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Critical meta-review of the link between technologies, information technology and cognitive development of individuals and organizations.

Dr. Emilio Sagredo Lillo[1]
Dr. Ignacio Salamanca Garay[2]
Dr. Ricardo Castro Cáceres[3]

Abstract

Information technology has accompanied human development since the beginning of socialization, facilitating organization, collaboration and quantification. Information theory resembles the way in which the brain processes, organizes and systematizes data and stimuli received. This association between cognitive processes and informatics is useful to understand how we learn and why we are constantly changing systems to interact with the context and avoid extinction. In addition, technologies in specific are fundamental to current development and learning. This meta-review is framed in a process of critical documentary analysis of the implications of Information and Communication Technologies (ICT) in the cognitive development of individuals and organizations. At the methodological level, a thematic content analysis is carried out, divided into the following categories: 1. ICT in cognitive processes. 2. Organizational and educational psychology. Among the conclusions are the importance of ICT in developmental psychology, in terms of external mediation, responsibility, planned and regulated access. The relevance of technologies for the organizations and individuals that compose them is also analyzed, recognizing them as a key element in both organizational and educational psychology, evidencing even more their protagonism in the current pandemic of covid-19.

Keywords: Information and communication technologies; Cognitive processes; Organizational psychology; Educational psychology.

[1]Académico Departamento Fundamentos de la Pedagogía, Universidad Católica de la Santísima Concepción (UCSC), Chile. Grupo de investigación Alter-Kimün (GAK) UCSC. Agradecimientos a DI-FIAI 02/2021 UCSC. correo: esagredo@ucsc.cl
[2]Centro de Investigación en Educación, CIE, Universidad Bernardo O'Higgins UBO.
[3]Académico Departamento Fundamentos de la Pedagogía, Universidad Católica de la Santísima Concepción (UCSC), Chile. Grupo de investigación Alter-Kimün (GAK) UCSC. Correo: rcastroc@ucsc.cl

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Resumen
La informática ha acompañado al desarrollo humano desde que sociabilizan, facilitando la organización, colaboración y cuantificación. La teoría de la información se asemeja a la forma en la que el celebro procesa, organiza y sistematiza los datos y estímulos recibidos. Esta asociación entre procesos cognitivos e informática es útil para comprender cómo aprendemos y por qué somos sistemas en constante cambio para interactuar con el contexto evitando la extinción. Además, las tecnologías en específico son fundamentales para el desarrollo y el aprendizaje actual. Esta meta-revisión se enmarcada en un proceso de análisis documental crítico de las implicancias que tienen las Tecnologías de la Información y Comunicación (TIC) en el desarrollo cognitivo de los individuos y organizaciones. A nivel metodológico se realiza un análisis de contenido temático que se divide en las siguientes categorías: 1. Las TIC en los procesos cognitivos. 2. Psicología organizacional y educacional. Entre las conclusiones están la importancia de las TIC en la psicología del desarrollo, en función de la mediación externa, la responsabilidad, acceso planificado y regulado. También se analiza la relevancia de las tecnologías para las organizaciones e individuos que las componen, reconociéndolas como un elemento clave tanto en la psicología organizacional como educacional, evidenciando aún más su protagonismo, en la actual pandemia de covid-19.

Palabras clave: Tecnologías de la información y comunicación; Procesos cognitivos; Psicología organizacional; Psicología educacional.

Introduction

The genesis of computer science from the epistemological point of view is closely associated with the social development of human beings. Since human beings began to coexist in society and settle in sedentary communities, they have sought forms of systemic organization that enable them, among other things, to quantify or dimension reality (from stones or vegetables, through the abacus and up to computers) to facilitate their calculations and mode of organization (Careaga and Avendaño, 2017). The above has deepened in what is currently called contemporary times, with a strong and increasingly automation-oriented trend.

