REVIEW ARTICLE

Didactic and Pedagogical Strategies, Pedagogical Models and Technological Tools in ICT-Mediated Higher Education*.

Estrategias didácticas y pedagógicas, modelos pedagógicos y herramientas tecnológicas en educación superior mediada por TIC*

Estratégias didático-pedagógicas, modelos pedagógicos e ferramentas tecnológicas no ensino superior mediado pelas TIC

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ABSTRACT

The aim of this article is to carry out a systematic review of the didactic and pedagogical strategies, the pedagogical models and the technological tools with which ICT-mediated higher education students achieve better academic results. To carry out the systematic review, the PRISMA methodology was applied, selecting a total of 52 articles from the Scielo, Dialnet plus, JSTOR, Proquest, Science Direct, Scopus and Emerald Insight databases.

Regarding the didactic and pedagogical strategies, gamification, storytelling, case-based learning, problem-based learning, collaborative learning and flipped learning are identified as trends, which despite generating improvements in the academic results of students, present difficulties at the time of being implemented due to the capacities of teachers to propose innovative proposals and the willingness of universities to finance and support this type of initiative.

Regarding pedagogical models, a prevalence of constructivism was observed, as well as the integration of the TPACK and TELL models, which seek to respond to learning needs from communication, self-regulated processes in individuality, the generation of knowledge from experience, the application of knowledge in controlled environments by students, the promotion of digital literacy, and the use of technology to generate knowledge.

Finally, LMS, social networks and online simulators are identified as technological opportunities to improve the academic results of students.

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Resumen

El objetivo del presente documento es realizar una revisión sistemática de las estrategias didácticas y pedagógicas, los modelos pedagógicos y las herramientas tecnológicas con las cuales los estudiantes de educación superior mediada por TIC alcanzan mejores resultados académicos. Para realizar la revisión sistemática se aplicó la metodología PRISMA, seleccionando un total de 52 artículos de las bases de datos Scielo, Dialnet plus, JSTOR, Proquest, Science Direct, Scopus y Emerald Insight.

En lo respectivo a las estrategias didácticas y pedagógicas se identifican como tendencias la gamificación, el storytelling, el aprendizaje basado en casos, el aprendizaje basado en problemas, el aprendizaje colaborativo y el aprendizaje invertido, las cuales pese a generar mejoras en los resultados académicos de los estudiantes, presentan dificultades al momento de ser implementadas debido a las capacidades de los docentes para plantear propuestas innovadoras y la disposición de las universidades en la financiación y apoyo a este tipo de iniciativas.

Sobre modelos pedagógicos, se observó una prevalencia del constructivismo al igual que la integración de los modelos TPACK y TELL, los cuales buscan responder a necesidades de aprendizaje desde la comunicación, los procesos auto-regulados en la individualidad, la generación de conocimiento a partir de la experiencia, la aplicación de saberes en ambientes controlados por parte de los estudiantes, la promoción de la alfabetización digital, y el uso de las tecnologías para generar conocimiento.

Por último, se identifican los LMS, las redes sociales y los simuladores en línea, como oportunidades tecnológicas para mejorar los resultados académicos de los estudiantes.

RESUMO

O objetivo deste artigo é realizar uma revisão sistemática das estratégias didático-pedagógicas, dos modelos pedagógicos e das ferramentas tecnológicas com as quais os alunos do ensino superior mediado pelas TIC alcançam melhores resultados acadêmicos. Para realizar a revisão sistemática, foi aplicada a metodologia PRISMA, selecionando um total de 52 artigos das bases de dados Scielo, Dialnet plus, JSTOR, Proquest, Science Direct, Scopus e Emerald Insight.

Roldando as Estratégias Didáticas e Pedagógicas, Gamificação, Contação de Histórias, Aprendizagem Baseada em Casos, Aprendizagem Baseada em Problemas, Aprendizagem Colaborativa e Aprendizagem Flipped são apontadas como Tendências, que Mesmo Genéricas Melhoram nos Resultados Acadêmicos dos Alunos devido às capacidades dos professores em propor propostas inovadoras propostas e a vontade das universidades de financiar e apoiar este tipo de iniciativa.

Relativamente aos modelos pedagógicos, observou-se uma prevalência do construtivismo, bem como a integração dos modelos TPACK e TELL, que procuram responder às necessidades de aprendizagem a partir da comunicação, dos processos autorregulados na individualidade, da geração de conhecimento a partir da experiência, da aplicação de conhecimento em ambientes controlados pelos alunos, a promoção do letramento digital e o uso da tecnologia para gerar conhecimento.

Por fim, LMS, redes sociais e simuladores online são apontados como oportunidades tecnológicas para melhorar os resultados acadêmicos dos alunos.

Introduction

Although teaching and learning processes in higher education were already in continuous evolution in relation to the influence that technology has had in the incorporation of emerging methodologies, the confinement caused by the global pandemic of the coronavirus imposed the use of Information and Communication Technologies (ICT) in higher education and has accelerated its inclusion, fostering a transformation process towards a digitalized university through online processes with new pedagogical models and learning environments (Torres et al., 2021).

