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PAPER

The Use of Educational Technology to Improve the Quality of Learning and Teaching: A Systematic Research Review and New Perspectives

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ABSTRACT

This paper aims to identify the main topics on which scientific research has been oriented, from 2019 through 2022, about the use of educational technology in teaching and learning. The methodological approach used was qualitative. The sample size was n = 92 (scientific articles from Web of Science, Scopus, Eric, and Google Scholar databases). Thematic analysis was used for data analysis. From the analysis of the data, it has been established that the main topics on which scientific research is oriented are the use of educational technology (1) for the learning environment, (2) as a pedagogical approach, (3) for student assessment, and (4) in support of students with special needs. Some perspectives are also given regarding the orientation of scientific research in this field.

KEYWORDS

educational technology, learning, teaching, pedagogical approaches

1 INTRODUCTION

In our classrooms today, we have the generation of digital citizens, or Generation Z students. Teachers, students, and parents must become aware of the benefits of using educational technology. The use of educational technology today in classroom settings and schools is becoming more and more present [1], [2]. This approach has received a very strong boost in the last 10 years, coupled with the very strong development of technology and its effect in a networked society [3]. Thus, many researchers emphasize that the use of technology in the learning and teaching process has advantages, as it provides multiple ways to learn, improves student achievement, leaves space for efficient and independent study, provides opportunities for the development of creative thinking, and develops independence in the learning process. Meanwhile, the COVID-19 pandemic identified some very positive elements

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of the use of technology in education. Pausder, as cited in Cone, emphasizes that, "The virus proved to be a very effective tutor concerning the digitalization of our schools. You could even say that Corona was the most effective, comprehensive advanced education training that our school system has ever experienced" [4].

The teacher's response has gone beyond a mere fulfillment of their duties and has instead become a new and untested part of their job for most of them. Online learning, of course, meant breaking new ground for them and their students. As Zancajo et al. pointed out, "The Covid-19 crisis has also evidenced the limitations of current educational systems in providing quality education under changing conditions" [5]. The limitations of the current system were highlighted in the digital infrastructure and the digital skills of teachers and students.

In response, European institutions have published several documents and communications on how to move toward the so-called European Education Area in the middle of the pandemic, including an entire strategy on digital education. In these documents, the Council of the European Union makes constant references to the COVID-19 crisis as an opportunity for change. In the case of teacher-related policies, in-service training for teachers is the most obvious line of action of the EU, mainly concerning the promotion of digital skills [6]. The post-COVID period dictates the imperatives of considering technology and digital skills as necessary for the teaching profession. There has been a boom in studies about online teaching and learning, its importance, and the many problems it has encountered. This topic is quite extensive and the spectrum of studies wide. Since we are now back in the classroom again, our focus has shifted to explore how educational technology can be used in the teaching and learning process in classroom settings.

In this light, the use of educational technology in classroom settings today is one of the most interesting challenges that teachers are facing. Since digital competence is one of the competencies that young people need to achieve, the use of technology in teaching and learning comes to the fore. The main purpose of this paper is to identify the main topics on which scientific research has been oriented from 2019 through 2022, concerning the use of technology in education as a function of teaching and learning. Through the systematic study of scientific articles published in journals indexed in Scopus, ERIC, Web of Science, and Google Scholar, this paper not only identifies the main topics on which scientific research has been developed but also gives some ideas, as a new perspective, for the orientation of scientific research in this field.

2 SEARCH METHOD

The research question that was defined from the beginning is: What are the main topics on which scientific research has been oriented from January 2019 to January 2023 about the use of technology in education as a function of teaching and learning?

Key variables in the research question were then identified. During the selection of the articles that served as a sample for this study, we considered articles that were written in the English language and that studied the use of education technology in the K-12 settings. We also included articles that discussed the use of technology in the classroom. Regarding the search query, journals that mostly dealt with the issues of the application of educational technology were selected from the Web of Science (WoS), Scopus, ERIC (Educational Resource Information Center), and Google Scholar databases. During the search process in the online databases, a truncation symbol (*) was used to extract as many possibilities as possible with a specified root term, e.g., learn*, teach*.