Information theory is summarized in a system that contains an input, then processing, output and feedback, to return to the input (Shannon and Weaver, 1949). The above can be applied to any type of data processing that, when automated in computer systems, receives a binary processing. The main differentiation found among these systems is in the output, which can vary according to the need, finding texts, numbers, graphics, sounds, images, etc. They can also generate a combination of all of the above, even more so in today's times. For example, this same process of academic writing that we are carrying out at the moment, may seem very simple, but this assumption is particularly due to habituation with these systems to help in the digital writing of ideas, as an extension of communication and linguistic skills.

Technological tools that allow to process a large amount of information are nothing more than an interface that helps the human being to work with a larger amount of data and mainly, perform tasks in a much shorter period of time than before (Careaga et al, 2018). Technologies alone are not artificially intelligent (At least for now), they require human interaction to be useful, a person programs, designs the software and hardware, when people go to an ATM, they do not really dialogue with the ATM, they dialogue with the bank data and indirectly with the individuals who designed and programmed the ATM systems.

Information theory did not come out of nowhere, the authors were based on the way in which our own brain processes, organizes and systematizes the data and stimuli received (Shannon and Weaver, 1949). For example, we hear, see or feel (Input) then the brain processes or decodes, we understand those stimuli as results of calculations, images and sensations (Output), to subsequently deliver feedback through a

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new approach or cognitive responses. The representation of reality through cognition is very similar to the process of information representation.

According to Aguilar (2009) in his work related to Bruner, he indicates that this famous author proposed a new look at cognitive theory in which he reinterprets the cognitive revolution, related to the mind's capacity to represent reality, proposing a cultural revolution (Bruner, 1991) that proposes that the human mind is a product of history and socially accumulated culture. This helps to understand even more why our current way of representing reality cannot be understood without communication and information technologies and, furthermore, why cognitive processes are currently mediated by these technologies.

This is consistent with the postulates of Vigotsky (1978), who points out that individuals and the construction of their knowledge (learning) are the result of their cultural and historical interaction, mediated by language (Zone of Proximal Development). For computer theory, there is also a language and of course social and cultural interaction is increasingly relevant in the accumulation of growing information and its processing. If we add to the above that Piaget (1952) proposes that cognitive development is also differentiated into different stages, the following question arises: How does information processing, mediated by technologies, affect the cognitive development of individuals and organizations?

Method

A meta-review process was carried out by means of a documentary analysis (Valles, 1999). The technique used is the analysis of thematic content present in the selected documents, which will allow for the development of categories of meanings, of the discourses expressed in the documents and texts chosen for their relevance to the thematic studied (Cáceres, 2003; Valles, 1999).

The documents were selected using logical criteria (Patton, 2002) that are directly related to the fulfillment of certain criteria that relate the data to the needs of the research.

Results and analysis

Computers and technology in cognitive processes

As already pointed out in the introduction of the paper, information theory (Shannon and Weaver, 1949) is quite similar to the way in which our brain receives, processes, systematizes, organizes and responds according to the available information. Key to this processing is social interaction and the accumulation of information that has been stored throughout history.

This information is available to help understand and make the best adaptive decisions to maximize our chances of existence and subsistence as complex and social living organisms. Language itself as a linguistic and communicational framework is the result of cultural interaction and historical context, even the languages used today are not too old compared to the history of mankind. The same with housing, clothing, transportation, food, behavioral codes, interaction and learning, are mediated by historical, social and cultural development (Bruner, 1991; Vigostky, 1978).

Formerly, all this information was accumulated in endless books and libraries, which had to be accessed when one needed them, to improve the data and thus achieve a better processing, learn something or make the right decisions or maybe not (In general, genocidal leaders have had a well-founded theoretical support, but analyzed according to their own interpretation). Moreover, even the access to this information was not so easy or accessible to everyone, people had to know how to read and write and that needed early access to this knowledge or interaction with those who had managed to develop this ability, according to their privileged possibilities of the time. In general, people had to trust those who read from first, second or third sources, because as already said, not everyone had access to such knowledge.

What is mentioned in the previous paragraph is the main achievement of

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information technologies, it was possible to collect and systematize information in electronic equipment using a binary language, with increasingly greater tools for accumulating information and performing calculations (Careaga and Avendaño, 2017).

