Digital Transformation in Education Sector Using Virtual Reality with Cardboard: A Systematic Review

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Abstract

In this article, a systematic literature review was conducted to investigate digital transformation applied to education, specifically using virtual reality technology. A total of 411 articles were collected from different repositories and through manual searches until June 2023, and after applying inclusion and exclusion criteria, 25 articles were selected for analysis. The literature review revealed that digital transformation can play an important role in improving student learning, especially in the areas of science and humanities. The educational levels at which digital transformation is used were identified, as well as the positive effects achieved by applying virtual reality in education. The need to close the existing gap in knowledge is highlighted, and the use of cardboard is proposed as an accessible tool to implement virtual reality in public educational institutions. The research conducted aims to open new paths in the application of virtual reality in education. By obtaining results from the application of cardboard in schools, it is expected to demonstrate the benefits and possibilities offered by this technology. This research aims to provide relevant and updated information on digital transformation in education and promote its adoption in educational institutions, thus allowing the improvement of the teaching-learning process and the provision of more enriching educational experiences for students.

Keywords

Virtual reality, digital transformation, cardboard, education on school, effects on classroom

1. Introduction

Nowadays, the technological revolution has cooperated to solve different problems in the world. Therefore, with the digital transformation, it is required to contribute to sustainability in educational institutions through the recognition of the various techniques.[1]

The power along with audiovisual technology have advanced, at the same time, has encouraged researchers to warn that conveniently use virtual reality as an educational tool that facilitates the ability to understand educational content by students through images, sounds and graphics incorporating as language [2] An application was created where the virtual reality application of Google cardboard that represents some parts of the human anatomy was taken into account [3].

This work investigates the effects related to the interaction of students when experiencing learning through tools with virtual reality, at the same time it is intended to determine indications that students participate in classes more effectively if the virtual avatars are displayed in an almost real way, at the same time having a scope on the correct posture when using such tools with virtual reality.[4]

The interest in virtual reality is growing due to its potential for embodied learning and group teaching, learning experiences and learning outcomes, it enhances the importance on the emotional experience of learners who are shown new ways of acquiring explicit knowledge.[5]

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1.1. Research problem

The process of education's transition to new technologies is now fraught with a number of serious difficulties. In spite of developments in digital transformation, there has not yet been a comprehensive investigation into and implementation of virtual reality in the educational sector, particularly via easily available devices such as Cardboard. This is despite the fact that virtual reality has the potential to significantly improve teaching and learning. Because of this gap, there are issues regarding whether or not adopting virtual reality with Cardboard as a teaching tool is feasible, whether or not it is successful, and whether or not it has any pedagogical consequences. In this context, there is a need to research how digital transformation, centered on the use of virtual reality with Cardboard, may enhance the quality and efficiency of educational processes, as well as identify potential hurdles and limits in its implementation.

1.2. Justification

The educational system absolutely has to undergo a digital transformation in order to adapt its instructional practices to the ever-shifting requirements of modern society. When seen in this light, virtual reality, particularly when implemented on low-cost hardware like Cardboard, appears as a potentially game-changing instrument that may improve the quality of the educational experience. This study is necessary because there is a need to investigate in more detail the influence that virtual reality has on education, with a particular emphasis on its application via the use of Cardboard.

Virtual reality with Cardboard provides a solution that is both easily accessible and inexpensive, making it especially applicable in educational settings that have a restricted amount of resources. Not only will having a better understanding of how this technology may be properly incorporated into teaching lead to an improvement in the overall quality of education, but it will also make it easier for students to participate in immersive educational experiences.

This project is conceived with the aim of improving the quality of education of our future professionals, ensuring their benefit in an educational environment suitable to the demands of the digital world.

Cardboard virtual reality, as described by [6], is defined as the use of affordable display devices, such as Google Cardboard, to immerse users in three-dimensional virtual environments. This approach seeks to provide immersive experiences at an affordable cost, allowing users to explore and participate in virtual environments through the use of a simple viewer and their mobile device. [7]

2. Methodology

In this systematic review, the search of bibliography will be carried out using the systematic review methodology PRISMA of Preferred Reporting Items for Systematic Reviews and Meta-Analyses. [8] Currently, advances in the review, methodology and terminology of PRISMA have required an update in the guide to identify, select, evaluate and synthesize studies using the 27-element PRISMA checklist. [9] In order to address the research question, an exhaustive literature search was carried out following the different steps involved in the flow of information necessary to perform an accurate systematic review (Included, Eligibility, Screening, identification) [10]. The main keywords, inclusion and exclusion criteria were identified, using articles for a rigorous systematic search process. [11]

The scoping review supports general and absolute purposes that allow researchers to analyze the extent, breadth, and character of the research, as well as to assess the usefulness of conducting a systematic review.[12]

A bibliographic search was carried out in Scopus, Wiley and IEEE Xplore to have the scope that the digital transformation will have in the education sector by applying virtual reality with cardboard and to know if these practices will have an effect of improvement in the learning of

schoolchildren, it is essential to have evidence of the existing literature on the use of the tool that is virtual reality for the performance of schoolchildren.

2.1. Research question

In order to have the scope that the digital transformation will have in the education sector by applying virtual reality with cardboard and to know if these practices will have an improvement effect on the learning of schoolchildren, it is essential to have the evidence of the existing literature on the use of the tool that is virtual reality for the performance of schoolchildren. In the process of planning the systematic review, appropriate techniques were used for the collection and analysis of primary studies. For this purpose, important repositories of indexed scientific articles were consulted, such as Springer Link, IEEE Xplore and Scopus. In addition, a review protocol was developed to identify the search needs and delimit the field of study related to articles, theses and academic information on the application of virtual reality as a digital transformation in the educational sector.

