

E-learning in the Teaching-Learning of Distance Higher Education: A Review

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Abstract– Currently, higher-level educational institutions are linked to the internet and ICTs as a consequence of the COVID-19 state of health emergency, the purpose of the study was to analyze e-learning in teaching-learning in distance higher education. The main theoretical approaches, strategies and tools used in the teaching-learning of the engineering career at a higher level were identified. The systematic review of scientific articles was used with the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) method applied the approach (PRISMA) Applying the Kitchenham approach. The search strategy consisted of choosing the databases: Scopus, Web of Science and Scielo with the use of Boolean operators (AND, OR) to perform unions or combinations with the previously chosen keywords and descriptors. As a result, 26 articles published between 2018 and 2022 were obtained, for the theoretical model 14 articles have been used, 17 articles were analyzed on the most frequent strategies and 22 were determined in terms of the tools used by teachers and students, finally as impact conclusions the use of different models and teaching-learning strategies based on e-learning, using online and audiovisual digital tools has been inferred.

Keywords: Teaching, Learning, E-learning, Distance Education, Teaching-Learning.

I. INTRODUCTION

Nowadays, all higher education institutions are urged to link to Information and Communication Technologies (ICTs). The pandemic has highlighted the shortcomings of e-learning worldwide, especially in Latin America. However, we can highlight the fundamental role of ICTs and e-learning in the implementation of new teaching methodologies. It is possible that teaching models based solely on technology may have a dispersed mission, and these risks could be even greater than in the classical model of university teaching [1].

The teaching-learning process in higher education has been massified in virtuality, which has accelerated, generating a didactic position superior to traditional teaching [2]. Therefore, traditional hands-on learning is combined with educational technology that enhances learning in the laboratory and has benefits for both the student and the academic [3]. However, there are still some tools that are not didactic in the

teaching of some careers, e.g., teaching dissections and cadaveric training practices, which are irreplaceable techniques in the teaching of Anatomy [4].

On the other hand, online teaching-learning facilitates the transfer of knowledge, reduces the stress associated with learning, actively involves students, and reduces the time required [5]. Soon the jobs positions will be replaced by automated machines for production, requiring personnel to operate, maintain, and restore facilities in case of obsolescence of certain components [6]. In addition, it became evident that there are negative aspects that include poor Internet connectivity and a lack of electronic devices to access digital resources. It is important to improve training and communication, but a model must also be designed to guide the planning and development of online learning and teaching [7]. Therefore, educators must acquire new knowledge and skills related to online learning platforms such as Moodle, Panopto, Chamilo, Canvas, Atutor, among others. In teaching engineering students, it is necessary to know all the models, strategies, and cutting-edge methods used in teaching-learning. It should be considered within all technological uses also, ethics as regulation and care. According to [8], ethics in Engineering Education 4.0, comes with a particular focus because it intervenes in the relationships between stakeholders of engineering faculties and technology, and the implications (good and bad) of those relationships on behavior.

This study is important because it allows us to be alert in a post-pandemic context, both for students and teachers who are immersed in virtual learning environments. The worldwide research review allows us to learn about theories, strategies, and tools most used in online teaching-learning [9]. Likewise, it serves as a methodological guide for university professors for constant updating since we are in a volatile society. In the epistemological sense, it allows us to understand and interpret the several theories, approaches and models applied by teachers worldwide.

Therefore, within the study, the following problem was posed Why is it important to analyze e-learning in teaching-learning of distance higher education? The importance for every teacher 5.0 in a digital society to be updated with their students who practically live in networks, internet, and technological tools is a necessity. A teacher who does not apply in their classrooms some kind of tool, strategy, and/or updated approach should not teach.