This online training process, making use of technologies, brought certain benefits to the teachers, allowing them to adopt a more flexible teaching schedule that met their availability and that of their students. Students also experienced the benefit of not having to learn in a physical classroom at a specific time, since, with the resources available online, they were able to study and review the material anytime, anywhere. It also meant that teachers and students did not have to travel to the campus in person, which saved considerable time and money, allowing teachers to spend more time preparing learning materials and students to have more study time (Weldon et al., 2021).

Given this scenario, the study of the articulation of ICT in higher education is key, and in this regard it is worth mentioning that some research addressing this issue has proposed: i) the use of didactic and pedagogical strategies such as *Storytelling*, gamification, case-based learning, challenges or projects, the flipped classroom, and active or collaborative or networked learning to improve the academic performance of students in ICT-mediated education (Argueta and Ramirez, 2017; Manotas Salcedo et al., 2018; Trujillo et al., 2015b), ii) the incorporation of pedagogical models that allow the interaction of the participants of the process (educator and non-educator agents) from technology, contemplating proposals such as the constructivist model, TPACK and TELL, which are explored as proposals for understanding learning processes (Dooly and Masats, 2015; Muianga et al., 2019; Papanikolaou et al., 2017), and iii) the impact on academic outcomes of ICT tools on students, where mobile devices and simulators, describe a spectrum of tools from the physical to the digital realm (Lameu, 2020; Tami, 2016; Vázquez and Meneses, 2015).

In this sense, research has focused on identifying the results of the application of certain pedagogical models, didactic and pedagogical strategies and technological tools[1] , which is why in each research analyzed a process of articulation of a particular strategy, model or ICT and its impact on the academic results of higher education students is proposed, but no overall picture is provided where educators and non-educators can contemplate the alternatives in a comparative and consolidated way, considering their impact on the training of students. Therefore, the objective of this article is to carry out a systematic literature review to consolidate the didactic and pedagogical strategies, pedagogical models and technological tools with which ICT-mediated higher education students achieve better academic results. The following three research questions were proposed to analyze the selected studies:

- With which didactic and pedagogical strategies do ICT-mediated higher education students achieve better academic results?
- with which pedagogical models do students in ICT-mediated higher education reach their goals? better academic results?
- With which digital tools do ICT-mediated higher education students achieve better academic results?

It is worth mentioning that, for the purposes of this research, a didactic strategy is understood as one that seeks to motivate socialization among participants through a set of actions that entails an active and dynamic role on the part of the student, while pedagogical strategies are understood to be

1 For the purposes of this study, a strategy is understood as procedures or sequences of actions, conscious and voluntary activities that pursue a specific purpose, while tools are a set of technological factors (physical, digital or virtual) that are used in training processes.

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those that are directed to the mastery of knowledge, a set of autonomous skills of the training process such as autonomy, reflection, memory, among others, or an inductive, deductive or mixed exploration by students, which constitute the learning objective set in the training process (Díaz and Hernández, 2002; Gamboa et al., 2013). Consequently, it is made clear to the reader that there may be pedagogical strategies that are in turn didactic, since they seek to deepen an objective of the pedagogical model by encouraging an active and dynamic role on the part of the students.

On the other hand, according to Ortiz (2013) and De Zubiria (2010), it is understood that a pedagogical model integrates a set of elements (knowledge, context, teacher and student) that are articulated in a space in accordance with certain specific objectives; consequently, it presents a grounded theoretical construction that serves to interpret, design and adjust the pedagogical reality from a context. Thus, a pedagogical model integrates both strategies and technologies, through conceptions or assumptions articulated to the pedagogical process in consideration of the training objectives. So it is important, to analyze the learning process as a set of interrelated factors (Ángel and Patiño, 2019; Henríquez et al., 2015; Morazán et al., 2008; Schindler et al., 2017; Sim and Stein, 2016).

With regard to technological tools, three groups are analyzed in this document: physical, digital and online. In the physical tools we identify their impact on the pedagogical processes and the ease of connectivity of training and non-training personnel, placing as the main reference the tablets and cell phones, which through the massification in their access have allowed: the ease of access to *software* and *websites* used in education, a real-time connectivity of individuals, a new training scenario for them, which, by downloading applications, *software* or access to websites can access various educational content, generate communicative processes that lead to the formation of collaborative knowledge or perform processes in parallel with the educational one. In this sense, physical technological tools, such as mobile devices, have positioned themselves as the platform for virtual or blended learning schemes, becoming the starting point for the other two sets of technological tools.

On the other hand, this document starts from a distinction between digital and virtual tools, recognizing in the virtual ones the internet connectivity as a difference. Thus, digital tools are defined as those *software*, simulators, applications or multimedia content that do not require the use of mobile data or internet for access, while online or virtual tools are those that necessarily require internet access, such as virtual learning environments (VLE), MOOCs, social networks, blogs, among others.

Methodology

For the preparation of this article, a systematic literature review was carried out, using the PRISMA methodology according to Urrútia and Bonfill (2010). Table 1 shows the dates on which the bibliographic references were extracted from the databases.

