

Information Technologies that Help Improve Academic Performance, A Review of the Literature

<https://doi.org/10.3991/ijet.v18i04.34821>

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Abstract—The health emergency originated by Covid-19 led humanity to a virtual coexistence, where the use of information and communication technologies took a fundamental role, in terms of education, teaching continued in remote mode and for this purpose different means, techniques and characteristics were used. The present study is a review of the scientific literature, which analyzes the best techniques and strategies used in remote times, Prisma methodology was used and 127 articles were collected from databases such as IEEE Xplore, ScienceDirect, EBSCO, Scielo, and Scopus, which according to the inclusion and exclusion criteria allowed to identify technologies that improve academic performance in these times, such as the development of mobile applications with artificial intelligence, augmented reality, gamification among others. It is concluded that these technologies are capable of improving academic performance and those that achieve a greater incursion are those that combine two or more technologies.

Keywords—technologies, education, academic performance, systematic review

1 Introduction

Nowadays, technology is becoming more and more essential for learning, especially in these times of pandemic and confinement, in which we have had to adapt quickly, as follows [1] mentioned that in order not to have negative effects on learning and student well-being, it was necessary to have a plan that guarantees continuity of learning, this could include online classes, according to [2], denotes the great benefits of educating based on technological tools, which later on, will help personal training, such as having a professional orientation. However, there are many digital gaps in education, where academic performance varies depending on the incursion of different technologies to make the learning process easier. So, there are immeasurable factors by which a certain technology can be more beneficial than another, depending on the benefits it offers.

Surveys conducted with students on the use of technology reflected that there is a positive influence, in terms of access to technology and ease of use of technology [3], with

the result that the application of technology in teaching enables academic self-efficacy, which has positively relationship with students' academic performance. Experiments conducted in the classroom of a public tenth-grade high school in Punjab [4], tried to demonstrate to what extent the incorporation of emerging technologies can affect teaching in schools, using two groups, one with traditional teaching and the other with emerging technology. The results obtained from the use of emerging technology, such as statistics and computer animation software, showed a large difference in academic performance between the two groups of students. The results indicated that emerging technology in youth education improves academic performance on a large scale.

Technology has generated a great impact in fulfilling the role of learning tool [5], 1:1 technology could be a factor in motivation to attend school, as well as in students' academic achievement, with greater exposure to technology through the use of multimedia tools, online reinforcement, both teachers and students find greater motivation reflected in academic performance. Studies on 365 participants to find out the impact of augmented reality [6], evidenced in their results that the inclusion of technology in school learning improves academic performance. It could be shown that the application of technology in teaching school children has a positive impact on performance, regardless of whether the students may have special educational needs, the outcome is still favorable for the students. Research conducted in 202 schools [7], it was found that shared access to computers has an impact on the improvement of students' technological skills. In addition, academic performance is positively influenced by the use of shared computers. They show that, for the same course, virtual teaching does not reduce students' learning, but maintains their performance as in a face-to-face class [8].

Therefore, the objective of the research is to determine the characteristics and technological tools used in times of pandemic, obtaining as a purpose different alternatives and perspectives to make new incursions to improve academic performance and especially the development at the formative level.

2 Methodology

2.1 Type of study

For this article, a systematic review of the literature was used to search and categorize information.

2.2 Research questions

The proposed research questions were:

- RQ1. Which digital technologies were able to improve academic performance, allowing easy adaptation and manipulation of the developed applications?
- RQ2. Which digital technologies are the most used to improve academic performance?
- RQ3. What characteristics achieve a better scope of the incursion of technologies in learning?

2.3 Search strategies

The collection of information from the different published articles came from the IEEE Xplore, ScienceDirect, EBSCO, Scielo, and Scopus databases. A total of 127 scientific articles were collected.