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E-learning has been considered a learning strategy that leads to new characteristics of teaching performance, provides opportunities to involve educational activity with the real world, experiment through updated information and reflect with holistic experiences. It is also a fundamental issue for the successful construction of educational models; however, research related to ICT-supported learning still has significant limitations. Hence the need to understand why and what drives students and teachers to e-learning. A concrete reason for these obstacles; challenges or barriers makes it easier to take appropriate actions to ensure the success of e-learning [10]. Concerning distance education, it provides students and teachers to experience a freer and more flexible teaching-learning process [11]. Regarding previous studies, in [12], the authors state that the development of learning under the face-to-face and online modality, based on ITCs use, has recently become a blended learning that has provided support for learning in higher education. This assertion is evidenced in a study that allowed them to identify the teaching approaches and instructional design applied by teachers in a blended learning environment by analyzing the effect of students' self-directed learning. In [13], they found that there are obstacles in Internet access, speed, and connection, which do not allow teachers to use ICTs in their teaching practice, and on the other hand, the use of virtual spaces saves on printing questionnaires because the tests can be done online. Similarly, in [14], they reported on the digital tools used by university teachers. We worked applying the positivist paradigm, so a research instrument was designed consisting of an estimation scale of three categories: (i) communication tools, (ii) digital platforms, and (iii) collaborative tools, which was applied to a sample of 33 teachers in seven months. In addition, it was reported that teachers stated that when teaching their classes virtually, they encountered connection problems that overloaded their work. On the other hand, in [15], they reported that the predominant strategy is related to the autonomy of university students, where the information coding strategy has more weight in the development of autonomy, and the risk strategy is when the student has low levels of autonomous learning. In [16], they formulated an innovation proposal that considered a form of social accompaniment at a distance, which allowed students to develop digital ecosystems wherever they are and at any time with only a computer and Internet connection, which opened the possibility that through this strategy they could obtain their professional degrees. The research sought to design a methodology that adapts to pandemic circumstances in virtual learning spaces. For this purpose, techniques, methods, and computer tools adapted to each situation or activity in online education were established. The study was carried out with students and teachers of civil engineering. Likewise, in the analysis [17], it made known the theories related to engineering thinking and automation for which the heuristic construction was developed on the theory of behaviorist, cognitivist and constructivist thinking that studies the thinking of man and his social behavior. Authors such as Max Meyer, John Watson,

Piaget, Siemens, and others have been considered because they have modeled the currents of constructivist, behaviorist, and constructivist thinking, which in turn are identified with the positivist approach.

II. METHOD

The systematic review of scientific articles was used following a rigorous methodology such as the Prisma method (Preferred Reporting Items for Systematic reviews and Meta-Analyses), characterized by the clear and detailed specification of the in-depth search process of scientific articles related to the topic [18]. The search strategy consisted of choosing the following databases: Scopus, Web of Science, and Scielo, and the use of Boolean operators (AND, OR) to make unions or combinations with the keywords and descriptors previously chosen. The selected combinations were: "e-learning AND University", "e-learning AND engineering AND university". Among the eligibility criteria, the following were considered as inclusion criteria: (a) original articles presented with qualitative, quantitative, or mixed approach with experimental or non-experimental design; (b) language: English and Spanish; (c) publications produced during 2018-2022; (d) open access and full text; (e) e-learning as the main topic; (f) higher education context. The exclusion criteria were: (a) documents other than articles, such as thesis, books, book chapters, editorials and letters to the editor, special articles, and research papers; (b) non-English and non-Spanish language research; (c) articles published outside the years 2018-2022; (d) documents with closed access and/or with a fee to view them; (e) context other than the higher education level.

After obtaining the data, they were transferred to an Excel sheet, and a digital file was created. The abstracts were filtered according to the inclusion and exclusion criteria, and then the selected abstracts were read, and the complete article was read until the results of the 26 selected papers were obtained, as shown in Figure 1.

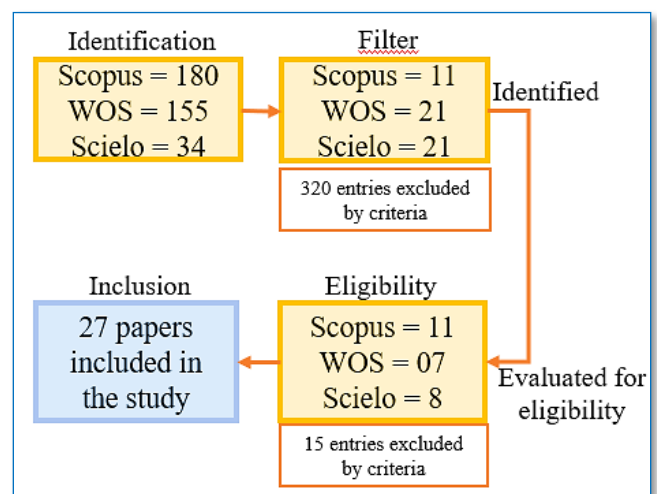


Fig. 1. Prisma Flow Diagram

Regarding the articles by database, eleven were selected from Scopus, seven from Web of Science and eight articles from Scielo (see Figure 2).