Table 1. ***Dates and databases consulted***

	Initial review	**Complementary review**
Database query start date	March 2, 2020	April 20, 2020
Consultation end date in database	March 4, 2020	April 20, 2020
Databases consulted	Scielo, Dialnet plus, Journal Storage Project (JSTOR), Pro- quest.	Science Direct, Scopus, Emerald Insight.

Source: Own elaboration.

The systematic review was carried out in two stages: an exploratory and a decantation stage. In the exploratory stage, the databases mentioned in Table 1 were consulted using search equations that were structured on the basis of the following words: Pedagogical Innovation, Distance Education, Higher Education, Information and Communication Technologies, ICT, ICT, TAC, Learning and Knowledge Technologies, Virtual Education, and University Education.

According to the PRISMA methodology, the following inclusion criteria were applied: *Type of document:* Article in indexed journal/ journal article; *Year of publication:* 2015-2020; *Language:* Spanish or English; *Access:* With full text available in PDF (Scielo, Dialnet plus, JSTOR, Proquest, Science Direct), Only content I have access to (Emerald insight), Open Access (Scopus); *Authors:* Maximum 7; *Title or Abstract:* Those articles that in their title or abstract made explicit that they addressed the use of ICT or CT in order to improve pedagogical innovation or teaching and learning processes in distance or virtual higher education. For this item, the introductions were reviewed, in the case of bibliographic records that did not have an abstract.

Upon entering the search equations in the databases and filtering the results taking into account the aforementioned inclusion criteria, a total of 186 records were discarded, therefore, the full-text articles to be analyzed were 100, of which 3 documents were retrieved from Scielo, 4 from Dialnet plus, 1 from Journal Storage Project (JSTOR), 81 from Proquest, 11 from ScienceDirect, 0 from Scopus and 0 from Emerald Insight.

In the decantation stage, of the 100 documents analyzed in full text, a total of 52 documents were selected for this article, which were selected because they addressed the topics of didactic and pedagogical strategies, pedagogical models or digital tools in ICT-mediated higher education. It should be noted that the 48 documents that were discarded focused on the recognition of problems and proposals to overcome them in educational processes. In addition, some focused on the problems of the technological, administrative and economic context that arise in educational institutions or on the technological barriers faced by countries.

Results

With which didactic and pedagogical strategies do ICT-mediated higher education students achieve better academic results?

Regarding the didactic and pedagogical strategies present in ICT-mediated education processes, the documents analyzed found didactic strategies such as gamification, which is considered as the integration of the dynamics and mechanics of games to educational contexts, which has allowed this strategy to generate interest and motivation in routine learning, presenting positive results at the cognitive, behavioral and affective levels (Adell et al., 2018). However, it has also raised questions about the importance of competitive motivation as opposed to collaboration, the vision of achievement or reward as the only motivating factor, and the analysis of the time incurred by students and teachers, both in the fulfillment and in the approach of the gamified strategy (Schindler et al., 2017).

Thus, gamification as a strategy articulated with pedagogy and technology has allowed advances in educational processes as well as new challenges and understandings regarding the moment of its use. A similar situation is presented in the didactic strategy of content under *storytelling*, which as a narrative and illustrated form of storytelling, allows students to acquire a greater understanding of the contexts and situations in which they must apply the knowledge given in the teaching and learning process (Carenys and Moya, 2016; Gómez et al., 2019).

Storytelling motivates assertive communication between teachers and students, as well as among students, with the purpose of generating a greater understanding of the application of concepts, their analysis and critique. In this sense, as a form of communication articulated with a game mechanics, it has allowed a greater dynamism in the learning processes. The above, allows recognizing the importance of these strategies in the educational field, additionally, its massive use is identified in pedagogical processes with greater use of technologies, i.e., in virtual and blended or B-learning (Taylor et al., 2017).

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In addition, it should be noted that these two strategies have not been the only ones that have promoted an active role of the student and facilitated communication and understanding of the learning processes. Case-based and problem-based learning have become pedagogical strategies that have been used by teachers through technological articulation (Fuentes, 2014). But, although the description, understanding and analysis of problems and cases by students stimulates critical thinking and leads them to a practical use of the theories and topics addressed in the sessions, which presents them with possible scenarios of a professional future; these cases require data and documents from real life, with the purpose of presenting situations to which the student will face and must propose solutions (Ranieri et al., 2018).

The collection of data and the posing of cases and problems, with the purpose of recognizing and aligning situations to the difficulty and thematic mastery of the students, derives in a greater investment of time and the selection of limited objectives in each case, which leads to greater wear and tear on the part of teachers and/or tutors, who must not only pose the cases, problems or scenarios, but also the best ways to communicate to students and guide them in their processes of applying knowledge and generating solutions (Ranieri et al., 2018).

However, in addition to the difficulty described above, through technological articulation, learning strategies based on cases, problems and even challenges, have allowed the sizing of simulators or immersive three-dimensional spaces; however, for teachers to use these technological tools, greater investments and collaborations with other areas of knowledge such as web design and development or the construction of 2D and 3D graphic content have been required, which imply the support of an audiovisual and programming area for the generation of their own pedagogical innovations.

