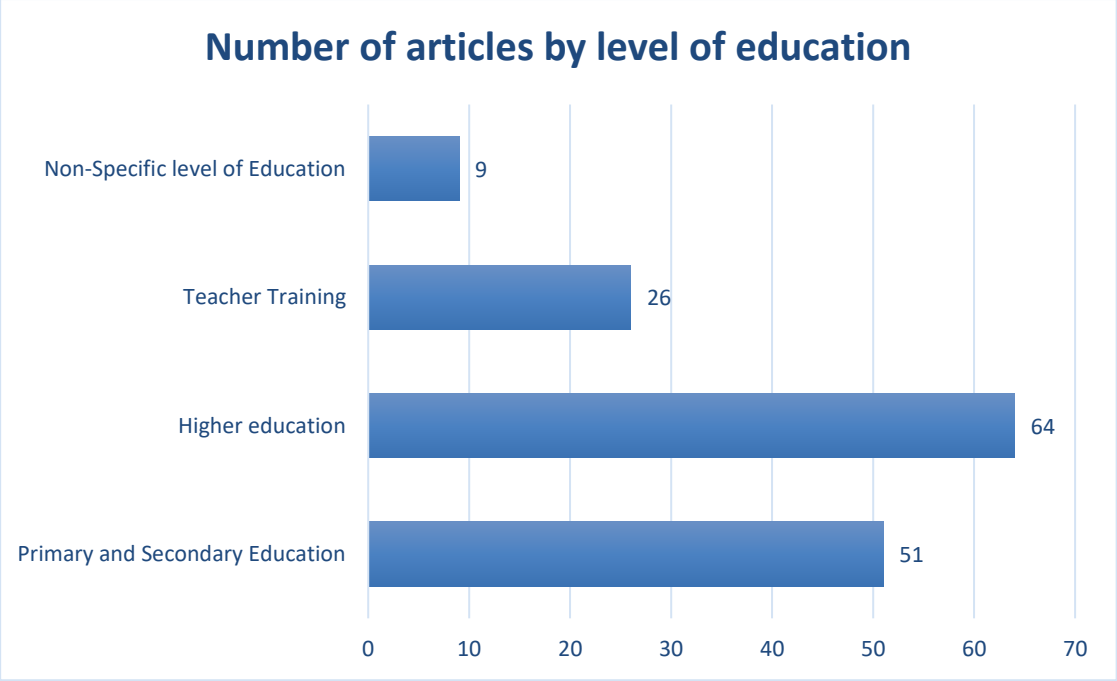
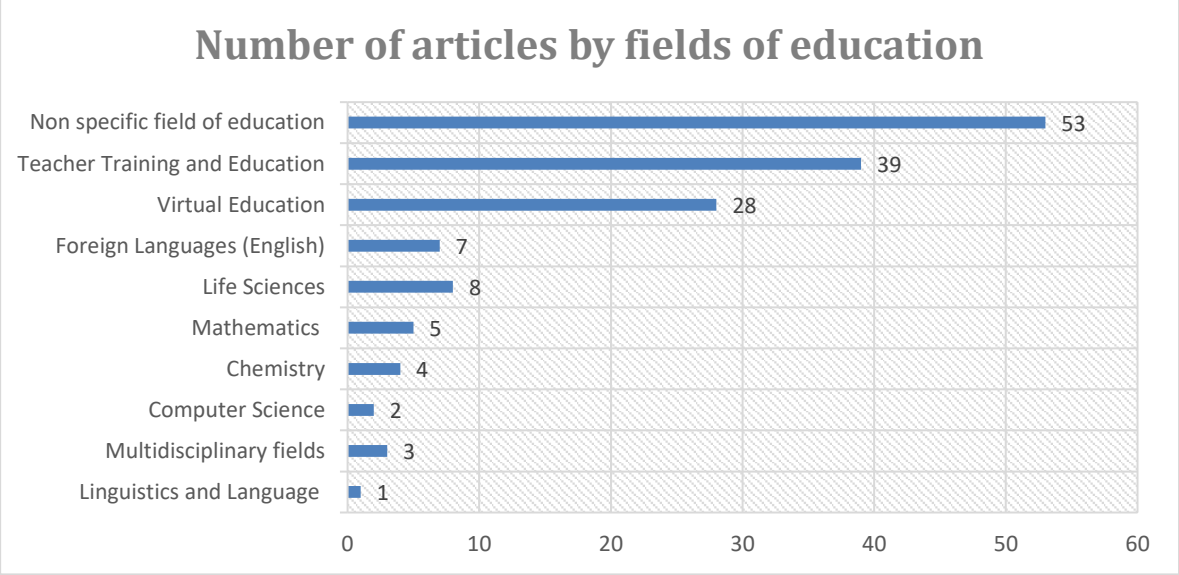