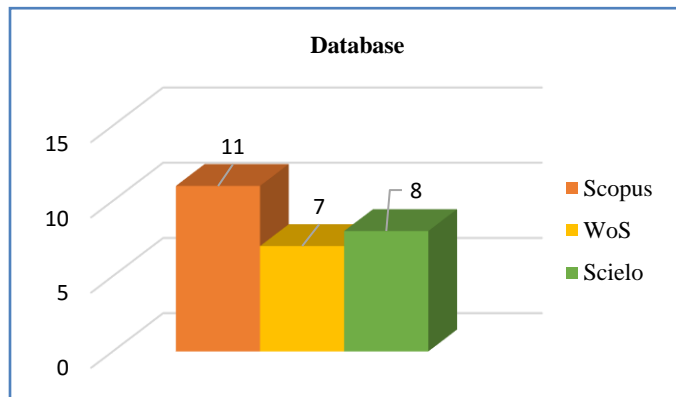


Fig. 2. Articles by database

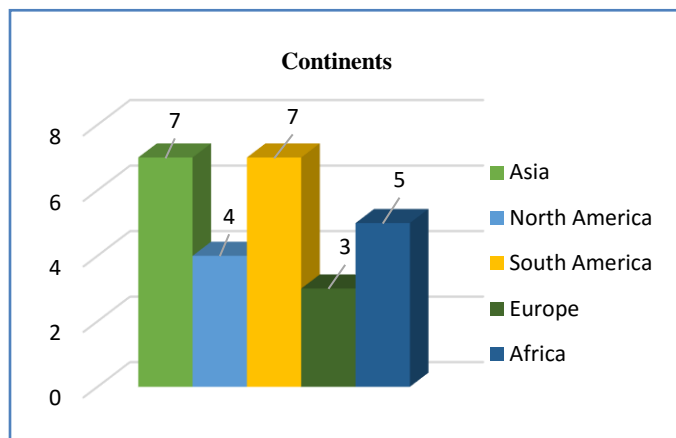


Fig. 3. Origin of articles by continent

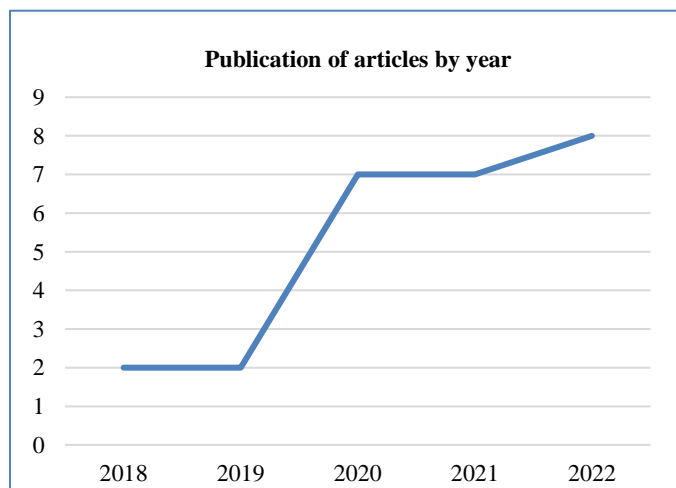


Fig. 4. Publications of articles by years

Concerning the origin of the articles, they were grouped by continent. The Americas presented eleven articles (four from North America and seven from South America), seven articles from Asia, five from Africa, and three from Europe (see Figure 3).

Regarding the publication years of the articles, Figure 4 shows that the highest production occurred in the years 2020 and 2022.

III. RESULTS AND DISCUSSION

A. Theoretical approach

Table I shows the articles reviewed that addressed approaches, theories, and models. Specifically, six articles were found that consider the social constructivist and cognitive constructivist approaches. The cognitive constructivist approach is based on the Piagetian theory, which sustains that the construction process is individual, and analysis is carried out in three perspectives: macro-genetic analysis, micro-genesis, and the integration of these two positions [19], [25]. Along these lines are the learning theories (didactic, experiential, constructivist, and collaborative) and the computer-measured didactic models of the constructivist approach [20], [21]. The theory of cognitive interests is also mentioned, which allows addressing the fundamental interests of the human being that influence the way of creating or co-creating, considering the technical, practical, and emancipatory interests [22]. Likewise, the approach based on the combined use of simulations was found, with the use of continuous modeling and discrete modeling, which is based on the theory of system dynamics, where an object or system is represented in a simplified manner and when hypothetical situations are posed, it is understood as a simulation of the object's behavior [23].