The following keywords were used: “technology for learning”, “technological applications for education”, “technology and education in schools”, “technology and academic achievement”, “application of technology in academic performance”, and “improving academic performance with technology”, “free software applications for education”, “technological applications for education and learning”, “technological applications for education or learning”, “technological applications for education and academic performance”, “technological applications for education or academic performance”, “application of technology or free software for academic performance”, “application of technology and free software for academic performance”. Figure 1 shows the process of article selection concerning its database.

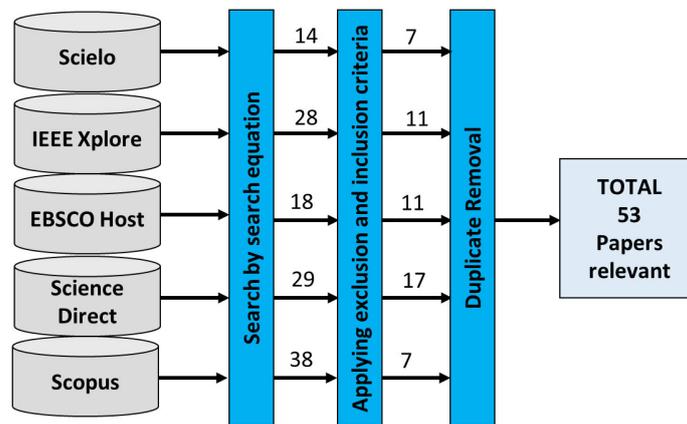


Fig. 1. Item inclusion chart

2.4 Inclusion and exclusion criteria

For the systematic review study, the following inclusion and exclusion criteria were applied, as shown in Table 1.

Table 1. Inclusion and exclusion criteria

Criteria		
Inclusion	I01	Articles on the technology used for education
	I02	Articles on improving academic performance with the use of technology
Exclusion	E01	Articles on teaching strategies without the use of technology
	E02	Academic performance improvement articles without the use of systematic programs
	E03	Articles with no relation to the improvement of academic performance
	E04	Articles in languages other than English and Spanish
	E05	Articles published before the Covid-19 era

3 Results

A total of 127 articles found in the databases related to the research topic were analyzed, from which articles that were duplicates and did not meet the inclusion criteria were discarded. After reviewing the articles, 53 articles were selected and chosen for the systematic review.

Figure 2 shows the automation that was carried out based on the prism method, which according to [9] mentioned the importance that this procedure denotes by explaining in a detailed and transparent manner the review of the articles. Inclusions and exclusions are regulated depending on the aspects to be considered.

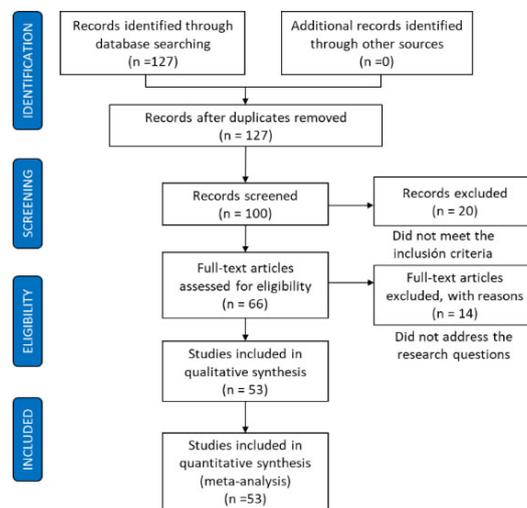


Fig. 2. Inclusion and exclusion of items flow chart

Figure 3 shows the number of items found in the database, where the largest number of articles collected is from ScienceDirect followed by EbscoHost and IEEE Xplore.

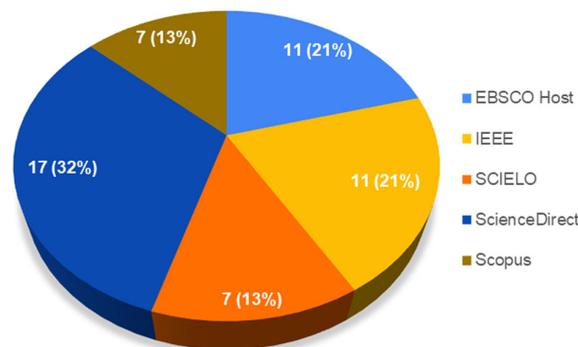


Fig. 3. Articles by database

The articles were collected during the years of the pandemic caused by covid-19. Figure 4 shows the number of articles published by year and database.