Together with pedagogical strategies, collaborative learning is identified as another of the strategies to be highlighted in the research analyzed. The collaborative and social construction of knowledge is located as one of the main factors to promote from the activities proposed by teachers, which is why, communication and interaction channels such as social networks, forums, blogs, video calls and boards given in virtual learning environments, facilitate interaction between students and teachers for the generation of knowledge (Calderón et al., 2019; Čičević et al., 2016; Echandi, 2019; Molina et al., 2015).

Now, the understanding of collaborative learning not only includes the connections between the participants of the process *in situ*, but also, through virtuality, access to discussions on the topics through the Internet, have raised an axis of autonomous training by students, where, educational processes have been mobilized to virtual spaces and taken out of the classrooms, both virtual and physical, reason why teachers have lost control of the possible sources, topics and ways to address a content or topic that they try to promote in their students (Calderón et al., 2019; Echandi, 2019; Molina et al., 2015). This situation has motivated virtual and blended learning, but, has focused attention on the communicative forms and dynamics, reason why, the collaborative learning strategy has integrated didactic strategies and other pedagogical strategies to generate in students both soft skills such as teamwork, active listening, among others, as well as knowledge of the areas of knowledge.

The above has been articulated with other types of learning such as inverted learning, where the student takes an active role in his process and the teacher acts as a tutor who guides those sources, topics and forms of communication that the student locates in virtual channels for his own interest and begins to structure his autonomous learning process.

Thus, although these strategies are known by researchers and considered as trends in the framework of an education articulated with technology, they present difficulties in their application, since the research describes limitations ranging from teachers' capacities to propose innovative proposals to the willingness of educational institutions to finance these alternatives.

In this regard, Lašáková et al. (2017) are clear in pointing out that the barriers to the materialization of innovations that link pedagogy and technology are multiple and are not only focused on teachers and their willingness to master or not a technological tool that can be articulated in their pedagogical and didactic strategies as well as in their thematic content. Therefore, it is recognized that, in spite of the progress made in

the selection of strategies that, by tendency, can generate better results in the learning processes of students proposals are required for the articulation of all the actors involved in the process with the purpose of reducing the lags present in the educational contexts.

With which pedagogical models do students in ICT-mediated higher education achieve better academic results?

The pedagogical models directed to learning integrate ICT tools and didactic and pedagogical strategies for educational purposes, this articulation contemplates a formative perspective from virtuality and *B-learning*, necessary for the fulfillment of learning objectives, which must contemplate actions guided by the teacher and made by the students from an active role on their formative process (Amaro and Chacín, 2017).

In this regard, the review of the selected research identified a total of 30 documents that recognize the constructivist (86%), TPACK (7%) and TELL (7%) models. These models have contemplated not only a techno-pedagogical articulation, but also the analysis of research, communication and immersive technologies for the construction of worlds where students apply their knowledge in a controlled manner. The link generated through pedagogical models has allowed to evaluate not only the importance of the teacher's role but also the participation of students in these processes, therefore, tools that allow better results are analyzed through research (Astudillo, 2016).

The main pedagogical model analyzed through research is constructivism, which admits self-regulated learning through individuality. Under this model, students construct a world of experiences mentally, which guide their cognitive processes, thus analyzing how the student understands and gains knowledge of the world. Constructivism uses technology to situate learning and the application of prior knowledge around problems, challenges or cases, through teacher instruction, collaboration, mutual teaching, virtual questions, among other methods of interaction under a controlled environment of knowledge application (González et al., 2019; Lim et al., 2019; Salas, 2016).

Constructivism has guided the generation of technological tools as well as positioned the use of pedagogical and didactic strategies in which students take an active role and apply previous and new knowledge in a controlled manner. In the application of these models, communication becomes relevant, as well as the training of teachers in the use of technology, since innovations such as immersion in virtual worlds (simulators) facilitate the control of environments and the application of knowledge in a guided manner by teachers (Astudillo, 2016).

As an articulating concept, the TPACK model (*Technology, Pedagogy and Content Knowledge*) links three dimensions, pedagogy, technology and knowledge to be communicated, with the aim of promoting digital literacy from the teaching practice (Gómez et al., 2019). This model focuses its attention on the approach of pedagogical dynamics and thematic knowledge, with the purpose of selecting the technological tool that allows fulfilling the educational objective. Therefore, TPACK establishes a set of relationships between the mentioned dimensions, which allow to systematically understand the training processes and close the gaps between the implementation of technological knowledge and pedagogy.

The research conducted on the TPACK model with teachers describes a greater willingness of teachers to implement strategies such as gamification or transmedia storytelling as opposed to the mastery of technological tools such as MOOCs (*massive open online course*) and *NOOCs* (*nano open online massive*). Consequently, despite the fact that the TPACK model favors technological understanding and the change that implements this dimension in education, the willingness to generate content articulated from the technological limits the actions of teachers and restricts them to a process of exploration, training, mastery and subsequent communication of technological tools, given their limitation in the direct creation of content (Gómez et al., 2019).

In addition to the TPACK model, the TELL (*Technology-Enhanced Language Learning*) model is identified, which focuses its analysis on three axes: the tools, the communicative function and the participants (teachers and students). This model proposes the use of virtual learning environments, particularly forums, as well as wikis

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in virtual classrooms, with the purpose of generating communication spaces between peers and students and teachers (Dooly and Masats, 2015).