Another related theory that was found was the reflective theory of Schon, which develops Design Thinking that is based on phases that help us to understand and gather information about the problem encountered to provide a solution [24]. Another theory is connectivism, considered a model that recognizes the constant changes brought about by technology, as well as the information exchanges that can take place through the World Wide Web [25]. In the models found we have the Stem model (science, technology, engineering, mathematics) or cognitive interests, which are new ways of connecting according to the interests of engineering students, as in the case of the intervention of interest based on problems in the laboratory exercise on soil pH and SIC [25].

On the other hand, there is the General Model of Acceptance of Extended Technology for Education which is an effective model because it has proven to predict the use of ICTs under two indicators: (a) Perceived Usefulness (Perceived Usefulness); (b) Perceived Ease of Use (Perceived Ease of Use) [21]. And finally, there is the techno-pedagogical design as one of the central theories in the construction of Moodle as a virtual environment [21].

In terms of continents and countries, leading research that apply these theories, models, and approaches in education are from the continent of North America (3), Africa (1), Asia (1), and Europe (3). As for South America (6) is distributed in Peru (3), Chile (1), Brazil (1), and Argentina (1).

It is important to know the theories that are currently used for a better understanding of the teaching-learning process. Constructivism has its Greek roots and continues to be applied in the 21st century; it is one of the theories that support the development of ICTs, training models that justify web technologies [26].

However, the epistemological gaps in the sciences, especially in education, are increasingly deep, because today networks have invaded online courses, educational spaces, book tubers, etc. Where everything is accessible and copyable, and the search for knowledge, knowledge, and truth is becoming shorter and shorter. Questioning that the student is the one who builds his knowledge today should be taken in depth.

TABLE I
ARTICLES BY THEORETICAL APPROACH, AUTHOR AND YEAR, SCOPE, AND APPROACH.

Topic	Number of articles	Author and year	Scope	Approach
Theoretical approach	1	Adinda & Najoua Mohib (2020)	France	Mixed
	2	Barber (2021)	Canada	Qualitative
	3	Zalavra & Kyparisia (2020)	Greece	Qualitative
	4	Mikhailova et al. (2022)	USA	Quantitative
	5	Purkayastha et al., 2019	Greece	Qualitative
	6	Mystakidis et al., (2020)	USA	Qualitative
	7	Huamán Romani, YL, et al., (2021).	Perú	Quantitative
	8	Vargas, H., et al., (2022).	Chile	Mixed
	9	Ocares-Cunyarachi, L., & Andrade-Arenas, L. (2022).	Perú	Mixed
	10	Lapitan Jr, LD, et al. (2021).	Philippines	Quantitative
	11	Borgobello et al. (2018)	Perú	Qualitative
	12	Delpont (2022)	Colombia	Qualitative
	13	García Aretio (2018)	South Africa	Qualitative
	14	Prokopyev et al. (2020)	Brasil	Qualitative

B. Strategies

This section considers the strategies included in the present study, which were compiled from the review of different scientific articles. As shown in Table II, it was estimated up to 17 articles that mention the strategies used in teaching and learning in higher education are considered in the research of the cited authors.

Distance education has gone through a transcendental evolutionary process, until reaching virtual education, bringing

as a consequence the development of strategies based on the use of ICTs. This is how the term e-learning arises, referring to educational processes using electronic media.

Pedagogical strategies are considered the instruments used by teachers to foster motivation, interest, and meaningful participation in students for the development of their learning [32]. But it is through the years that constructivist and behaviorist theories allowed the emergence of conceptual pedagogy that seeks the development of student competencies through the incorporation of technologies in the teaching process [19]. Thus, the concept of Virtual Learning Environments (VLE) arises, which, according to [33], are called classrooms without walls, which can be multi-synchronous, depend on networks and not on a fixed infrastructure and can be located anywhere in the world, which is consistent with the strategies considered by the various authors in the scientific articles reviewed, grouped as follows: Continuous quality improvement can provide access to the change process, innovation, evaluation, and improvement of blended and online learning [32]. Meanwhile, Moodle virtual platforms facilitate the content management of learning and improve students' competencies [32]. The flipped classroom or inverted classroom is a new didactic strategy that allows moving from collective learning to individual learning, combining face-to-face work with virtual work in which students can choose the appropriate use of their time according to their sensory modalities and intellectual processes [34], [27]. According to the cited authors, ICTs are considered tools that facilitate learning using technology in online media favoring the active participation of students, as is the case of this study conducted in South Africa [28], [24], [24], [24], [37] including [20], [29]. Blended learning combined strategies that integrate teaching processes in remote and face-to-face environments, an active strategy that seeks for people to understand and gather the necessary information to propose a favorable outcome [12], [29]. Likewise, Blended E-Learning allows the development of technology in the learning processes, making possible the implementation of platforms that facilitate the combination of synchronous and asynchronous moments outside or inside the universities [36]. FOLC model allows to create and co-create [20]. The Learning Designer is an open-access creative strategy that helps teachers improve their learning designs through a Moodle platform [26]. Active learning strategies using virtual laboratories raise the need to implement formative assessment, especially in science courses, during the implementation of learning experiences that take place in laboratories but online [21]. Meanwhile, the control and automation using the 3D tool, called Factory I/O, makes us reflect that the practices of engineering students are developed in real-time, which will allow them to deal with various unpredictable positions that arise in their future professional life [28]. We can also mention that, in relation to the continents in which these pedagogical strategies are being tested through virtual learning environments, we have Asia (4), Europe (3), Africa (4), South America (5) and North America (1).