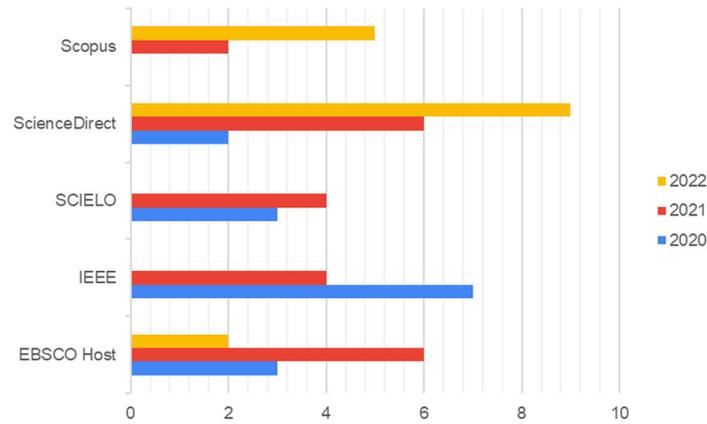


Fig. 4. Articles by year and database

Figure 5 shows the number of articles published by country. There is evidence of a greater number of publications in China.

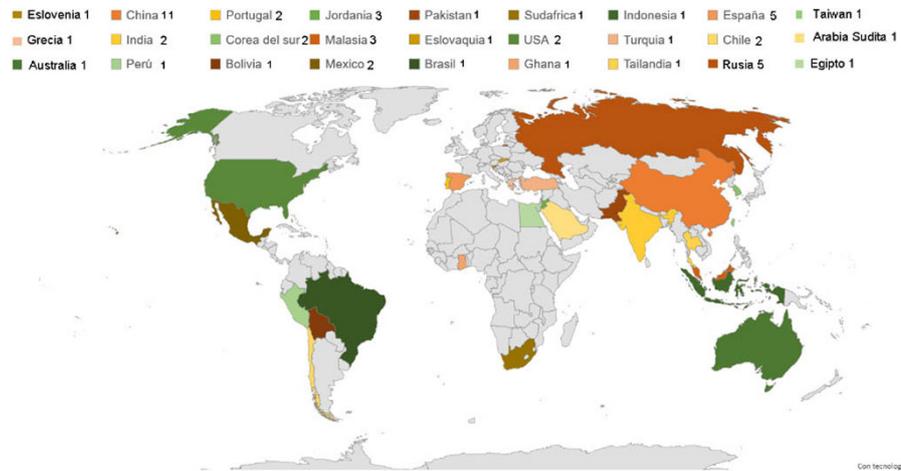


Fig. 5. Articles by country

Figure 6 shows the number of selected articles grouped by database and the category of technologies used.