Figure 3 shows the articles that have been published by fields of education, the highest number was found in non-specific fields of education (53). These articles did not focus on a specific area of knowledge but on the advantages, contributions and studies related to the impact of technologies carried on education. The second highest number of articles was found in the Teacher training and Education field (39), followed by Virtual Education (28), Foreign Languages (7), Life Sciences (8), Mathematics (5), Chemistry (4) Computer Science (2), Multidisciplinary Fields (3), and finally, Linguistics and Language (1).

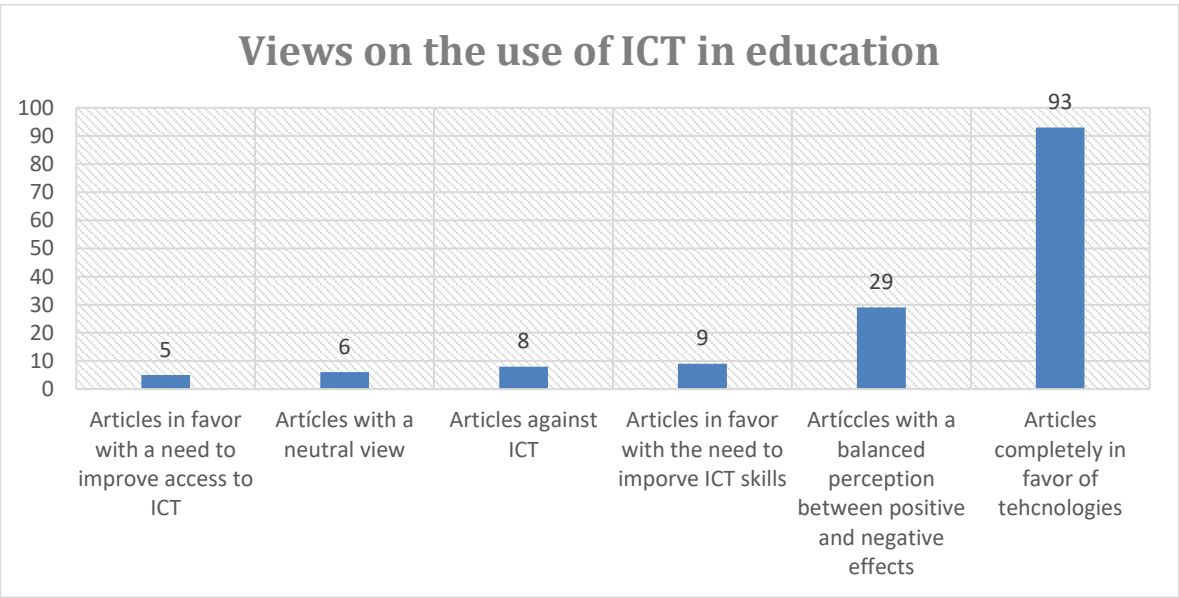
ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

**Figure 3**




All the articles were classified according to their results as can be seen in figure 4. 63.3% of the revised articles reported a full support of the use of technologies in education, highlighting a positive effect on learning and cognitive performance. 19.3% reported a balanced view between positive and negative effects. 8.1% showed mixed results with recommendations in order to make the most of digital technologies. Only 5.3% of the articles reported to be against of the use of technologies in the classroom and 4% had a neutral appreciation (neither in favor nor against).

**Figure 4**




The analysis showed that most articles reported positive effects in terms of learning and cognition. However, when it comes to measurable progress in standardized tests, for

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

example, the use of digital technologies in education does not seem to enhance learning outcomes meaningfully (Paùl, 2019; Zubiría, 2013). That is why it is relevant to reflect on these results bearing in mind the views of scholars who support or criticize the use of ICTs in the classroom, in order to delve into the true impact of technologies on learning and cognitive processes.

