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Technology and Innovation in Education: Interfaces for Digital Skills

A Tecnologia e a Inovação na Educação: Interfaces para Competências Digitais

Abstract

This article addresses technology and innovation as inherent elements of 21st century education within a broad context. It is intended here to describe the common elements between technology and innovation. We undertook a bibliographic study that focuses on the analysis of the two elements of technology and innovation, that demonstrate, in different ways, the approach (dialogue) between both, as practices of education of individuals fully inserted into the information and knowledge society. Technology is a phenomenon that has been constituted in the manner, in the environment, and in the context of human action in the world. In education this is a reality for all those who attend educational institutions, allowing for structural changes in teaching and learning methods. On the other hand, innovation is multifaceted and can manifest itself in different ways. Of course, depending on its application, innovation can bring about a transformative dynamic in the field of education, enabling it to meet the challenges of an increasingly global and digital society, focusing on relevant learning that adopts innovative and active pedagogies. It is concluded that both technology and innovation have brought changes in educational institutions, in the way students are accessing information and knowledge, leading teachers to explore teaching methods and learning environments in the digital age, resulting in this way, in educational digital competences as defined by international organizations.

Keywords: Technology, innovation, education, digital skills.

Resumo

Considerando contextos mais amplos, o artigo aborda a tecnologia e a inovação, enquanto elementos inerentes à educação do século XXI. Pretende-se aqui descrever os elementos comuns entre a tecnologia e a inovação. Desenvolvemos um estudo bibliográfico que se centra na análise dos elementos que demonstram, de maneira distinta, a aproximação (diálogo) entre ambos, enquanto práticas de educação de indivíduos plenamente inseridos na sociedade da informação e do conhecimento. A tecnologia é um fenómeno que se tem vindo a constituir no modo, no meio, e no contexto da acção dos Homens no mundo. Na educação esta é uma realidade de todos aqueles que frequentam as instituições de ensino, permitindo mudanças estruturais nas formas de ensinar e aprender. Por outro lado, a inovação é multifacetada e pode-se manifestar de diferentes maneiras. Dependendo, evidentemente, da sua aplicação, a inovação pode imprimir uma dinâmica de transformação no domínio da educação, permitindo enfrentar os desafios de uma sociedade cada vez mais global e digital, centra-se numa aprendizagem pertinente que adopta pedagogias inovadoras e activas. Conclui-se que tanto a tecnologia como a inovação, trouxeram mudanças nas instituições de ensino, nos modos como o estudante está a aceder à informação e ao conhecimento, levando professores a explorar pedagogias e ambientes de aprendizagem na era digital, resultando, neste sentido, na definição das competências digitais educativas pelas organizações internacionais.

Palavras-chave: Tecnologia, inovação, educação, competências digitais.



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Introduction

Since the 1960s, technology and innovation have gained prominence and been consolidated as concepts and definitions, demonstrating clear differences between them. Within this scenario, the portmanteau phrase technology/innovation has brought changes into the knowledge production chain in educational institutions, leading to some of them gaining competitive advantages (Valente et al., 2007).

In order to better understand these two realities: technology and innovation, we conducted a bibliographic study to understand the meeting points between them. We start by characterizing technology as well as innovation, focusing on its manifestation in and impact on education.

Technology in education is a tool whose functioning is maximized by teachers by adapting it to their teaching purposes. In this context, the teacher should motivate the students, promote ICT-oriented teaching practices, since the technology can arouse in the student some interest and attention that can stimulate the desire to learn (Angotti & Auth, 2001, Prensky, 2001). On the other hand, innovation is regarded as the introduction and diffusion of originality, or improvement of products and/or processes, having as its fundamental aspect the fact that it constitutes, in itself, applied knowledge and the generator of results. In this regard, educational institutions are called upon to redefine their educational strategy, and enhance experiences of technological use in a collaborative production of knowledge, which, concomitantly, allows society to form digitally competent citizens, able to critically perceive the influence of these media in their social, economic, political and cultural domains.