As already mentioned, for information theory to be operational, human intervention is always necessary, the difference is that now there are greater possibilities of tools and access to this huge source of information. Then everything is facilitated and revolutionized even more, with the emergence of Web 2.0 concept that according to Perez (2011) among others, is attributed to Dale Dougherty in 2004 and Tim O'Reilly in 2005. With this technological revolution, not only is there access to accumulated information, but it is also possible to interact communicatively in a synchronous or asynchronous way, with people from all over the world (social networks), which has narrowed various gaps, such as distance and language, basically interacting in a common language and very much in tune with the vision of postmodernity (Foucault, 1966) and human globalizations, more present than ever with its pros and cons.

It is argued that the world currently lives in a global culture or society (McLuhan, 1962) that requires worldwide interaction and feedback (when the powers that be weaken, the whole world suffers the consequences in some way; this did not happen before). Along with the above, today's society is called information society, cyberculture or cybernetic culture (Castells, 1997; Masuda, 1968).

With all the above information and what has been exposed in the other preceding paragraphs, it was not strange to expose Prensky (2011) coined the concepts of digital natives and immigrants, even today the word digital native is almost used at least as part of colloquial language, without knowing where it came from. According to Prensky, digital natives are those who were born in cyberculture and digital immigrants are those who have adapted to it.

Maturana and Varela (1984) developed the epistemological concept called biology of knowledge based on autopoiesis. Autopoiesis proposes an understanding of the dialectic between structure and function, in the organization of living systems and their quality of reproducing and maintaining themselves, in an existence of continuous and permanent reproduction. According to the above, autopoiesis symbolizes an organized unit that undergoes processes of construction, reproduction and destruction, producing that these processes interrelationships and transformations, finally become a network of self-contained relationships that occur in a given space. They also say that human beings have a need for certainty so they prefer fundamentally processed things, without the clear intention of reflection and deep analysis.

This characteristic of destruction and maintain a reproduction adapting to the environment to achieve prevalence, contributed in that people feel the unavoidable need to interact, learn and develop basic operations with the use of technology, ading the need for certainty avoiding deep reflection to achieve the objectives in the easiest way possible, the cybernetic society has developed in fertile ground and easy reception and acceptance. Those who have not adapted in one way or another, have tended to destruction or transformation (digital immigrant).

Piaget (1952) proposes that the construction of knowledge and learning are in different stages of human development. But it will be pertinent to reinterpret these stages and how they are influenced by technological disruption and cybernetic culture. Undoubtedly, the cognitive development of people globally has been affected by information technologies, either positively or negatively. Children are handling technological computer languages from a very young age and, on the other hand, there are studies that indicate that the development of conventional language is being affected (Huesmann, 2007), increasing, for example, the prevalence of language disorders in children.

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If learning is mediated by the social and historical context (Bruner, 1991; Vigostky, 1978) clearly something must have changed in the cognitive development of humans. Especially, considering the aforementioned adaptive need for social prevalence. Islas (2017) says that no matter how much we adults have tried to adapt to the new computer reality, trying to talk about technological development, less effective development has had its use for real learning. He points out that children have great handling of tools, but that these are not taken advantage of by education. On the other hand, he finds adverse visual and cognitive effects due to prolonged exposure to technology. In relation to this, it is known that several governments have gone back on decisions related to the use of information technologies for learning at an early age, as is the case of France, for example. In addition to the above, Huesmann (2007) finds a significant impact on the violent attitude of children exposed to technologies and online video games on a sustained and continuous basis.

Organizational and educational psychology

Organizational psychology has more than a century of specific disciplinary development, however, historically it is based since human beings began to work collaboratively and establish hierarchical organizations to maximize their chances of success. The above is closely linked to what was previously exposed in that the organizational and the association of individuals, is mediated by information technology (Careaga and Avendaño, 2017).