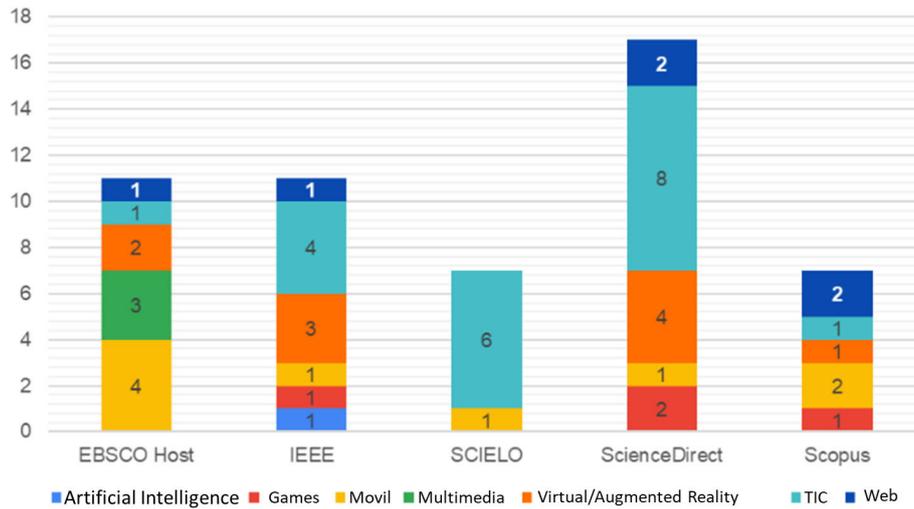


Fig. 6. Articles by database and category of technologies used

Figure 7 shows the number of items according to the technology used, highlighting ICT followed by virtual and augmented reality.

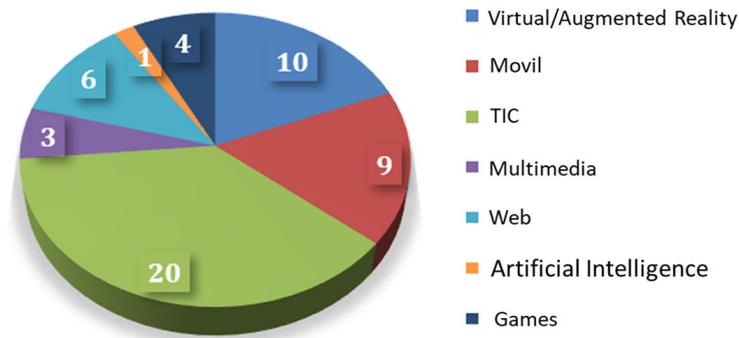


Fig. 7. Articles by database

The impact of ICT as a frequently used tool for online sessions, and virtual teaching platforms is reflected in research that contributes to education. Figure 8 shows the graphs showing the level of efficiency according to the technology applied.



Fig. 8. Impact level

Based on the results obtained and shown in Figure 7, it can be established that Mobile technology was the technology that had the highest level of impact in terms of quantity; likewise, Artificial Intelligence and Multi-media technologies achieved a high level of impact in all the references collected. ICT was the second technology with the second highest number of articles, which shows that it had a high impact, but it is also the technology that also obtained a low level of impact in several references, based on this it is determined that the technology most used to generate an impact on students is ICT, but it is also the technology that does not always achieve the same level of impact that is expected. For the bibliometric graphs of terms in common with the articles that were systematized. VOS viewer was used, which, based on [10] mentions the ease and data management provided by this tool, where the keywords highlighted in nodes, show some guidelines to get into the relevant topics in the context of research.

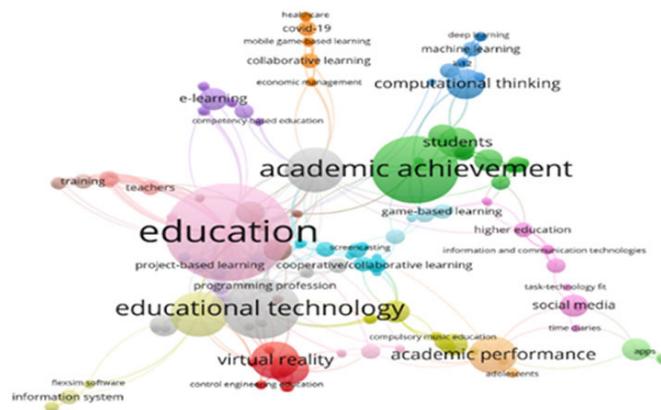


Fig. 9. The relationships between the common terms using the bibliometric map

Figure 9 is the visual representation of the network map, which allows visualizing the popularity of keywords of all references collected, showing “academic achievement”, “education” and “educational technology” as the most frequent keywords in all references collected.