In this respect, we must ask to what extent technology can be exploited as a teaching factor, or how an ICT within teaching enables the potential of innovation to be used to educate digitally competent citizens. Our discussion begins at this point by emphasizing the relationship between technology and innovation.

1. Technology

Technology is seen as a set of techniques, processes, methods, means and instruments from one or more areas of activity, resulting from either scientific knowledge or accumulated experience (Carvalho & Ivanoff, 2010; Orange, Simões, & Fontes, 1997). In the same sense Tigre (2006) argues that technology can be defined as a system of knowledge about specific techniques. The techniques involve applications of knowledge in products, processes and organizational methods. The use and access to technologies allowed the information age to be characterized by

behaviors, practices, information and knowledge that change with extreme speed, thus characterizing the current stage of knowledge (Kenski, 2003). In this sense, the development of technologies has led us to a historical level of changes beginning with the wave first took place in agriculture, moving to industry, and which currently relates to information and communication. This last wave marks the transition from technological innovation to artificial intelligence and /or Web 5.0 (Dias, 2014; Paraskeva & Oliveira, 2006).

Technology, whatever it may be, whether it be discovering the mastery of fire or the wheel, has left nothing like it in history.

The adoption of digital technologies in education does not necessarily mean new and modern equipment, but rather the development of learning environments, with the current use of the concepts of interactivity between students and teachers (Gobbi, 2010). Technology is thus seen as a tool for processing and processing information, which favors the construction of new knowledge by students (Palfrey & Gasser, 2011; Paraskeva & Oliveira, 2006).

Consequently, the receptiveness of contemporary societies towards these new technologies has created new consumption patterns, as well as new platforms for communication and interaction without geographical barriers, while allowing and enhancing democratization and widespread access to information. On the other hand, the same receptivity is not always agreed upon by users. Time and again, the excessive use of a particular technology becomes uncontrolled, eventually making the individual increasingly dependent on it to the point of preferring virtual rather than physical human relations, and even engaging in illicit acts and, fracturing human, social and labor relations. It is in this sense that the process of adoption and diffusion of new technologies constitutes a field of knowledge with contains ungovernable characteristics.

1.2. Technology in education

Technology strengthens the natural state of affairs, nurturing flexibility and productive proficiency. However, one of the major current issues among educators is specifically the fact that in general they still have a background based on 19th century methodologies, while they are imposed upon to deliver methodologies for a 21st century society.

Educators are mandated to adapt to the current needs of societies on the one hand. On the other hand, occurring simultaneously, there are large and rapid technological changes, directed at not only society, but also partly at education from the creation of open educational scenarios to new opportunities for self-training and (Figueiredo, 1995),all thanks to the development of the Internet, which is the main aspect of technology in this digital age, complemented by the

computer, the mobile phone and artificial intelligence which acts as a convergence of all the latest technologies) (Angotti & Auth, 2001; Figueiredo, 1995; Ilharco, 2004; Macedo & Foltran, 2007). In this respect, according to Costa (2014), education has the difficult challenge of being able to respond to the needs and demands of the changing society.

It is precisely at this point of convergence that the discussions occur on technology in education, which, for Costa (2014), do not escape the reality of young people who attend school and were born within an information society, where most technological tools such as the computer and the Internet are familiar to them. In this context, education systems, schools and teachers should seek to develop the necessary technical skills to achieve an intersection that recognizes the reality of these students as digital natives (Prensky, 2001; Fonseca, Carvalho, Escola & Loureiro, 2017).