Since human beings began to be sedentary and position themselves in a geographical space, they developed commercial and relational relationships to ensure the success of cultural-familial survival or at least try to do so. For this to work, it is key to try to understand how organizations and systems work, as well as to know how they interact with the environment and, depending on the case and criteria, to achieve a balanced subsistence or maximize the collective and individual utilities and benefits, of course there is some inequality in the distribution of potential gains or benefits, with the leader or leaders in a privileged position with respect to the others (Espinosa, 2014).

Organizations have this name because they supposedly resemble a living organism in which its members make up microorganisms or departments (Hargreaves and Fullan, 2014), basically the individuals belonging to an organization would be the cells, then the departments would be the organs or systems and the organization would be the living organism. The above analogy could be perfectly applied to computer systems. Precisely at this point organizational psychology becomes relevant, institutions and systems have a life of their own, a collective representation that provides identity and particular characteristics (Moscovici, 1961), which is why having the best members for an organization is the equivalent of having specialized cells for each part of the body or having better information processors or a sophisticated electronic component. Such members must have special and relevant cognitive skills, a developed language for administrators and product marketers, good psychomotor development in welders or any less complex physical work and in some cases the ability to obey to any test.

Who is in charge of selecting the right individual, who has the relevant skills and experience, is the organizational psychologist, hence its close link with companies and industries? At this point, technology and the skills of 21st century human beings acquire a relevant role. What happens to those individuals who have not been able to adapt to the current computerized context? Along the same path Careaga-Butter et al. (2020) refer to the current lack of technological preparation of individuals. This is evidenced in the current pandemic of coronavirus, when Ribeiro et al. (2020) say that most were not prepared for telework and that many workers became obsolete in online and remote work, even if they were very prepared in technical or disciplinary knowledge, what was mainly tried, was to work as if they were face to face, but virtually (Careaga-Butter et al.,

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2020).This was because they were not prepared for virtuality, even though it has been said for a long time that these skills are key for the 21st century, and apparently it has also been complex for many students who are supposedly digital natives (Prensky, 2011).

As mentioned, organizational psychology has been developing as a discipline for more than a century, some consider its precursors to be the psychologists Hugo Münsterberg and Walter Dill Scout with their books Vocation and Learning (1912) and Psychology and Industrial Efficiency (1913) (Enciso and Pirilla, 2004).

Among the theoretical elements most associated with organizational psychology are organizational climate and culture; these topics have a development that can be dated from the 1960s to the present. In contemporary times, the environment and the representation that the climate is part of a context, has achieved prominence in all types of organizations, not only linked to the company, but also to the social sphere, in fact, there are many researchers who closely link organizational psychology with community social psychology (Bastos, 2002). The author who begins with the development of organizational climate as a key element of organizational psychology is Lewin (1942) with his field theory, which refers to the interaction of the members of an organization with their environment or context as a key to understanding how they affect each other. However, it is necessary to point out that it was Gellerman (1960) who first spoke explicitly of the concept of organizational climate.

Considering that the human resource from the point of view of organizational psychology is seen as a key and necessary element for institutions of any kind to achieve success (Chiavenato, 2001), organizational psychologists have achieved prominence not only in the selection of personnel according to their skills and competencies, but have recently been able to gain spaces in organizational leadership, information technology, technology and even in the field of management and social administration.Recent studies indicate that organizational psychology is the key for an organization to be successful or not (Cardona and Zambrano, 2014; Chesley, 2014; Cuervo-Carabel et al., 2020), then what future will have the organizations that do not adapt to technological disruption and likewise, how will be currently the organizations that failed to adapt to the context of telework in pandemic.

There is currently a growing interest in research on the impact that psychologists have had on organizational success, on the perception of organizational climate and satisfaction of the members of the organization (Chiappetta, 2017; Cuervo-Carabel et al., 2020) and therefore, there is also a growing interest in knowing how organizational psychologists are being trained and what is the profile that these professionals should have (Vera et al., 2019), 2019).

In this regard, it has been found that there is no clear internationally unified training policy and that mainly Latin American universities have focused on a generalist training, in this regard, in Chile it is not mandatory to have any mention to practice any discipline of psychology, the last antecedent was clinical psychology, but currently, there is no mandatory mention of such mention either (Urzúa et al., 2015).