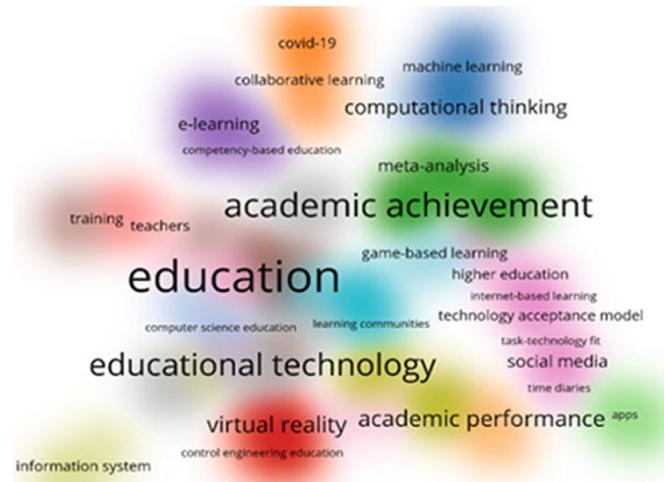


Fig. 10. Density visualization

Figure 10 is the representation of the density of the relationships between the keywords, so that the cooccurrence between them can be visualized in the following keywords “achievement”, “education” y “educational technology”.

4 Discussions

4.1 Research questions

RQ1. Which digital technologies were able to improve academic performance, allowing an easy adaptation and manipulation of the developed applications?

According to Table 2, it can be established that ICT technology achieved better efficacy in terms of its level of use in different educational institutions, providing the necessary functions and tools to improve students’ comprehension and performance during the pandemic period that was taking place.

Table 2. Classification of items according to categories and effectiveness in their implementation

Categories	Efficiency in its Implementation	References
Virtual/ Augmented Reality	These items were effective in their environment, showing that the implementation of virtual or augmented reality provided immersive experiences to enhance learning.	[11], [12], [13], [14], [15]
Movil	These articles denoted the importance of implementing a mobile application, being a practical environment and widely used by most students. Where easy accessibility helped to improve cognition and autonomous learning.	[16], [17], [18], [19], [20], [21], [22], [23]
TIC	These articles achieved a considerable impact in the world of ICT, where the implementation of various technologies in this environment, facilitated a great adaptation and scenario to improve academic performance. Being very participative, the incursion of current trends for its execution.	[24], [25], [26], [27], [28], [29], [30], [3]
Multimedia	These articles achieved positive results with the incursion of multimedia technology, where nowadays, this environment is a viable means to stimulate the student in both visual and sound demonstrations.	[31], [32], [33]
Artificial Intelligence	This article achieves high effectiveness in using artificial intelligence as a means of continuous learning for the student, where the incursion of appropriate environments and good knowledge supply, will boost personal development.	[34]
Games	These articles obtained positive results with the implementation of interactive applications through games, where the student's experience highlighted that being in an environment of distraction and learning leads to better retention of knowledge.	[35], [36]
Web	These articles managed to emphasize that web technology is very referenced in personal development and that the different online applications, execute better learning practices. Being all online drives an improvement in the accessibility and support of the users.	[37], [38], [39], [40]

Likewise, social networks can be used as a learning platform, for example, the use of a social network such as Facebook Gaming (FBG) was a change very accepted by students since it is not only a known platform but also allows live interaction, changing the approach to the use of social networks [28], similarly, mobile technology helped to enhance academic performance in different educational institutions in the world, being a learning tool that improves skills and academic results; such as the development of the IMELS Android application, using MySQL and the Java programming language, added to this the implementation of Moodle (web learning platform) [20], thus allowing free access at any time and place, see Figure 11.

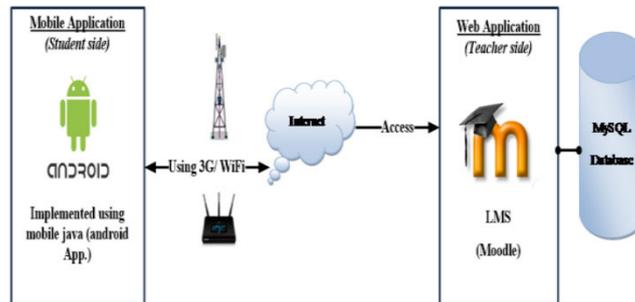


Fig. 11. Estructura de IMELS

It is demonstrated that its implementation contributes to inclusive education through a specific game for children with dyslexia called FORDYS-VAR [13] Figure 12 although it is in the beta phase, detecting errors to solve them, and children with dyslexia has no complications in understanding the game, they managed to obtain an influence and understanding of the high impact on these children. As a result, it shows that Virtual Reality technology for the education of children with dyslexia can be effective and easy to use.