The scholars who support the use of digital learning emphasize that ICTs have the potential to increase the motivation to learn and facilitate the access and use of information through different multimedia resources able to adapt to individual interests, cognitive styles and learning pace. They also point out that autonomous learning might be easily enhanced due to the versatility of the web tools and hypertexts which allow individuals to search for information intuitively and easily.

Collaborative work seems to be another benefit since it is possible to perform team tasks and interact in synchronous or asynchronous sessions regardless of distance and time (Bergman & Sams, 2012; Mitra, 2012; Khan, 2012; Prensky, 2009; Christensen, Horn y Johnson, 2008; Pletka, 2007; Siemens, 2005). Due to these advantages, avant-garde proposals like the Flipped Classrooms, and the Self-Organized Learning Environments (SOLE), among others, have had an enthusiastic reception.

However, it is important to bear in mind that the digital learning outcomes might depend on four key factors: firstly, the technical conditions, i.e. infrastructure, quality and efficiency of equipment, and ease of access to the Internet; secondly, digital literacy, which implies the mastery of technological tools and computer programs; thirdly, psychological and cognitive conditions such as attention, willingness to work individually or in collaboration with others, and trained thinking skills (categorization, inference, analysis, synthesis, abstraction, among others). At last, but not least, a pedagogical approach, which requires to be coherent with the use of technological resources in order to get the most of them.

On the other hand, skeptics see ICTs only as a resource to support learning, not the cornerstone of an educational transformation. Those who assume this perspective, consider that a number of misconceptions have risen around new technologies and their users as a consequence of an over-expectation with no conclusive evidence (Adell & Castañeda, 2012; Wellings & Levine, 2009). These views are supported with academic reports that refute such misconceptions. A good example has to do with the skills attributed to millennials (Howe, & Strauss, 2000), digital natives (Prensky, 2009), net generation (Tapscott, 2009), app generation (Gardner, 2013) and all the ones who have had access to digital technologies since childhood, and seem to have different cognitive and behavioral characteristics from those belonging to the generations that preceded them.

One of such skills is multitasking, which, in this context, refers to the ability to develop various activities or use social networks and different applications simultaneously with a high level of efficiency and concentration (Prensky, 2009). However, what neuroscience studies have shown is that cognitive performance is optimized by doing one task at a

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

time because brain functions that require attention and memory are accomplished in a serial way.

So, trying to undertake different tasks at the same time, would often bring unsuccessful results and may lead to unwanted side effects (Nordengen, 2018; Ophira, Nass & Wagner, 2009; Bachrach, 2012). Research suggests that not only attention and concentration are more easily dispersed but also cognitive processing and long-term memory efficiency dramatically decline when many applications are used simultaneously, (Castells, 2011).

In extreme cases it can lead to addiction. Some brain imaging studies have demonstrated that some cognitive areas deteriorate as it happens to drug consumers. Hyper-connectedness also makes technology users less empathic and prone to depression and anxiety (Carr, 2015, 2011; Greenfield, 2014).

With regard to learning, the report Students, Computers and Learning (2015) presented by the Organization for Economic Co-operation and Development (OECD) shows that in countries that have made high investments in ICTs for educational institutions, there is no appreciable progress in science, mathematics and reading comprehension. The report also emphasizes that there is no evidence to support the idea that the use of computers helps to decrease the gap between high and low performing students.

Another report, The Impact of Digital Technology on Learning (Higgins, Xiao and Katsipataki, 2012), points out a similar tendency in countries like the United States and England, where longitudinal studies found a low correlation between the use of ICTs and better test scores. Only in some schools in England, meaningful statistical correlations were identified, according to the Teacher Training Agency Study. Nevertheless, it was attributed to the fact that suitable teachers were open to using innovative strategies and digital resources including the use of digital technologies.

An Australian report about the results of a national teachers and principals' survey on the use of technologies in schools released by the Gonsky Institute for Education (2020), determined that: "84 % believed devices were a growing distraction in classrooms; 78 % reported students' ability to focus on educational tasks had decreased; also, a decrease in student empathy (78 %) and physical activity (60 %), while four out of five (81 %) said they had seen an increase in online harassment and cyberbullying. Almost six out of 10 teachers and principals (59 %) reported a decline in students' overall readiness to learn over the last three to five years" (Gonsky Institute for Education, 2020).