TABLE II
ARTICLES BY AUTOR AND YEAR, STRATEGY, AND SCOPE

No.	Author and Year	Strategy	Scope
1	Jdaitawi (2021)	Flipped classroom	Asia
2	Lapitan et al. (2021).	Flipped classroom	Asia
3	Wu y Plakhtii (2021).	E-learning	Asia
4	Ahn (2019).	Flipped-learning,	Asia
5	Adinda & Najoua Mohib (2020)	Blended learning	Europe
6	Purkayastha et al., 2019	E-learning	Europe
7	Zalavra & Kyparisia (2020)	Learning Designer	Europe
8	Chaka et al. (2020)	ICTs	Africa
9	Barber (2021)	FOLC model	North America
10	Huamán Romání et al. (2021).	Flipped-learning,	South America
11	Vargas et al. (2022).	Factory I/O-Strategy for continuous and discrete modeling simulations	South America
12	Ocares-Cunyarachi, & Andrade-Arenas (2022)	Design Thinking	South America
13	Delport (2022)	Screencasts	South America
14	Prokopyev et al. (2020)	E-learning	South America
15	Bulege-Gutiérrez et al. (2022)	Flipped classroom	Africa
16	García Aretio (2018)	Blended- learning and Flipped-classroom	Africa
17	Matarirano et al. (2021)	ICTs	Africa

C. Tools

The digital tools are software or computer programs that we find in cellular computers and tablets, to favor the academic activity of teaching-learning, with the repositories composing the collection that prevents teachers to enable material that already exists on the network. They can be organized according to the needs of the users, for a better understanding of the information in the educational process, its application is based on the theory that supports the development of ICTs, within the framework of the training models that justify the web technologies [26].

Regarding the digital tools used, the application of the EPUB3 document is distinguished to practice the practical concepts of HTML web programming [30], as well as the Online and blended learning [12], [36]. The xMOOC (Massive Online Open Courses) software concerning student-student interaction and feedback practices [31], also the tools: Moya, WhatsApp, and ODF from myUnisa were used [26]. Likewise, digital tools were used that are complemented using online audiovisuals [32]. As a characteristic of these tools, the use of online questionnaires [33], the use of the LRE scale twice, at the beginning (M1) of the study and another at the end (LRE scale M2), the instrument used for data collection, as well as web-based questionnaires before and after the test [27], online

questionnaires of independent learning ability [34] can be observed. One can also observe the use of POGIL in online laboratory environments for process-oriented guided inquiry learning [21], software for Windows [20]; as well as virtual platforms, Moodle, Google, Padlet [36]) as well as Factory I/O simulation tools [23].

In turn, it should be noted that the use of the aforementioned tools coincides its purpose with the use of mobile chatbot applications for the Computer Engineering Programming Course applied to students, wireless technology with the WBRCCS evaluation system [29], for the self-assessment problems (SAQ) and module exams the main evaluation tools used were CHE 211 and CHE 216 online, as well as for the face-to-face conferences [38]. It should also be mentioned that the use of the virtual learning management system Blackboard Learn LMS [39], the Moodle platform [40], and software products (applications, websites, programs) that perform various tasks [21], is complemented by Blended-learning and Flipped-classroom, in the integration of media, resources, technologies, methodologies, activities, strategies and techniques, both face-to-face and distance [41]. Also, the use of the pedagogical test to measure learning [42], and the open questionnaire [25], being perceptions, is complemented with Likert scale questionnaires to evaluate the proposal and to know the attitude of the respondents [16]. Likewise, the use of the Gauss-Jordan algorithm as an instrument that uses operations with matrices to solve systems of equations of "n" number of variables [43], has similarity with the coding processes in which Digital Technology has been used Integration between Dynamic Geometry and multiple representations, multimodality, mobile or portable technologies and Digital Mathematical Performance [11].