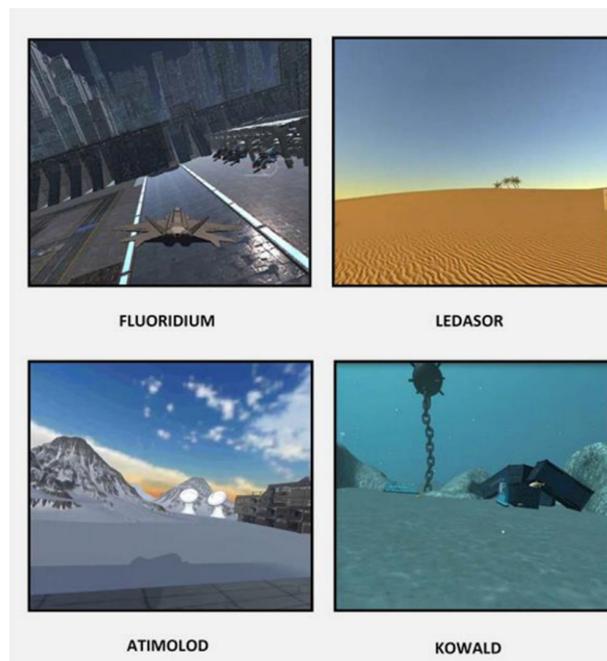


Fig. 12. Images of the different planets that make up the game environment

RQ2. Which digital technologies are the most used to improve academic achievement?

According to Table 3, it can be established that the technology that was most used to improve academic performance during the pandemic period was ICT.

Table 3. Classification of items according to categories and topics of functionality

Categories	Themes and Functionality	References
Virtual/ Augmented Reality	These articles propose using virtual/augmented reality to create learning motivation in students, improving the academic experience based on situations where they can live in a virtualized form, resembling reality as much as possible, so that academic performance is better compared to traditional theoretical teaching.	[41], [42], [11], [43], [12], [44], [13], [45], [14], [15]
Movil	This set of articles proposes the use of mobile technologies to improve teaching, based on ease of access to information by connecting with other networks and external services, better understanding, and simple and compact use of technology.	[46], [16], [17], [18], [19], [20], [21], [22], [23]
TIC	These articles raise the possibility of using ICTs to improve the traditional teaching of educators, who fail to fully see the benefits of technological learning.	[47], [24], [25], [26], [48], [49], [27], [28], [50], [51], [26], [52], [53], [54], [55], [29], [30], [56], [3], [57]
Multimedia	These articles denote that the uses of multimedia applications achieve a better environment for cognitive development and improve academic performance. Where every visual demonstration is important for training.	[31], [32], [33]
Artificial Intelligence	These articles raise the importance of artificial intelligence in the field of learning, where the continuous knowledge handled by the applications is a source of improvement for academic performance.	[34]
Games	This set of articles states that the use of games as a learning tool not only improves academic performance but also enhances the ability to find solutions to different situations, increases creativity, and improves critical thinking.	[35], [36], [58], [59]
Web	These articles establish the implementation of technological tools such as web or cloud platforms, allowing students to access information remotely through different devices.	[37], [60], [38], [39], [61], [40]

There is evidence of a greater number of investigations in the incorporation of ICT, through virtual sessions on different platforms, as well as the use of pedagogical tools such as Google Classroom, Edmodo, Padlet, Popplet, and Kahoo, among others. Followed by the development of mobile applications with augmented reality, for the teaching of biology, astronomy, geometry, languages, etc.