In the Latin American context, the results of international tests like PISA, PIRLS and TIMSS also suggest that in the last decades, in which the use of new technologies has increased in education, there has not been evidence of any significant improvement neither in the development of argumentative, propositional and interpretative competencies, nor in the deductive and inductive operations of students (Paùl, 2019; Zubiría, 2013).

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

Peronard Therry (2007), reported that a research study about the differences between reading on paper and reading on computer screens, conducted with 158 freshmen from six different academic programs at the Pontificia Universidad Católica de Valparaiso (Chile), found that although the level of inferential comprehension was very low, the use of paper generated higher levels of comprehension and reading speed than the use of screens, results that are consistent with previous researches such as those conducted by Piolat, Roussey and Thuning ( 1997); Dillon, Richardson and McKnight (1990); And Kerr and Symons (2006).

Another study carried out between 2010 and 2011 by the Universidad Autónoma de Barcelona, the Institut Català de la Salut and the FPCEE Blanquerna (Ramon Llull University) identified, through a sample of 5538 Spanish students in compulsory secondary education, meaningful correlations between the use of ICTs and school failure and the use of ICTs and consumption of psychoactive substances.

Based on the information displayed above, a general overview of the possible benefits and dangers of technology can be grasped. However, these data must be analyzed critically to avoid misjudgments. It is true that the overuse of ICTs implies potential dangers, some researchers have investigated the consequences of an excessive or inappropriate manipulation of technologies, and it has to be taken into account by teachers and parents. In terms of learning, it implies that a balanced and appropriate use of ICTs must be encouraged (Coll, Mauri & Onrubia, 2008).

From the opposite view, some data derived from international tests and reports has generated uncertainty regarding these technologies given that ICTs in schools and universities do not seem to provide substantial advantages in learning and cognitive development. In this sense, it is clear that the mere presence of new technologies in classrooms is not enough to achieve higher learning outcomes.

In fact, one of the constant claims of some advocates of digital learning is that beyond the integration of ICTs in educational settings, innovative environments and strategies oriented to promote a new learning culture must be designed (Fullan & Langworthy, 2014; Thomas & Seely Brown, 2011; Resnick, 2002). This notion coincides with the Nesta report The Proof, Promise and Potential of Digital Education (2012), which stresses the crucial role of context and resources like people, tools, knowledge, and skills in learning by means of new technologies.

Another aspect that should be examined has to do with the variables that are usually taken for granted and, for that reason, neglected in the research reports, such as the technical conditions of the equipment and the network; the technological command of teachers and students; the suitability and relevance of the tasks, aligned with the learning objectives and the individual features of the learners (motivation, learning preferences, etc.), all of them related to the psychological and technical conditions described above which, under strict control, might increase the likelihood of success when using ICTs in classrooms.

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

These variables may have a positive or negative impact on performance, contributing to the complexity of the learning process. That is why it is difficult to determine the specific reasons of success or failure when using ICTs in educational contexts.

## Pedagogical insights and conclusions

Historian Peter Burke (2012) says it is possible to become information giants and at the same time knowledge dwarves. It implies that the information society does not necessarily lead to the emergence of a knowledge or a learning society.

In the educational context, this must be taken very seriously: although there is access to limitless sources of information as never before in human history, thanks to digital technologies and the internet, this does not mean that learning and comprehension are easier processes in the current world. In fact, in the ever-changing and complex societies of the liquid modernity, as Bauman called it (2000), where it is necessary to move from the sterility of certainties to the fecundity of uncertainties, (Max Nieff, 1991), it is unquestionable that these cognitive skills are even more difficult to develop.