Each reference was scanned according to the eligibility processes during the screening process. This was done based on the purpose of the review and the research question

for this study. In all cases, the search was started using the key variables of this study connected by the Boolean operators "OR" and "AND". Moreover, to increase the efficiency of the search process, the Boolean operator "OR" was first used, and then "AND" was used. All research was focused on articles published from January 2019 to January 2023. From the initial search across all databases, 3170 articles were initially identified. By filtering articles by reading their abstracts, a total of 92 articles were identified that are relevant to the aim of this research. This process was developed in 5 months by the entire team of researchers. Even though 92 articles were scanned for the writing of this work, only 39 references are presented in the References section. This step was taken as including all the primary sources as references would have required a lot of space.

2.1 Data analyses

All data were imported into the NVivo program. The process of importing data into the database was done in several stages so that there was no loss of data. In the first stage, the level of initial coding was carried out, where the basic units that identified the meaning required to answer the research question were combined. This process was very important for the entire data analysis, as it provided information on the similarities and differences of the data that were available from scanning the 92 articles selected. After identifying the qualities that are most evident in the text, first-level coding was completed and was followed by second-level coding. Then these basic units of meaning were grouped into categories, where specific codes were used to identify each category. The next stage was the comparison of the categories. Based on the categorization schemes, we identified sub-topics and main topics on which the thematic data analysis was carried out.

To increase the reliability of the method used, a comparison of multiple perspectives was carried out. Thus, from the sample of articles selected for this study, 8 articles were randomly selected, and two other researchers developed independently the process of identifying the meaning of units, categories, sub-topics, and topics. After comparing the data, it was found that the same decisions were made in 85% of the articles.

Throughout the process, great care was taken to keep bias and preconceptions under control. This was how the conclusion stage was reached after the data had been fully analyzed. Equal attention was paid to all data collected. The statements identified during the analysis process were derived from in-depth thematic analysis and not from the individual perceptions of the researchers.

Thematic analysis was then developed for the argumentative interpretation of the findings of this study.

Some limitations to the search methods are that articles reviewed for this paper were mainly focused on pre-university education. This was done for two reasons. The first reason was that, from the preliminary review, a vast number of studies have already been done for higher education, including those in journals dedicated specifically to higher education. The second reason was to provide as complete a picture as possible of using educational technology in pre-university education.

3 MAIN FINDINGS

The information presented in Table 1 included different phases of work with the extracted qualitative data, where the following sub-topics and topics were identified. This came from merging the concepts identified by the unified categories.

From the thematic analyses, 4 topics, and 4 sub-topics were identified.

Table 1. Topics and subtopics identified by thematic analysis

Main Topics	
T1. Educational technology and learning environment	
Subtopics for Topic 1	Sub-topic 1.1 Educational technology, student learning process, learning achievement, and performance
	Sub-topic 1.2 Integrating technology to foster student motivation
T2. Educational technology and pedagogical approaches	
Subtopics for Topic 2	Sub-topic 2.1 Integrating technology in the function of teaching models design
	Sub-topic 2.2 Integrating technology in the function of teaching practices.
T3. Educational technology and assessment of students	
T4. Educational technology in support of special needs	

4 DISCUSSION

Many teachers today are facing the challenge of transforming the existing reality in the classroom and outside it so that the student is not a passive recipient of information, but an active participant in the learning process. From the analytical review of the research papers taken into consideration, we concluded that with the use of educational technology in the classroom, students take the learning process into their own hands, develop flexible knowledge that can be transferable in real-life situations, and are more motivated and more cooperative.