RQ3. What characteristics achieve a better reach of the incursion of technologies in learning?

Table 4 shows the factors that influence and stand out in each category, as well as aspects that can be improved to achieve a greater impact, in this way the result of the implementation of these technologies would be more noticeable.

Table 4. Classification of articles according to outstanding factors in the incursion of new technologies

Categories	Salient Factors	References
Virtual/Augmented Reality	Incorporation of simulation tools for the execution of easily developed three-dimensional activities.	[11], [12], [13], [14], [15]
Móvil	The environment created should be easy to access, since it is necessary to maintain a continuous use, for greater impact by associating it with augmented reality.	[16], [17], [18], [19], [20], [21], [22], [23]
TIC	To achieve an implementation based on the incursion of technological social media. To obtain a better management of information and online communication in a fast, accurate, and effective way.	[24], [25], [26], [27], [28], [29], [30], [3]
Multimedia	Maintain a focus on representative videos, and associate them with augmented reality technology.	[31], [32], [33]
Artificial Intelligence	Improve the learning environment, by using virtual assistants to support education and development activities.	[34]
Games	Based on user-friendly, visually, and interactively appealing, enhance teacher-student interaction, and develop critical thinking, and problem-solving skills.	[35], [36]
Web	Achieve an attractive and user-friendly approach, maintain smooth data transfer, and increased recreation.	[37], [38], [39], [40]

From Table 3 and Figure 7, it is evident that mobile technology and augmented/virtual reality have had a greater impact on the creation and use of applications related to the academic environment. M-learning, learning through mobile technology, is a current trend that is constantly increasing, thanks to the large consumption of these devices for their fast and instant access to routine activities [20], as well as the Moodle tool, is a good resource for managing information in a system, allowing users to interact and learn at any time. Another important aspect is Augmented Reality, with characteristics of an environment focused on games [22], establishing a better adaptation of the knowledge imparted to the student more durable and effective for their training. Each technology generates a different level of impact, varying in use and which is the most common or most used technology if you want to improve academic performance. Better achievements are evidenced in research in which more than one element is combined, such as M-learning, with educational platforms, and incorporation of augmented reality among others.

4.2 Related studies

The systematic review [62], to analyze the link between the use of technology and academic performance, unlike the present research, concluded that, despite the time elapsed, the approach to the use of technology for the development of students is still not properly valued, since different factors influence the initiation of the use of technological tools such as fear and habit or traditional teaching. Also, unlike the present research, which conducted a literature review of all technologies that can improve academic performance, other reviews such as [58], focused on a review on GBL (Game-Based Learning), which also collected outstanding information, by focusing not only on game-based learning but also on the use of any type of technology that helps students to learn, China was found to be one of the countries that most supported the implementation of technology for the education of students. Another literature review [63] focused on identifying innovations and applications of ICT applied in technical and vocational education and training (TVET); finding that the use of artificial intelligence, robotics, data science, and cloud computing among other similar technologies is necessary.

5 Conclusions

After having managed to systematize the 53 articles related to the research topic, the following conclusions were reached:

ICT technologies, Mobile and Augmented/Virtual Reality were able to drive a greater degree of improvement in academic performance, based on their easy interaction and the manipulation of their applications. ICT, Mobile, and Web technologies are the most used in the educational field, denoting a vision of how to develop applications that are governed by current trends. The characteristics that achieve a greater incursion of the technologies in academic performance are focused on the combination of two or more technologies, giving the developed application will be the ability to count with all the compressible and friendly functionalities so that the student can quickly understand a subject. In addition, the environment where the application is managed must be designed for the different cases that reality presents and that it is within the reach of the user.

Finally, it is essential to focus that any implementation of technology for the field of education has as a reference the personal and professional development of each user, which, when establishing a new incursion, supports them not only to be consumers of technology but also to be able to create it.

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Article submitted 2022-08-21. Resubmitted 2022-12-01. Final acceptance 2022-12-03. Final version published as submitted by the authors.