This is why educational researchers must be constantly asking for the cultural and social conditions under the light of complexity before focusing on the procedures, which in the end, will only be provisional solutions demanding constant updating and elaboration.
Taking this scenario into account and based on the content analysis developed in this study, it is possible to state some pedagogical insights aimed at the designing of teaching and learning ecosystems mediated by the use of new technologies:

a. Although it is premature to assure that new technologies are by themselves the primary source needed to transform the educational paradigm in the 21st century, their omnipresence and potential to boost teaching and learning performance are undeniable. So, schools and universities are called upon to explore critically their advantages and limitations. Nevertheless, all the contributions from pedagogy, linguistics, psychology, and more recently, cognitive neuroscience, among other disciplines, should be taken into account when thinking about the role of ICTs in learning. In this way, learning research will be enriched rather than overshadowed by unrealistic expectations about the impact of the digital world on education.

b. A teaching and learning ecosystem, which incorporates the use of digital devices, requires a conceptual framework in which ICTs are more than mere accessories. In this sense, it is relevant to revise some theories like the ones of distributed cognition, situated cognition, the extended mind, and activity theory since they might work as epistemic platforms to investigate the learning processes from a holistic view where the interaction among mind, body, environment and technological artifacts has a prominent place, without leaving aside the practical, social, affective and ethical dimensions of learning.

c. Nowadays, it is clear that there are no universal methodologies that fully meet the individual needs and features of learners (Kumaravadivelu, 2012). So, it is necessary to have an inter-structuration approach to teaching and learning (Not, 2006), which implies that students and teachers participate actively in the

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

knowledge construction process taking into account their learning skills, styles, interests, and paces.

d. In a world where the misuse of technologies implies the risk of causing cognitive dysfunctions as research data suggests, learners need to be instructed in the responsible, efficient, and ethical use of ICTs. Additionally, educational institutions should promote whole learning experiences, powerful enough to strengthen cognitive, metacognitive, creative, social, affective, and practical skills, since it is clear that those who are critical, innovative and empathetic problem solvers will have more chance to succeed in a global society characterized by constant change, obsolescence of information and complexity but at the same time full of ubiquitous learning opportunities.

## Conclusion

Finally, it is relevant to say that, still, a lot of research must be done in order to get a more accurate discernment on the topic addressed in this article. Hence, future research has to determine the accurate impact of online academic programs and virtual courses on learning and cognitive skills. It is also important to determine the differences, both qualitative and quantitative, between on-campus and online or hybrid education.

## Recommendation

Another important recommendation has to do with cutting edge technological resources that are hastily widespread in educational settings without proving their effectiveness. Due to their amazing resourcefulness and novelty, these devices might dazzle teachers and students. Nevertheless, sometimes they are good at generating excitement and entertainment but very limited learning opportunities. Thus, it is highly advisable to be critical and cautious when testing these new products. It requires empowered teachers and researchers able to systematically assess new technologies in order to identify their real benefits and limitations in situ, and, consequently, rearrange teaching, learning and assessment practices according to the findings.

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

## References

Adell, J. & Castañeda, M. (2012). Tecnologías emergentes, ¿Pedagogías emergentes? In Tendencias emergentes en educación con TIC (pp.13-32). Espiral.

Bachrach, E. (2012). Ágilmente. Buenos Aires: Random House Mondadori.

Bardin, L. (1996). El análisis de contenido. Madrid: Akal.

Bates, A. W. (2015). Teaching in a digital age: guidelines for designing teaching and learning. Creative Commons. Retrieved from: https://www.tonybates.ca/teaching-in-a-digital-age/

Bauman, Z. (2000). Liquid modernity. Cambridge, UK: Polity Press.

Bergman, J. & Sams, A. (2012). Flip your Classroom: Reach Every Student in Every Class Every Day. Washington: International Society for Technology in Education.

Brynjolfsson, E. & McAfee, A. (2014). The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies. New York, NY: W. W. Norton & Company.

Burke, P. (2012). A social History of Knowledge, volume II. From the Encyclopedie to Wikipedia. Cambridge: Polity.

Carr, N. (2011). The Shallows: What the Internet is Doing to Our Brains. New York, NY: W. W. Norton & Company.

Carr, N. (2015). The Glass Cage. How Our Computers Are Changing Us. New York: W. W. Norton & Company.

Castells, M. (2011). Comunicación inalámbrica, economía y sociedad. In Comunicación móvil y desarrollo económico y social en América Latina (pp. 331-374). Ariel.

Chemero, A. (2009). Radical embodied cognitive science. Cambridge, MA: MIT Press/Bradford.