Thus, students must be able to set their objectives in the learning process, select appropriate learning approaches to achieve these objectives, and be able to change these strategies when necessary. But it is important to determine from the beginning the direction of the use of educational technology, especially in the classroom. In the first approach, instructions are given first, and then the students are helped to apply them in exercises or practical situations using educational technology; in the second approach, the practical cases are presented, using the appropriate technology-based learning environment, and the students are helped to organize the proper activity of the learning process to achieve the desired learning outcomes. These two approaches, known as direct and non-direct teaching, pose the main question of how education technology should be used. In the first case, the teacher can present the principles of projectile motion and then guide the students to do simulations using, e.g., "Phet Interactive Simulations" (https://phet.colorado.edu/). Or this scenario can be presented vice versa: starting from the simulation, students carry out different simulations of projectile movement, do a lot of trials, and have a lot of opportunities to explore and discover independently the main principles. It is quite important to understand in what position the student will be in this case. If we want the student to develop inquiry learning, and higher levels of thinking processes, such as analysis, comparison, and evaluation, the second teaching approach needs to be used.

To answer the main research question of this paper—to identify the main topics on which scientific research has been oriented in the last four years, specifically, about the use of technology in education as a function of teaching and learning—4 topics, and 4 sub-topics have been identified. They are analyzed below.

4.1 Topic 1. Educational technology and learning environment

Different researchers have treated integrating educational technology to create a technology-based learning environment by looking at it from several perspectives. Creating the right technology-based learning environment is important for the learning and teaching process [7] [8] [9]. Chang et al. took into consideration studies carried out over the last 20 years and came to the conclusion that teachers pay a lot of attention to the application of technology-based learning environments, using it for purposes different in function of learning and assessment [10].

From the review of studies on this topic, two subtopics have been developed.

Sub-topic 1.1: Educational technology, student learning process, learning achievement, and performance. The improvement of students' learning process and performance by using technology is one of the elements that has been dealt with extensively by researchers. This element is supported by the theoretical framework, where Ainsworth proposed the Design, Function, and Task framework, where the effectiveness of the learning process was addressed with multiple representations (combinations of representations such as diagrams, animations, sound, video, and dynamic simulations), taking into consideration the main design parameters, their respective functions, and the tasks to be undertaken by the student. Ainsworth determined that these representations can have complementary roles and can build in students a deeper and more complete understanding [11]. Many studies have addressed the inclusion of educational technology in the improvement of active learning, learning performance, learning activities, learning abilities, interactive and collaborative learning, and inquiry-based learning [12], [13] [14].

Sub-topic 1.2: Integrating technology to foster student motivation to learn. Motivation is a very important topic in all aspects of daily life, but especially so when discussing how to increase students' motivation to learn. The studies taken into consideration for this article have highlighted that the use of technology increases student motivation [15], [16] and involvement in a certain activity and affects their engagement [17], [18]. The use of educational technology makes it possible for students to have access to a very wide spectrum of videos that give examples of different content knowledge [19], [20]. In this context, using self-modeling videos can increase students' self-regulated learning process. The improvement of self-regulated learning behavior because of the use of technology has received the attention of researchers because the determination of goals and the mobilization of efforts and resources necessary to achieve these goals increase the activity of the students. Another aspect is the increase in interest and curiosity [21].

4.2 Topic 2. Educational technology and pedagogical approaches

Sub-topic 2.1: Integrating technology in the function of pedagogical content knowledge. Numerous educational technological resources can be used to improve pedagogical content knowledge [22], [23]. For example, Gentile and Oswald explore how the frameworks of Technological Pedagogical and Content Knowledge and Mindset can influence design instruction [24]. Zha et al. analyzed 281 lesson plans collected from the websites of 12 educational physical computing and robotics (ePCR) educational devices. Applying the Technology Pedagogical Content Knowledge Framework (TPACK) identified how technology, instructional content (mathematics), and pedagogy were integrated into lesson plans for five main categories [25].