In this sense, the use of the Internet and social communication spaces support an authentic communication dynamic in the classroom, guided by the teachers' interventions. This technological interaction focused on language also has a use of vocabulary through the use of forums, where students promote their mastery of language through the topics raised in the classroom (Dooly and Masats, 2015).

Thus, the TELL model integrates its three axes of interaction (tools, communicative function and participants) in the learning process, in order to ensure training in language proficiency for the case analyzed, also integrates technological tools to the dynamics proposed by teachers through oral and written communication, which is facilitated by tools such as the forum, wikis and virtual meetings between participants (Dooly and Masats, 2015). Therefore, this model emphasizes the role of the teacher and his pedagogical proposal for the learning objective, using technology as an integrating and management tool for the fulfillment of its educational purpose.

The TELL model, presents an emphasis on technology and the elements that constitute the communicative processes (referential, discourse analysis, appeal, text writing, among others), which characterizes its contribution as a pedagogical model, since it integrates the forms of communication to research to generate self-learning processes, giving importance to both the forms of communication and the search for knowledge in processes where technology and pedagogy take an essential role (Grinsztajn et al., 2019).

These three models present different objectives and articulate technology and pedagogical and didactic strategies in different ways. However, all three highlight research, communication and technological implementation of controlled environments (such as immersive worlds), as it is these elements that facilitate the search for knowledge by students, the application of knowledge under the guidance of the training staff and the forms and intentions of the communication given between students and trainers (Adell et al., 2018; Albertos et al., 2016; Dooly and Masats, 2015; Gómez et al., 2019; Venkatesh et al., 2016).

Thus, scientific research is located as an aspect that is articulated to the processes of analysis of the interrelations between technology and pedagogy. In fact, research as an articulating axis of training is privileged by pedagogical models, since it consists of generating questions from one's own knowledge and leads the student to inquire for answers to their questions (Nkonki and Ntlabathi, 2016; Oliveira et al., 2016), enabling recommendations to be issued in the processes of students and leading to innovation in physical and virtual classrooms (Albertos et al., 2016), at the same time that it is located as a constant feedback to own knowledge and as an opportunity to strengthen communication with peers that results in the generation of solutions to the questions posed from the student in a collaborative manner (Adell et al., 2018; Albertos et al., 2016; Dooly and Masats, 2015; Gómez et al., 2019; Venkatesh et al., 2016). This constant feedback, as a pedagogical exercise, facilitates the teacher's understanding and mastery of technological tools as it involves the recurrent use of technology and knowledge (Henríquez et al., 2015).

On the other hand, it is relevant to mention that the pedagogical models addressed, have raised needs in *software* development, where a basic proposal is recognized, the educational virtual immersion. Under this proposal, users use role-playing games and propose the construction of scenarios in which their interactions lead to the use of the tools and thus to the training proposed by the tutors or moderators (Badilla and Meza, 2015). However, this immersion is guided, both by virtual tools and by the tutors, who not only adapt the functionalities of the virtual space to their educational needs, but also innovate in the proposal of alternatives that lead to their training objectives (Badilla and Meza, 2015).

In this sense, immersive worlds through scenarios facilitate the student's approach to problem solving through challenges that are overcome by the students and that in turn develop in them the necessary skills for their future professional practice. However, it has been identified that these platforms require a high volume of

content that can lead to connectivity difficulties (Badilla and Meza, 2015). This technology applies an active role of the student and implements a challenge-based learning, which describes the application of the constructivist model on training processes and encourages teamwork and collaborative construction of knowledge and skills to overcome challenges, hence it is located as one of the important tools to generate pedagogical impacts (Badilla and Meza, 2015).

But, despite its advantages and approaches, technology presents different problems, since the approach of scenarios is unique and independent, which is why, the determination, design and development of audiovisual and interactive content for training processes involves a high cost and conceptualization from the information and skills to be linked in the curricula or training plans of Higher Education Institutions (HEIs) (Lameu, 2020; Revelo et al., 2018).

Thus, the pedagogical models analyzed integrate technological tools as well as pedagogical and didactic strategies, and these models also propose a particular learning objective: constructivism explores those processes that generate knowledge elaboration from experience and the application of knowledge in controlled environments by students; while in the TPACK model, the objective is to promote digital literacy that ensures that students use technologies to generate knowledge and meet their learning needs. Finally, the TELL model articulates tools to facilitate teaching with an emphasis on communicative processes. Consequently, the models as a whole present different learning objectives as well as different articulations of technology and pedagogy, which are the subject of analysis in the research.

Additionally, although learning processes require technological and pedagogical expertise, research as a basis for self-learning, forms of communication and the purposes determined by the learning objectives are as necessary as the previous ones, being the educational objectives those that allow the articulation of technology and pedagogy, since they describe the way in which the student interacts and experiences when coming into contact with the educational content through the pedagogical model, as well as describing the purpose of the content or training activity, put into operation by means of technology.