Chi, E. H. (2009). Augmented social cognition: using social web technology to enhance the ability of groups to remember, think, and reason. In Proceedings of the 2009 ACM SIGMOD International Conference on Management of data (SIGMOD '09), Carsten Binnig and Benoit Dageville (Eds.). ACM, New York, NY, USA, 973-984. https://doi.org/10.1145/1559845.1559959

Christensen, C., Horn, M. & Johnson, C. (2008). Disrupting Class: How Disruptive Innovation Will Change the Way the World Learns. McGraw-Hill.

Clark, A. (2008). Supersizing the mind: Embodiment, action, and cognitive extension. Oxford and New York: Oxford University Press.

Cobo, C. & Moravec, J. (2011). Aprendizaje Invisible. Hacia una nueva ecología de la educación. Col·leccio Transmedia XXI. Laboratori de Mitjans Interactius / Publicacions i: Barcelona: Edicions de la Universitat de Barcelona.

Coll, C., Mauri, T. & Onrubia, J. (2008). La utilización de las tecnologías de la información y la comunicación en la educación: del diseño tecno-pedagógico a las prácticas de uso. In Psicología de la Educación Virtual (pp. 47-103). Ediciones Morata.

Crisafi, A. & Gallagher, S. (2010). Hegel and the extended mind. AI & Soc (2010) 25: 123. https://doi.org/10.1007/s00146-009-0239-9.

Dehaene, S. (2019). How we learn. Why brains learn better than any machine. New York: Viking, Penguin Random House.

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

Desmurget, M. (2019). La fabrique de crètin digital. Paris: Editions du Seuil.
Diamandis, P. & Kotler, S. (2020). The Future Is Faster Than You Think: How Converging Technologies Are Transforming Business, Industries and Our Lives. New York: Simon & Schuster.
Dillon, A. (1992). Reading from paper versus screens: A critical review of the empirical literature. Ergonomics, 35(10), 1297-1326.
Estany, A. & Sturm, T. (2014). Extended cognition: New philosophical perspectives. Special Issue of Philosophical Psychology, 27(1), 2014. http://www.tandfonline.com/toc/cphp20/27/1#.Uw7BgXkzd0o
Fullan, M. (2012). Stratosphere: Integrating Technology, Pedagogy and Change Knowledge. Canada: Pearson.
Fullan, M. & Langworthy, M. (2014). A Rich Seam: How New Pedagogies Find Deep Learning. Canada; Pearson.
Gardner, H. & Davis, K. (2013). The App generation. New Haven: Yale University press.
Gee, P. & Hayes, E. (2011). Language and Learning in the Digital Age. Routledge.
Gerver, R. (2010). Creating Tomorrow's Schools Today. New York: Continuum.
Gonski Institute for Education. (2020). Growing Up Digital Australia: Phase 1 technical report. Gonski Institute for Education. University of South Wales (UNSW). https://www.teachermagazine.com/au_en/articles/the-impact-of-digital-technology-on-student-learning-and-wellbeing
Greenfield, S. (2014). Mind Change: How 21st Century Technology is leaving its mark on the brain. London, UK: Random House.
Hertz, M. (2019). Digital and Media Literacy in the Age of the Internet: Practical Classroom Applications. Maryland: Rowman and Littlefield.
Higgins, S., Xiao, Z. & Katsipataki, M. (2012). The impact of Digital Technology on Learning. Durham University.
Howe, N., & Strauss, W. (2000). Millennials rising: The next great generation. New York: Vintage Books.
Huertas, A., Vesga, G., Vergara, A. & Romero, M. (2015). Effect of a computational scaffolding in the development of secondary students' metacognitive skills, International Journal Technology Enhanced Learning, 7(2), 143-159.
Hutchins, E. (1995). Cognition in the wild. Cambridge, MA: MIT Press.
Kerr, M. & Symons, S. (2006). Computerized presentation of text: Effects on children's reading of informational material. Reading and Writing, 19, 1-19.
Khan, S. (2012). The One World School House. Education Reimagined. New York: Twelve.
Klein, N. (2020). Screen New Deal. https://naomiklein.org/the-screen-new-deal/
Kozulin, A. (2000). Instrumentos psicológicos: la educación desde una perspectiva sociocultural. Barcelona: Paidós.
Krippendorff, K. (1990). Metodología de análisis de contenido. Teoría y Práctica. Barcelona: Paidós.
Kumaravadivelu, B. (2012). Language Teacher Education for a Global Society: A Modular Model for Knowing, Analyzing, Recognizing, Doing, and Seeing. New York: Routledge.
Logan, R. K. (2007). The Extended Mind: The Emergence of Language, the Human Mind and Culture. Toronto: University of Toronto Press.