Recognizing that there is an unprecedented acceleration in the development of science, technology thus offers the educational field a panoply of facilitating tools for the administration of schools and for the teaching and learning process itself. These potential tools, in addition to being fundamental to education, usher in a rediscovery-centered learning paradigm in which students experience autonomous learning, leaving behind the old-fashioned method of knowledge transmission centered essentially on the teacher (Patrão & Sampaio, 2016; Ruivo & Carrega, 2013; Carvalho and Morais, 2011). In this respect, technology in its interaction with education implies levels of education and educational, cultural and professional sophistication for its use (Barros, 2013; Ilharco, 2004). It must be used and put to work when the context in which it is provided supports the pedagogical objectives (Ilharco, 2004; Palfrey & Gasser, 2011).

The technologies in education, as well as the information provided by them, correspond to the discovery of a pedagogical dimension that demands much more from teachers than the simple alteration of resources. It requires a significant change in practices accompanied by changes in their beliefs (Costa, 2014; Ruivo & Carrega, 2013). New technologies have thus brought to the school transformations in the ways in which knowledge works and demand new ways of organizing time, space, and internal relations within the school community. In this sense, we can understand that technology in education is, in addition to being an instrument of help for the teacher and student, an opportunity for the renewal of the school itself and a way for the formation of individuals with skills to face the information and knowledge society (Castells, 1999).

1.2.1. Technologies and the student

Lagarto and Andrade (2010) argue that the unavoidable presence of new technologies in school and in society in general has a decisive contribution to make in changing the current educational paradigm. In the same vein, Menezes and Almeida (2014) argue that change is becoming increasingly necessary due to this new generation of digital students. The school needs to be technologically updated to meet the needs of its students, becoming a stimulating place that enhances learning with the use of technologies, arousing interest and the desire to learn. On the other hand, technology imposes technological skills on young people, which will bring them advantages, not only at a personal level, but above all at a professional level, as their mastery has become a requirement in almost all areas. Thus, Freire and Lagarto (2012) state that: "our students were born in this reality, surrounded by computers, the Internet, smartphones (mobile phones), television, games, among others. As such they are characterized by abdicating paper in favour of

the computer and/or the smartphone. Young people have changed radically and they are no longer the people for whom our education system was designed." (p. 265). It is also argued that students can explore the potential of technology as a tool for processing and processing information, which favors the construction of new knowledge (Palfrey & Gasser, 2011; Paraskeva & Oliveira, 2006). In this context, the teacher should guide the students and not control them autocratically. This means changing the paradigm that initially advocated that new technologies would replace the teacher's presence by the emerging convergence paradigm, which assumes new and old teaching-learning methodologies to interact in an increasingly complex manner (Fonseca et al., 2017). Technology arouses in the student interest and attention that can stimulate the desire to learn, taking into consideration the understanding and interest that a student naturally has for technological language. Digital natives are becoming essentially active and creative, developing new forms of expression and learning by simulation through the wide use of different technological tools (Gomes, 2012). Therefore, the underlying discussion between technology and the student, is the influence that the former has on the cognitive stimuli of the latter. Technology leads students to expose their native digital skills (Prensky, 2001).

2. Innovation

According to Thiollent (1984 p.44), 'innovation' is broadly defined as a new 'idea, practice or object perceived by an individual', whilst the process of 'diffusion' is considered from the point of view of formal and informal channels in themselves, regardless of the nature or content of the

innovation. But first and foremost, innovation represents the updating of an occurrence, idea, product or process considered first (Invention). Innovation is multifaceted and can manifest itself in different media, depending mainly on its application. But there is no innovation without invention, just as there are no techniques without technology (Nobrega & Lima, 2010; Tadeu & Salum, 2012; Tigre, 2006).

Some basic differences between “innovation, invention and creativity” allow us to state that “invention” is the conception of new technologies, processes and products, and that knowledge is the basis for evaluating novelty. In this sense, “innovation” is defined as the introduction and diffusion of originality and/or improvement of products or processes to a particular sector of activity (Valente, Fuente, Oliveira, Jenner & Grilo, 2007).