The following section analyzes technological tools as essential elements of the educational process, since they are constantly changing due to technological innovation and generate opportunities and challenges for pedagogy, communication and the purposes of education.

With which digital tools do ICT-mediated higher education students achieve better academic results?

When analyzing digital tools, it is identified that their use in training processes has started from the linking of functionalities of mobile devices to education. As a sample of this, the use of applications for reading multimedia content such as pdf, doc, xls, among others, as well as audiovisuals, is a first articulation of tools to pedagogical strategies and activities (Echandi, 2019; Kumar and Daniel, 2016).

This initial articulation describes the use of technological tools as substitutes for physical elements associated with educational processes in the classroom, such as notebooks, books, note taking, photocopies, among others. It should be recognized that this articulation characterizes an incremental improvement in educational processes, since access to digital notes at all times, as well as multimedia and digital content such as videos, audios or digital books, decreases search times and access capacity by students, democratizes sources and allows the teacher to focus on strengthening the understanding of these contents, instead of solving problems of access to sources that students may face (Kumar and Daniel, 2016).

As an advance of this set of technological tools in the articulation with pedagogy, desktop applications and simulators that do not require Internet connection are recognized. These tools allow the deployment of situations in which students apply their knowledge in a controlled manner and generate conclusions that allow them to reinforce learning.

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However, the construction of this type of tools presents high costs for educational institutions, since their use is limited and their development requires not only pedagogical knowledge, but also the design and programming of applications or installable software. However, these tools complement the educational processes of students who have difficulties in accessing the Internet, since, due to the specific conditions of the economies and geography of the countries, access to the Internet is restricted in several regions, where the content that can be installed on the devices allows the student to continue his or her process autonomously (Manjarrés et al., 2020).

As identified, this set of digital tools presents opportunities and limitations in its articulation with pedagogy, since, although it solves problems such as access, application and even evaluation of students' knowledge, the generation of this type of tools is costly and the capacity of teachers to master them and articulate them to their activities within the framework of the pedagogical and didactic strategies they execute is limited (Rajasekharan and Prakash, 2017; Revelo et al., 2018).

In opposition, online tools are identified, which have presented multiple advances, since the development of websites and the massification of content through the Internet allows greater volumes and types of content, however, it presents access restrictions to those students who face difficulties to connect. Given the multiplicity of tools present in this set, this research proposes their segmentation into four main types: LMS (*learning management system*), MOOCs, social networks and their contents, and finally, online simulators. As can be observed, the four types present a characteristic to highlight, massification, i.e., the possibility of linking countless users or students to the same educational process, which allows savings for educational institutions, however, it also means a necessary investment for the materialization of these tools (García, 2017; Gil and Domínguez, 2018; Sangrà et al., 2015).

When talking about LMS, Oliveira et al. (2016) describe it as a virtual space or platform, which allows communication and interaction between actors (teachers, students and administrators), the dissemination of teaching resources, the evaluation and verification of progress, the design of interfaces and navigation in a controlled environment for learning, as well as the administrative and coordination support that allows the execution of changes to the LMS and its contents. According to the authors, through the review of research associated with this tool, it was identified that the best known LMS are Moodle and Blackboard, which present a greater positioning in educational centers, due to the functionalities they grant to the actors (Nkonki and Ntlabathi, 2016; Oliveira et al., 2016).

According to Olaniran et al. (2017), LMS are distinguished by their functionalities, therefore, educational institutions resort to those platforms, which by cost criteria, contemplate support, ability to modify and customize elements within them and the largest number of tools for the execution of educational processes by teachers. However, their implementation requires training for teachers, students and administrators for proper operation. This need in its implementation characterizes the dynamics between teachers and the platform, since resistance to change and the lack of training spaces lead to inefficient and insufficient use of the functionalities presented by the platforms, and leads to disagreements between the different actors (Dorner and Kumar, 2016; Grinsztajn et al., 2019; Henríquez et al., 2015; Lašáková et al., 2017; Olazábal, 2019).

Therefore, the articulation of this online tool presents several points of risk that must be addressed by educational institutions, as well as by teachers, since, aspects such as accompaniment and training that lead to the mastery of the tool by the participants of the same, improve their willingness to change and allow locating the benefits in the use of online platforms (Revelo et al., 2018). Next, MOOCs describe a dynamic of constant transformation through the interaction of agents in the educational environment. Massive open online courses have made it possible to generate new pedagogical dynamics, where students present an active role and teachers through collaborations build new formative proposals through these. Thus, these courses seek for students to take control and manage their learning, connecting resources in a personally managed space (Czerniewicz et al., 2017; Vázquez and Meneses, 2015).

In this regard, it should be recognized that MOOCs were initially identified with low social interaction, where the student developed the contents according to their criteria; however, the constant evolution in technological terms motivated a greater interaction of the participants generating MOOCs (*social massive open online course*) (Osuna et al., 2018). Moreover, tMOOCs (*transfer massive open online courses*) integrate authentic tasks, transfer of learning to the profession, pedagogical transformation, information and communication technologies, transmediality, open temporality, collaborative work, intercreative talent, transnationalism and tolerance (Osuna et al., 2018). These characteristics of tMOOCs pose a design that is directed to training processes, where, factors such as transmediality combine both physical and digital elements for students to perform activities that allow them to obtain conclusions in a guided, although independent, way from the field of knowledge they want to address (Osuna et al., 2018).