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

Logan, R. K. (2013). Mcluhan extended and the extended mind thesis (EMT). AVANT. The Journal Of The Philosophical-Interdisciplinary Vanguard, 4(2), 45-58. Available at http://openresearch.ocadu.ca/id/eprint/841/

López Noguero, F. (2009). El análisis de contenidos como método de investigación. Revista de Educación, 4(2002), 167-179. Retrieved from http://rabida.uhu.es/dspace/bitstream/handle/10272/1912/b15150434.pdf

Luckin, R., Bligh, B., Manches, A., Ainsworth, S., Crook, C. & Noss, R. (2012). The Proof, Promise and Potential of Digital Education. London: Nesta.

Luri, G. (2020). La escuela no es un parque de atracciones. Barcelona: Ariel.

Max-Neef M. De la esterilidad de la certeza a la fecundidad de la incertidumbre. Planteamientos en Educación (Bogotá). 1991; 2 (3):33-

Mitra, S. (2012). Beyond the Hole in the Wall: Discover the Power of Self-Organized Learning. TED books.

Menary, R. (ed.) (2010). The Extended Mind. Cambridge, MA: MIT Press/Bradford.

Monford, D. & Brown, S. (2013). What Do We Mean by Cyberlearning: Characterizing a Socially Constructed Definition with Experts and Practitioners? Journal of Science Education and Technology, 22(1), 90–102. doi: https://doi.org/10.1007/s10956-012-9378-8

Muñoz-Miralles, R. et al., (2014). Acceso y uso de nuevas tecnologías entre los jóvenes de educación secundaria, implicaciones en salud. Estudio JOITIC. Atención Primaria, 46(2), 77-88. http://www.sciencedirect.com/science/article/pii/S021265671300187X

National Science Foundation (2012). Cyberlearning: Transforming Education. Program Solicitation. http://www.nsf.gov/pubs/2011/nsf11587/nsf11587.pdf

Not, L. (2006). La enseñanza dialogante: hacia una educación en segunda persona. Barcelona: Herder.

Nordengen, K. (2016). Your Superstar Brain. London: Piatkus

OECD (2015). Students, Computers and Learning: Making the Connection, PISA, OECD Publishing. http://dx.doi.org/10.1787/9789264239555

Ophir, E., Nass, C. & Wagner, A. D. (20019). Cognitive Control in Media Multitaskers. Proceedings of the National Academy of Sciences. https://doi.org/10.1073/pnas.0903620106.

Paùl. F. (2019, December 6). Pruebas PISA: qué dice de la educación en América Latina los malos resultados obtenidos por los países de la región. BBC News. https://www.bbc.com/mundo/noticias-america-latina-50685470

Pea, R. (1993). Practices of distributed intelligence and designs for education. In Distributed cognitions: Psychological and educational considerations (pp. 47-87). Cambridge University Press.

Peronard, M. (2007). Lectura en papel y en pantalla de computador (Reading from paper and from computer screen). Revista Signos, 40(63), 179-195 http://dx.doi.org/10.4067/S0718-09342007000100009

Piñuel, J. L. (2002). Epistemología, metodología y técnicas del análisis de contenido. Estudios de Sociolingüística, 3(1), 1-42. https://www.ucm.es/data/cont/docs/268-2013-07-29-Pinuel_Raigada_AnalisisContenido_2002_EstudiosSociolinguisticaUVigo.pdf

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

Piolat, A., Roussey, J-Y. & Thuning, O. (1997). Effects of screen presentation on text reading and revising. International Journal of Human-Computer Studies, 47(4), 565-589.

Pletka, B. (2007). Educating the Net Generation: how to engage students in the 21st century. Santa Monica: Santa Monica Press.