To address the above, the main development of specialization of psychologists in general and in particular of organizational psychologists, has been self-instruction and postgraduate training, but on their own initiative, at this point, a key aspect to become a good organizational psychologist, is an adequate knowledge of the theory of computer systems and technology.

To refer specifically to the main theme of the article, it should be noted that an area frequently investigated in organizational psychology is technological disruption and the role it plays in contemporary organizations, as an inescapable and mandatory element (Chesley, 2014; Chiappetta, 2017; Cuervo et al., 2018; Hung et al., 2015). Some also approach to address the issue related to the fact that, in the not-too-distant future, the human factor, which is

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supposedly the greatest organizational weakness, will definitely be replaced by machines and artificial intelligence ambition or, in the best case, will be part of the same organization as another active element. It is for the same reason that the concept of digital native of Prensky (2011) with its respective flats and conceptual evolution is becoming more and more relevant, until reaching what today could be known as homo-cyberneticus (Careaga and Avendaño, 2017).

To link organizational psychology with another area of psychology, we have already approached with social psychology, but now we will do it in a more specific way with educational psychology in which organizational psychology plays a fundamental role. The link will not be with all aspects of educational psychology, it will be from learning, skills acquisition, development of competencies, key elements in personnel selection and with a specific part linked mainly to collaborative work and the importance of learning computer and technological competencies. There are currently many psychologists and theorists who have contributed to educational psychology from the organizational (Fullan, 2002; Hargreaves and Fullan, 2014; Harris, 2012; Harris and Lambert, 2003; Harris et al., 2015; Üstüner and Kis, 2014).

If we consider that Piaget (1952) points out that the process of knowledge construction and learning is related to the fact that human beings develop according to their maturity and the specific stage in which they find themselves, and even more so, taking into account that there are critical periods for the acquisition and development of certain skills, the construction of individuals as future workers and professionals, begins from early childhood and in this we must be careful with the age at which a child is exposed to technology, it has already been said that this should be monitored and that it will not necessarily mean greater computer competence (Mendieta, 2017).

It has been shown that parents and/or caregivers directly influence the profession or future employment of people (Fernández et al., 2016) with their demands or through vicarious learning (Bandura, 1978) and of course, formal education will contribute to the cognitive development, interest and specific skills that determine the role they will play in the organizations they will be part of, in the future and/or in the present.

Learning is directly mediated by the social and historical context (Bruner, 1991; Vigostky, 1978) in which, as mentioned above, information technology plays a fundamental role, not only in recent times. We possess an adaptive need of social prevalence also linked to the desire for socio-organizational success, in which our condition of gregarious and social beings, make us develop according to our proximity and specific context to which we belong, including the very option of becoming psychologists is of course directly mediated by education, the same with information and communication technologies.

In other words, people are what they learn from the environment and from there, they will develop the competencies that will position them as specific individuals in an organization. In some societies the role to be fulfilled is determined by the cradle (Espinosa, 2014) and although this is not so lapidary in Western organizations, this is only in theory, because in practice our societies are quite unequal, even with access to technology and information.

Today a theoretical trend is emerging in what some call educational organizational psychology (Hargreaves and Fullan, 2014) related to educational organizational climate, learning achieved by teachers, collaborative work, the use of technologies and the achievement of student learning as fundamental and key members of an organization.

Teachers as trainers live more and more in a competitive environment (Harris, 2012), since educational establishments in the world are increasingly assimilated to any company or other type of organization and, for example, an establishment better equipped technologically and with more qualified teachers has the advantage. From organizational psychology, institutions have a kind of life of their own and the more

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collaborative work is developed, the greater the probability of success (Hargreaves and Fullan, 2014) which, in the case of educational establishments, is the achievement of student learning. But at this point the drawbacks begin, a large number of studies indicate a tendency of teachers to develop their work through individual and balkanized work, more, in few cases we find collaborative work in organizational learning community (Echeita, 2017; Sagredo et al., 2020; Weiss et al., 2017).