Thus, it is identified that MOOCs are tools that have presented a tendency to complement for the strengthening of teaching processes, allowing a greater attention of students, as well as their freedom in their formative processes. Hand in hand with Moocs, the implementation of LMS and EVA platforms has promoted other pedagogical forms of knowledge generation such as collaboration, discussion and teamwork (García, 2017; Sangrà et al., 2015).

However, it is to be recognized that the creation of MOOCs requires not only pedagogical but additionally technological support, since, as multimedia content involving transmedial actions, the construction of such formats combines a work between teachers and multimedia experts (Gil and Domínguez, 2018). This process constitutes an investment by educational institutions, which end up being of a strategic nature, since, once the MOOC has been developed, according to its approach, it allows the attention of a large number of students, who only require the guidance of the teacher to advance their learning processes (Gil and Domínguez, 2018).

On the other hand, social networks are an online tool that can be used to promote learning, it is important to note its pedagogical approach, which is based on a collaborative construction of knowledge through the construction of academic networks by students. In this sense, it not only collects an active perspective but also combines the need for students to socialize and discuss their knowledge through virtual communication channels (Albertos et al., 2016). Among the social networks that have been used as tools for education are located Facebook, Instagram, Pinterest, Skype, SoundCloud, Tumblr, Twitter, WhatsApp, Wechat and YouTube. However, these networks have not necessarily had the same impact in terms of academic use by students, since, although networks such as WhatsApp, Skype and Facebook are massively used by students, their use in pedagogical terms is limited, since students use these channels for functions other than academic ones (Calderón et al., 2019; Trujillo, Aznar, et al., 2015a).

On the other hand, social networks such as Youtube, Pinterest and Instagram, although they present a different function in students and do not allow interaction among participants with the same dynamism of networks such as Facebook or WhatsApp; they describe a greater use by teachers and students in the formative processes, particularly in the provision of content that provide clarity to students or become spaces for discussion and criticism of the contents (Trujillo, Aznar, et al., 2015a). In general, authors such as Calderón et al., (2019) and Trujillo, Aznar, et al., (2015a) point out that the implementation of social networks to formative processes improves students' results and allows a mastery of thematic knowledge subject to comparison and analysis in the environments in which the student develops. Therefore, social networks facilitate the construction of dynamic and effective learning communities, as well as knowledge networks in different fields (Calderón et al., 2019).

However, it must be recognized that, just as social networks allow students to build knowledge collaboratively, they can motivate their leisure and divert their attention from the educational processes, which is why their application must be guided and motivated through the role of a tutor, so that the student obtains the information and support required for the process (Calderón et al., 2019).

Finally, the online simulators allow students to experience the processes of applying knowledge specific to their training, in addition to becoming spaces for the construction of collaborative networks that facilitate

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discussion and the joint elaboration of knowledge. Some of these tools use role-playing games for the student to experience and apply their knowledge from specific perspectives, so that, through multiple roles inside the simulator, the achievement of objectives and thus knowledge is allowed, promoting gamified and collaborative learning (Giudicessi et al., 2016).

Regarding their pedagogical impact, simulators facilitate the construction of their own active behavioral structures in students, promoting the mastery of technical knowledge and skills as well as aptitudes and attitudes for their application (Calabor et al., 2018). However, despite its benefits in pedagogical terms, the construction of these contents requires high investments, since it involves not only the design but additionally the development and payment of service costs, i.e., it depends on the users who have access to the platform, which requires the payment of servers and online resources that imply higher costs to the process (Ángel and Patiño, 2019).

From the description of these technological tools, it is identified that, the classification that describes three types, the physical, the digital and those online, raise possibilities of integration with ease or not by teachers and HEIs (Rajasekharan and Prakash, 2017). Therefore, it is recognized that the physical tools allow the manipulation of educational content under the students' connection conditions, while the digital ones use the physical ones to visualize defined content such as PDF, Excel or Word files, among others; for their part, the digital ones promote with greater impact the interactivity of students and their collaborative learning (Czerniewicz et al., 2017).

In general, technological tools have promoted student autonomy not only in access but also in the construction of behaviors and social networks that allow them to strengthen their knowledge through discussion, collaboration and socialization. This social dynamic has allowed the expansion of knowledge spaces, so that the role of teachers is destined to a greater extent to the exercise of tutoring or guidance (Bozkurt et al., 2020; Rajasekharan and Prakash, 2017; Sangrà et al., 2015).

With respect to the actors, although technological tools have demanded an effort from educational institutions and teachers in terms of investment, training and adaptation to knowledge, the application of these tools, as well as their analysis in pedagogical processes, has occurred to a greater extent in recent years in educational centers worldwide. Therefore, it is recognized that technology has sought to promote a greater number of tools that can be articulated pedagogically to promote facilities for teachers, students and educational institutions to achieve better academic results (Rajasekharan and Prakash, 2017; Revelo et al., 2018).