“Innovation” reflected as “invention” are two terms that have been widely used for the purpose of achieving economic advantage (Moreira & Queiroz, 2007; Valente et al., 2007). If, on the one hand, “innovating” is introducing something new with a view to improving products or processes, which thus gain value. On the other hand, this introduction of novelty is not in itself an innovation. Innovation needs to be perceived and accepted by its final consumers, thus being a maturing process that leads to its practical use (Tadeu & Salum, 2012; Valente et al., 2007).

A generic definition of “innovation” is presented through an equation, according to Moreira and Queiroz (2007), which characterize as a fundamental aspect of innovation, the fact that it reveals itself as applied knowledge that generates results. Therefore, “innovation” as an idea, a practice and/or an object, perceived as new by the individual (Tigre, 2006), has to be systematized to objectively cover a certain purpose (Tadeu & Salum, 2012). It is in this sense that, in essence, many innovations are the result of practical experimentation or the simple combination of existing “technologies” and which is the origin of the so-called creative disruption, driving the change in current “technology” (Palfrey & Gasser, 2011; Silva, 2003; Tigre, 2006).

In this way, the cycle of creative disruption gave rise to the microinformatics revolution and allowed the development of new platforms for more innovation (Dias, 2014; Godeluck, 2000), which culminate today with the domain of artificial intelligence.

"Technology" in general and on the basis of its conceptual interpretation is thus closely linked to invention, since technology" represents processes, technical and or methodological improvement that, by itself, is able to put in innovation into action. This link between “technology” and “innovation” has given rise to what today we call “technological innovation” (in its broadest sense) and that is defined by the application of new technological knowledge, which

results in new products, processes and/or services, or even in the significant improvement of some of its attributes, allowing an organizational innovation and a break with traditional logic (Godeluck, 2000; Laranja et al., 1997; Moreira & Queiroz, 2007). In this sense, we define innovation as the engine of scientific development and the mechanism of social, economic, political and cultural transformation.

2.1. Innovation and technology in education

At present, digital natives (Prensky, 2001), present wide productivity due to the use of ICT. Consumer-driven innovation and creativity platforms, with which each party (both platform creator and creator based on these platforms) is incorporated to as to permit a viable alternative even in teaching processes (Palfrey & Gasser, 2011). This scenario, encapsulated by the phrase “technology” and “innovation”, covers changes in the knowledge production chain in educational institutions, at the most varied levels and systems, causing some of them to gain competitive advantages (Valente et al., 2007). Thus, the technological revolution, especially the evolution of ICT, has dynamised transformation, not only in the field of science and technology, but also in the field of education (Ruivo & Carrega, 2013). Thus, in order to meet the challenges of an increasingly global and digital society, education and training systems need to focus on relevant and high quality learning that takes advantage of the range of available technologies and adapts pedagogies., both innovative and active (Patrício & Mesquita, 2017). From this perspective, the education system, due to the important role it plays in the development of competences, reiterates that more innovation and technologies need to be sustained. Thus, the manifestation of innovation in education and the impact of digital technologies on teaching and learning has led organizations such as UNESCO to assign digital skills and education sectors to the innovation process through smarter policies, involving all stakeholders for innovation in education. For this reason, documents such as “The Futures Of Learning 3: What Kind Of Pedagogies For The 21st Century?”, published by UNESCO in 2015 and the OECD's “Innovating Education and Educating for Innovation: The Power of Digital Technologies and Skills” 2016 report also stressed the overriding need to develop digital skills in students and teachers, as well as to explore pedagogies and learning environments in the digital age (Patricio & Mosque, 2017).

In this respect, at a time marked by constant technologies and innovations, educational institutions are called on to teach by redefining their education systems for academic emancipation, focusing on the interaction and active participation of students as citizens inserted in society, which means connecting different territories, physical and virtual, of learning, culture

and information, for the sharing of experiences and for the collaborative production of knowledge (Costa, Rodriguez, Cruz, & Fradão, 2012).