Pozo, J. I. (2016). Aprender en tiempos revueltos. La nueva ciencia del aprendizaje. Madrid: Alianza Editorial.

Prensky, M. (2014). The World Needs a New Curriculum. The Global Future Education Foundation and Institute.

Prensky, M. (2010). Teaching Digital natives. Partnering for Real Learning. California: Corwin, Sage Company.

Reeves, L., Schmorrow, D. & Stanney, K. (2007). Augmented Cognition and Cognitive State Assessment Technology – Near-Term, Mid-Term, and Long-Term Research Objectives. In Foundations of Augmented Cognition (pp. 220-228). Springer.

Resnick, M. (2002). Rethinking Learning in the Digital Age. In The global information technology Report: Readiness for the networked world (pp. 32-37). Oxford University press.

Rifkin, J. (2014). The Zero Marginal Cost Society: The internet of things, the collaborative commons, and the eclipse of capitalism. New York: Palgrave Macmillan,

Robinson. K. & Aronica, L. (2016). Creative Schools: The Grassroots Revolution That's Transforming Education. New York: Penguin.

Romero, M. & Vergara, A. (2014). Virtual Learning Environments and Metacognition: a bibliometric study in the Latin American context. Papeles, 6 (11), 72-86.

Salomon, G. (1996). Distributed Cognitions. Psychological and educational Considerations. New York: Cambridge University Press.

Salomon, G., Perkins, D. & Globerson, T. (1992). Partners in Cognition: Extending Human Intelligence with intelligent Technologies. Educational Researcher, Vol. 20, N. 3, pp. 2-9.

Schwab, K. (2016). The Fourth Industrial Revolution. Geneva: World Economic Forum.

Schunk, D. H. (2012). Learning theories: an educational perspective. Boston: Pearson.

Siemens, G. (2004). Conectivismo: Una teoría de aprendizaje para la era digital. En: https://es.scribd.com/doc/201419/Conectivismo-una-teoria-del-aprendizaje-para-la-era-digital.

Sternberg, R., Sternberg, K. & Mio, F. (2012). Cognitive Psychology. Belmont: Wadsworth: Cengage Learning.

Strenberg, R. & Preiss, D. (2005). Intelligence and Technology. The Impact of Tools on the Nature and Development of Human Abilities. New Jersey: Lawrence Erlbaum associates.

Tapscott, D. (2009). Grown up digital: How the Net generation is changing your world. New York: McGraw Hill.

Thagard, P. (2005). Mind: introduction to cognitive science. Boston: Massachusetts Institute of Technology.

Thagard, P. (2006). Hot thought: Mechanisms and Applications of Emotional Cognition. Boston: Massachusetts Institute of Technology.

Thomas L.G., Knezek D.G. (2008) Information, Communications, and Educational Technology Standards for Students, Teachers, and School Leaders. In: Voogt J.,

ISSN: 2765-8252
Recepción: 15-07-2021 Aprobación: 14-10-2021

Knezek G. (eds) International Handbook of Information Technology in Primary and Secondary Education. Springer International Handbook of Information Technology in Primary and Secondary Education, vol 20. Springer, Boston, MA. https://doi.org/10.1007/978-0-387-73315-9_20

Thomas, D. & Seely Brown, J. (2011). New Culture of Learning: Cultivating the Imagination for a World of Constant Change. Lexington: CreateSpace

United Nations (2020). Policy Brief: Education during COVID 19 and beyond.

Vergara, A., & Perdomo, M. E. (2016). Fortalecimiento de la expresión oral y escrita en inglés a través de un andamiaje de escritura creativa colaborativa: un estudio de diseño desde la cognición distribuida. Forma y Función, 30 (1), 117-155.

Weisberg, R. & Reeves, L. (2013). Cognition: From memory to Creativity. New Jersey: Wiley.

Wellings, J. & Levine, M. (2009). The Digital Promise: Transforming Learning with Innovative Uses of Technology. Retrieved from: https://dmlcentral.net/wp-content/uploads/files/Apple.pdf

Zubiría, J. (2013). Como diseñar un currículo por competencias: fundamentos, lineamientos y estrategias. Bogotá: Magisterio.

Zubiría, J. (2006). Las competencias argumentativas. La visión de la educación. Bogotá: Magisterio.