Zhai and Jackson proposed ideas for a pedagogical framework for mobile learning. They suggested the development of materials and activities based on the use of technology, better coordination of teacher and student roles in the classroom, consideration of affective factors as contributors to student achievement, and focusing on student gender when discussing the design of mobile learning [26].

It has been established that teachers use those technologies with which they are most familiar [27] and that they generally have positive attitudes toward the use of technology [28].

Sub-topic 2.2: Integrating technology in the function of teaching practices. Teachers in the classroom are using technology tools in different disciplines. Thus, STEM teachers use such digital tools as GeoGebra [29]. From the studies conducted in this field, natural science teachers use virtual laboratories [30]. Humanities teachers use digital tools such as Smithsonian Learning Lab and Chronicling America [31].

The use of technology is a great help for English and foreign-language teachers to improve students' achievement of necessary competencies for the 21st century, such as digital literacy. Teachers in this field use digital tools to improve students writing [32], including VoiceThread [33], [34] and BrainPOP [35].

Educational technology is also used by music teachers. To improve the learning environment, music teachers can use GarageBand [36], Soundtrap [37], etc.

4.3 Topic 3. Educational technology and assessment of students

The use of technology is also widely used for student assessment. From the data collected for this purpose, it emerged that teachers use different types of software for evaluating students, both inside and outside the classroom. Studies have shown that educational technology can be used very well for the process of formative assessment. Throughout the formative assessment, teachers can use educational technology to provide evidence regarding the achievement of learning outcomes and to provide feedback and improve the teaching process [38], [39], [40]. The use of technology for assessment has had a particularly great impact on students with special needs [41].

4.4 Topic 4. Educational technology in support of special needs

Studies have shown that there is a wide range of digital tools that are used today by educators to improve learning environments for students with physical difficulties, learning difficulties, visual impairment, and dyslexia and other reading difficulties. Technology provides support for representation, action, expression, and engagement for students with disabilities [42], [43]. Students with a dyslexic profile (listening comprehension greater than decoding skills) have shown significant gains in reading comprehension using text-to-speech (TTS) software [44]. Mobile social-story maps have contributed to the development of listening comprehension skills of participants with ASD [45]. Moreover, technology can help children with disabilities establish and improve social relationships as well as independence and performance [45], [46].

5 NEW PERSPECTIVES

From our review of the research studies, we found that almost all the authors designed their research with very specific and, to some extent, fragmented variables

highlighting the real importance of the use of technology in education in the learning and teaching process in the classroom settings and beyond Student should be at the center of the entire teaching and learning process, and the focus should be for the student to build the learning process him- or herself, because this will also lead to the development of the competence to learn, and the teacher should be the facilitator or guide. The use of educational technology in the classroom and beyond can provide great help to enhance the learning experience and boost learning effectiveness. It should be of great interest to teachers that studies can be oriented towards t quasi-experimental studies, where groups are compared, and towards testing the importance of teacher instruction using student-centered methods and digital tools in the classroom.

Studies can also be oriented to topics that should explore the importance of the teacher's role in creating an effective learning digital environment, the preparation of teachers concerning the use of technology, the need for professional development in this realm, and the level of stress teachers may experience when using educational technology.

Another aspect that should be taken into consideration is the study of the curricula of the institutions that prepare teachers and how these curricula are designed to prepare new teachers with the appropriate digital competencies.

Likewise, it is quite important to focus studies on topics such as the ethical issues of educational technology use. From this perspective, topics related to digital equality and digital exclusion are of particular importance.

6 CONCLUSIONS

The main purpose of this research review was to identify the main topics on which scientific research has been oriented from 2019 through 2022, about the use of technology in education as a function of teaching and learning. A qualitative method was used to review a sample of 92 scientific articles. It can be concluded that technology in education is used by teachers to develop different types of learning, to improve the content of teaching methods, to encourage students' motivation to learn, to be applied in the assessment process, and to help teach students with special needs. In contrast to the findings of this study, some perspectives on the orientation of scientific research to increase the efficiency of the use of educational technology are presented.

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