Along with the above, the importance of organizational climate for organizational psychology has been mentioned (Schein, 2010) and according to this, in general a significant and positive relationship has been found between organizational climate and teachers' motivation and satisfaction (Köse, 2016; Pozveh and Karimi, 2016; Sagredo and Castelló, 2019). Considering that, in general, teachers have a poor perception of the organizational climate, with few exceptions (Kitratporn and Puncreobutr, 2016) the development of learning will be highly mediated and influenced by this organizational climate, teacher motivation and satisfaction or, as a synonym of all this, by the organizational psychological standards of the establishments of which the students themselves are part as integral members. Therefore, if teachers do not understand that information technology has always accompanied the development of human beings and that technology is not something new, it will be difficult to educate the human beings of the 21st century, so it is important to avoid teachers to stagnate and resist change and continuous improvement.

Conclusion

According to what has been reviewed and analyzed, the information revolution has produced a substantial change both in the vision of the human being and in the society itself, which is currently recognized as an information society belonging to a cybernetic culture (Castells, 1997; Masuda, 1968). This change has been global and, among other things, has modified at least the means for the cognitive development of human beings. In the same way, it is believed that when faced with the question: How does information processing, mediated by technologies, affect the cognitive development of individuals and organizations?

We are convinced that it does affect and that the positive or negative degree that technologies have on development depends fundamentally on the age at which this exposure begins, the contents, the appropriate education and the skills that adults have to mediate access to information as a useful tool of infinite possibilities. What we must understand is that unless something catastrophic happens, technologies for massive information processing are here to stay and the best strategy is to adapt to them, trying to mediate so that they are a contribution rather than a harmful element for the development of society and humanity. Learning without resisting change.

Notwithstanding the above, we wonder what will be the vision and transfer of knowledge when the whole of society is composed of digital natives, with no digital immigrants left in the world (Prensky, 2011). Probably at that time the paradigms and the development of cognitive skills will have a radical change, perhaps difficult to project today or, on the contrary, perhaps it will have no major effect. Recall that Prensky himself pointed out that the digital natives, rather than a new species, responded to a new category, but that it has taken very little time for the human being subjected to technologies, for this to mean a deep and real evolutionary change. According to this, it is probable that, if information technologies were to disappear from the earth, human beings would evidently be able to continue, to deconstruct, construct and reproduce themselves without problems (Maturana and Varela, 1984).

Organizational psychology has developed a systematic relevance today, establishing itself as a key part of the development of all types of organizations in which, of course, the human factor, information technology and technologies are fundamental, since it is people and their learning, who give life to institutions, even when that could be mediated or, according to

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some resistors, threatened by technological disruption. It is for this reason that the cognitive skills and competencies that individuals need to have according to the profile required by each organization must be well captured and identified by the so-called organizational psychologists, in charge of the selection and institutional development processes. It should be considered that organizational psychologists are gaining spaces in other multidimensional roles in the different organizations of which they are or could be part and that, in contemporary times, they must be very close to information and communication technologies.

The skills and competencies that members and candidates of the different organizations must have are of course mediated by the educational and psychological development of the individuals. It is at this point that a second important aspect appears: "Educational psychology", linked not only to learning throughout the life cycle, but also to the organizational development of teachers in educational institutions and the importance of this in the work of learning-teaching and in the role of the students themselves as an integral part of the educational organizations.

Finally, it is stated that people and cognition, understood as a way of organizing, systematizing and processing information, can be nourished effectively and efficiently by the computer revolution that provides the possibility of continuing to develop and coexist in the current context, with a vision of continuous improvement and without resistance to change, to better understand reality, but on a large scale. In the same way, we are convinced that the different theories associated to cognition can assemble very well with informatics and technology, understanding that informatics has always existed in humanity and that both are very connected with the social, cultural and historical heritage, to explain and understand themselves. Technology is nothing more than a tool for cognitive development (Salomon, 1992), visualizing mainly a significant change of access and processing of information, contextualized and also in a temporally different and disruptive reality.

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