In terms of continents and countries leading research applying and knowledge of theories, models, and approaches in education, there is a slight preponderance of Asia (6), Europe (2), and North America (4), compared to Africa (3) and South America (7), the latter distributed in Argentina (1), Brazil (1), Colombia (1), Ecuador (1), Chile (1) and Peru (3). Table III shows the articles organized by author and year, tools, and scope of application.

TABLE III
ARTICLES BY AUTHOR AND YEAR, TOOLS, AND SCOPE

Nº	Author and Year	Tools	Scope
1	Prasetya et al. (2020)	EPUB 3 document, practical use of content and interactive based on the EPUB3 document.	Asia
2	Bi y Chen (2022)	Online independent learning ability questionnaire designed by Zhu Zude Alabama.	Asia
3	Lapitan et al. (2021).	Self-assessment problems (SAQ) and module exams were the main assessment tools employed in CHE 211 and CHE 216 online, as well as the face-to-face lectures.	Asia
4	Wu y Plakhtii (2021).	Blackboard Learn LMS as a case study.	Asia

5	Ahn (2019)	Gauss-Jordan instrument using matrix operations to solve systems of equations of "n" number of variables.	Asia
6	Chen et al. (2022).	Wireless technology. WBRCCS assessment system	Asia
7	Zalavra & Kyparisia (2020)	Software for windows	Europe
8	Purkayastha et al., 2019	POGIL in online laboratory environments A review of process-oriented guided inquiry learning.	North America
9	Mistakidis et al, (2020)	Online questionnaire	Europe
10	Ramos Gonzales et al. (2022)	Coding processes Digital Technology: Integration between Dynamic Geometry and multiple representations, multimodality, mobile or portable technologies and Digital Mathematical Performance.	Africa
11	Bulege-Gutiérrez et al. (2022)	Pedagogical test for the measurement of learning a 20-item pedagogical test was applied.	Africa
12	García Aretio (2018)	Blended learning and Flipped-classroom integration of media, resources, technologies, methodologies, activities, strategies and techniques, both face-to-face and distance.	Africa
13	Elizondo-García & Gallardo (2020)	xMOOC (massive online open courses).	North America
14	Barber (2021)	Online digital and audiovisual tools	North America
15	Mikhailova et al. (2022)	Web-based pre- and post-test quizzes.	North America
16	Huamán Romani et al., (2021).	Virtual platform, Moodle, Google, Padlet.	South America
17	Vargas et al. (2022).	Simulation tools, called Factory I/O	South America
18	Ocares-Cunyarachi, & Andrade-Arenas (2022)	Mobile applications (cell phone) chatbot Programming course in Computer Engineering applied to students.	South America
19	Borgobello et al. (2018)	Moodle platform	South America
20	Delpont (2022)	Open questionnaire	South America
21	Prokopyev et al. (2020)	Software products (applications, websites, programs) that realize a variety of ideas can be created using	South America
22	Torres Morales et al. (2021)	Likert scale questionnaires were used to evaluate the proposal and to know the attitude of the respondents towards it.	South America

IV. CONCLUSIONS

The work has shown that, in distance higher education, constructivism continues to be applied in the 21st century and constitutes one of the theories that, together with the behaviorist theory, seek the development of students' competencies, support the development of information and communication technologies, as well as the training models that justify the use of web technologies.

Likewise, it is corroborated that virtual environments called classrooms without walls, digital moments, and

combined strategies that link remote and face-to-face teaching processes, such as pedagogical strategies, are necessary to help the student in grasp of concepts during the teaching-learning process.

It was determined that flipped learning, using e-Learning, mobile-enhancing and mobile-dependent mobile devices, smart devices, mobile platforms for blended learning environments, learning designer, and digital tools, contribute to improving collaborative work and interaction in the teaching and learning process.

In addition, in Peru, Flipped Learning and Design Thinking are used as strategies, and tools, the Moodle virtual platform, as well as Chatbot mobile applications (cell phones) and computer engineering programming courses applied to students.

Finally, we can say that, in science, technology, engineering, and mathematics education, use is made of combined pedagogical strategies, with the application of multiple technological activities of communication and the Internet, providing learning experiences that contribute to developing competencies, increasing productivity and efficiency of human activities to face the demands of the changing world; constituting a motive for future research on learning in higher education at a distance.

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