Innovation permeates and shapes the constitution of the organization and should therefore be understood as a cumulative and articulated process that interacts with invention and diffusion. If, each successful technological innovation changes the patterns of dealing with the previous reality and changes the level of usage requirements, according to Gujamo (2018), pedagogical innovation must be induced within (educational institutions and actors), which implies reflection, creativity and a critical and self-critical sense. Innovation of pedagogical practices using ICT in a restricted and particular way to each teacher is not considered (innovation does not happen alone). The social dimension, which becomes controversial, must be evoked by the multiple opinions and cultures in which the actors are characterized. Furthermore, pedagogical and educational innovation is not a question that can be posed in strictly quantitative terms, that is, by the mere incorporation of it into the school, namely, when the definition of its use consists in doing with it exactly what would be done in its absence.

According to Rodrigues (2014), to an certain extent, the main limitations and constraints regarding the integration of technologies in the educational context are represented by : a) reduced technological knowledge; b) poor perception of the benefits of using technology; c) low confidence in the use of technology; d) resistance to change; e) lack of equipment and investments; f) lack of time and individual decision to use; g) reduced leadership vision and unclear guidelines when used in conjunction with educational projects and/or programs; h) preparation and training format of teachers whose focus highlights technical rather than pedagogical aspects; i) lack of technical support.

Pedagogical and educational innovation is necessarily affirmed by the linking of the format in which it can promote the qualitative improvement of pedagogical practices, either by the explanatory aspects of users' intention to adopt and spread a general innovation (UTAUT), and in particular, either by the behavior of users of technology or addition in their learning action, a strong multidisciplinary pedagogical aspect stimulated by the curriculum (TPACK); or through simulated learning of multimedia content and networks that allow students to share knowledge and experience (AVA, OER or LMS) (Chipaco, 2018; Gujamo, 2018).

Thus, the use of technology in teaching has shown that the world outside the classroom has changed, advanced, and now presents the school with new (in) training devices (Hughes & Daniels, 2014), so technology must be incorporated into the processes of teaching and learning,

not with the idea that its introduction will promote change (something that will inevitably happen), but as a transforming element in the way the student is accessing information and knowledge (Costa et al., 2012).

Final considerations

When we analyze the main ideas of the authors who developed their theories around technology and innovation in education, we understand that there is a convergence of opinion as to the value and meaning shown by the two concepts regarding digital competences.

Technology embedded in the education and lives of students, who are mostly digital natives (Prensky, 2001), challenges education and training systems to focus on relevant, high-quality learning that takes advantage of new technologies. For Patrício & Mesquita, (2017, p. 1374) “education systems for their important role for innovation through the development of skills that underpin new ideas and technologies”, highlight the overriding need to develop digital skills between students and teachers, which discover pedagogies and learning environments in the digital age (Patrício & Mesquita, 2017).

Thus, the presence of innovation in education and the impact of digital technologies on teaching and learning has forced international organizations to define the role of digital skills and education in the innovation process through smarter policies involving all stakeholders.

Technology, through innovation, has led society to demand from educational institutions the training of technologically competent citizens who “know how to access, organize, treat, analyze, critique, evaluate and use information responsibly to generate new knowledge and apply it intelligently, and leverage other core competencies and integrate them effectively for lifelong learning” (Patrício & Mesquita, 2017, p. 1373).

In addition to forcing a change, the adoption of technology is matched by education, allowing us to educate for a future that is not ours, and which does not yet exist, with accelerated cycles of technological evolution, which imply a systematic change in organization and educational activity, requiring the design of plans that usually involve academic management, teachers, students and technology (Andrade, 2017).

As we have learned, technology, in fact, as a supportive tool in the teaching and learning process, puts the teacher into the role of mediator in learning, and requires the ability to combine resources with technological competences, on behalf of meaningful learning on the part of the students. Looking at innovation, there is a need for both the teacher, students, school, and

government to redefine their traditional pedagogical perspectives and educational policies in order to resize themselves as processes and agents of education and pedagogical innovation.

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