Discussion

During the course of this document, a review of didactic and pedagogical strategies, pedagogical models and technological tools that are currently being implemented in different training contexts in the process of articulation of ICT in higher education was carried out. This analysis identifies around the pedagogical and didactic strategies, a distinction according to their purposes where, those directed to learning take to the student flexible instruments to interact significantly with topics and solve problems; while, the didactic ones allow activating previous knowledge, orienting and guiding students on relevant aspects in the topics through different dynamic work methods (Amaro and Chacín, 2017; Salas, 2016; Sandí Delgado and Sanz, 2019).

In this regard, these strategies should focus on the objectives of the learning processes, which are proposed from the pedagogical model and in consideration of the articulated technological tools. Now, given that learning can be generated at any time, the role of the teacher-educator becomes a guide that leads the student in his formative process and provides him with support in the search for sources, topics and ways of approaching the contents as well as in the structuring of his self-learning processes (Mendieta, 2016; Revelo et al., 2018).

In order to achieve these goals, the main trends described in the research studies analyzed are learning collaborative and inverted, which privilege an active role of the students in their learning processes.

This role facilitates a joint construction of knowledge around the topics of interest of students, strengthening their soft skills and generating questions about their interests, which lead the teaching work in the classroom and the approach to the topics (Gogoi, 2016). Additionally, it is noteworthy that the implementation of this type of strategies has raised the need to build audiovisual resources in a guided way by educators, which describe the need for investments by educational institutions (Revelo et al., 2018).

However, additional factors that hinder this articulation include the creation of solutions based on the conditions faced by teachers and educational institutions, which focus on training and availability of resources for investment. As solutions, didactic and pedagogical strategies have been mobilized through the models applied in classrooms, which contemplate the inclusion of games, technological tools, social actors, among others, allowing to analyze not only the role of the teacher in the application of the strategy and the approach to topics but also the participation of the student in their interaction with the content and their learning process, an aspect observed by educational institutions through academic results (Albertos et al., 2016; Islam Jony et al., 2017).

Next, the constructivist, TPACK and TELL models focus their analysis on the approach of technological tools, pedagogical strategies and thematic knowledge, in addition to communication as a fundamental aspect of the process, with the aim of describing ways of approaching thematic content with students (Dooly and Masats, 2015; Gogoi, 2016; Gómez et al., 2019). These models use inquiry as a motivational axis for students in their autonomous learning process and outline communication tools for the improvement of guidance and feedback results by teachers (Grigoryan, 2018; Morris et al., 2015). Additionally, research is considered as necessary behavior for the autonomous pursuit of knowledge, which the student directs for their academic purposes (Albertos et al., 2016; Calderón et al., 2019).

Likewise, the pedagogical models analyzed in the document integrate technologies such as immersive worlds that constitute scenarios where students interact and apply knowledge in an active and collaborative way. In this regard, both research and immersion in virtual worlds require immediate communication that leads the thematic approach towards the guidance and feedback of the student's actions (Albertos et al., 2016; Calderón et al., 2019). Therefore, social networks are identified as a technological factor that favors the collaborative construction of knowledge as well as the autonomous role of the student in his or her training process (Albertos et al., 2016; Calderón et al., 2019).

As a third axis of analysis, technological tools are located, which are analyzed from their contribution to the learning process in physical, digital and virtual, being the digital ones those that allow access through electronic devices to contents that are not necessarily on the network, and the virtual ones those whose place is located on the network, that is, the Internet, favoring spaces for the implementation of pedagogical and didactic models and strategies (Carmen and Hernández, 2017; Manotas Salcedo et al., 2018; Osuna et al., 2018). In this sense, virtual tools have facilitated access to content and have generated spaces for discussion among peers that lead to collaborative knowledge generation.

These tools are varied; however, virtual learning environments, massive open online courses and social networks have been the tools most analyzed by the research, recognizing in them their character of constant innovation that demands from teachers and educational institutions recurrent training in their mastery, as well as investments in technological structures that support the contents required by the applied educational processes.

Therefore, these tools complement the articulation made through the learning models and are applied through the pedagogical and didactic strategies that the teacher can execute. Thus, it is recognized that there are other elements that complement the articulation processes of ICT in higher education, which should be considered during the approach of educational processes for students in educational institutions (Gogoi, 2016; Revelo et al., 2018).

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Conclusions

This document reflects a set of elements (strategies, models and tools) that promote better academic results in ICT-mediated higher education students; however, it is important to point out that the multiple characteristics associated with social processes such as education require further analysis in order to determine the best tools, models or strategies that lead to successful results in education, which implies understanding the social and personal objectives associated with these educational processes.

Consequently, this review of elements constitutes a support for future research that analyzes the processes of articulation of ICT in higher education for specific cases, which requires an understanding of both the variables involved in the process and the different solutions to which educators can resort during the planning of activities that lead to the fulfillment of their objectives with their students.

Finally, it should be noted that the pedagogical models have favored the use of digital and virtual tools, which have facilitated communication processes and access to the construction of knowledge by students, consequently, the need for new processes of analysis in context is identified that allow establishing paths or actions for the articulation of these trends in strategies, models and technological tools in local training environments.

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