Table 1
Search question, research and motivation

ID	Search Query	Motivation
Q1	How does the integration of virtual reality with cardboard contribute to digital transformation in the secondary education sector?	Identify the level of digital transformation involving virtual reality in the education sector.

The PICO (Problem, Intervention, Comparison, and Outcomes) method was chosen to provide a structured response. [13] It is a tool that is commonly used in quantitative systematic reviews to identify the different components of the review, and is recognized by the world's best known organization that facilitates evidence-based decision making, which is known as the Cochrane Collaboration [14]

Table 2
Description of the PICO strategy

Acronym	Definition	Description
P	Problem/Population	Secondary education sector
I	Intervention	Virtual Reality
C	Comparison	Traditional vs. virtual reality teaching methods
O	Results	Digital transformation and impact on learning

2.2. Define the search education used

The search process started on April 18, 2023, with the first searches interconnecting the related key terms. "Digital transformation", "effects", "schools", "virtual reality", "education","

productivity", "anatomy", "techniques", in the following databases: IEEE Xplore, Wiley, Scopus and Springer.

Table 3
Definition of the search equation used

Consultation	Search query
Q1	((((REALITY AND VIRTUAL AND TRANSFORMATION) AND DIGITAL) AND EDUCATION))
Q2	((((((VIRTUAL AND REALITY) AND EDUCATION) AND CARDBOARD)))

2.3. Inclusion and exclusion criteria

Next, the search was extended with the Boolean operators AND and OR. in combination with the terms "digital transformation", "education", "virtual reality", and "effects".
The initial searches generated a large number of results, but many of them were found to be repetitive or irrelevant to the topic in question. Despite this, these searches provided a general idea of the spectrum of keywords that should be most effective in the search. In addition, they allowed verifying that no systematic review results were found related to the topic of digital transformation applying virtual reality with cardboard in the education sector.

Table 4
Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Publications related to digital transformation applying virtual reality in the education sector.	Articles that do not meet the inclusion criteria
Publications related to techniques to improve learning in schools using virtual reality.	Review articles, theses, newsletters, books, manuals were excluded.
Publications mentioning digital transformation applying virtual reality in the education sector.	Articles focused on the application of virtual reality in companies were excluded.

2.4. Information extraction

The information was organized and structured for subsequent analysis. The figure shows the processing flow diagram following the PRISMA method.

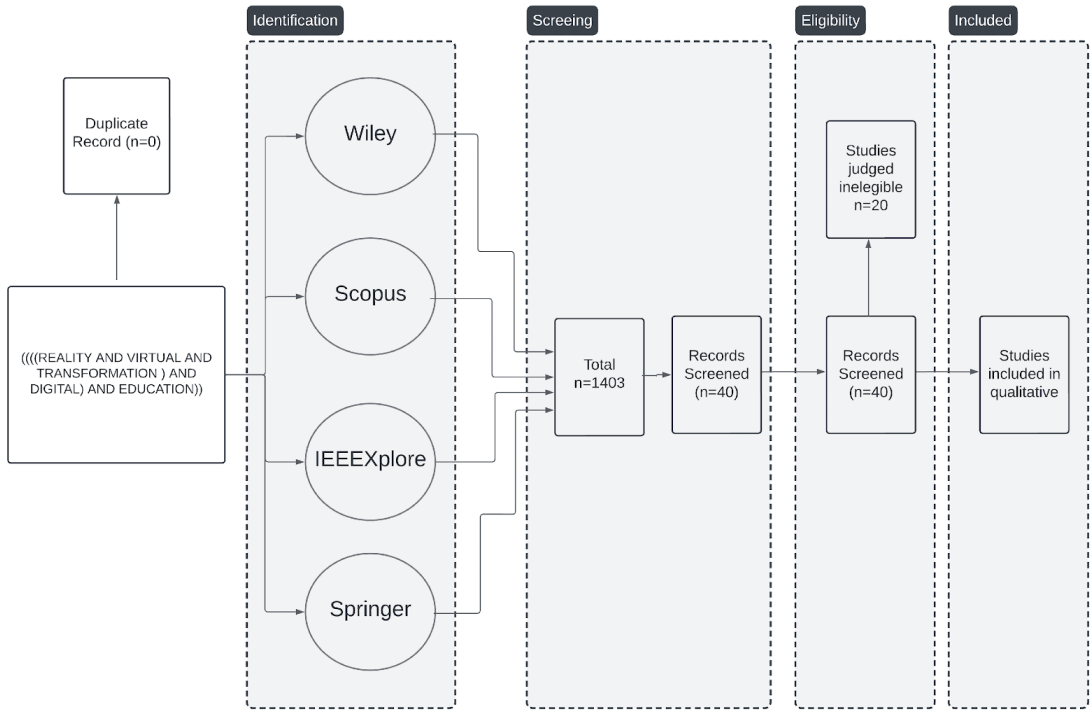

Figura 1: Extraction of information according to Prisma Method

3. Results

A total of 411 documents were found, including articles and conferences from different academic repositories, from which 25 articles were selected and analyzed through the Prisma system.

Table 5
Number of articles per database

Databases	Number of articles
Scopus	49
Springer	327
IEEE Xplore	35
TOTAL	**411**

After a thorough examination of the specific databases, significant findings were obtained in several categories. These findings covered not only aspects related to the application in question, but also data on the countries involved, the research techniques used and the years in which the relevant articles were published.

The table below shows the number of publications found per year in the databases analyzed.

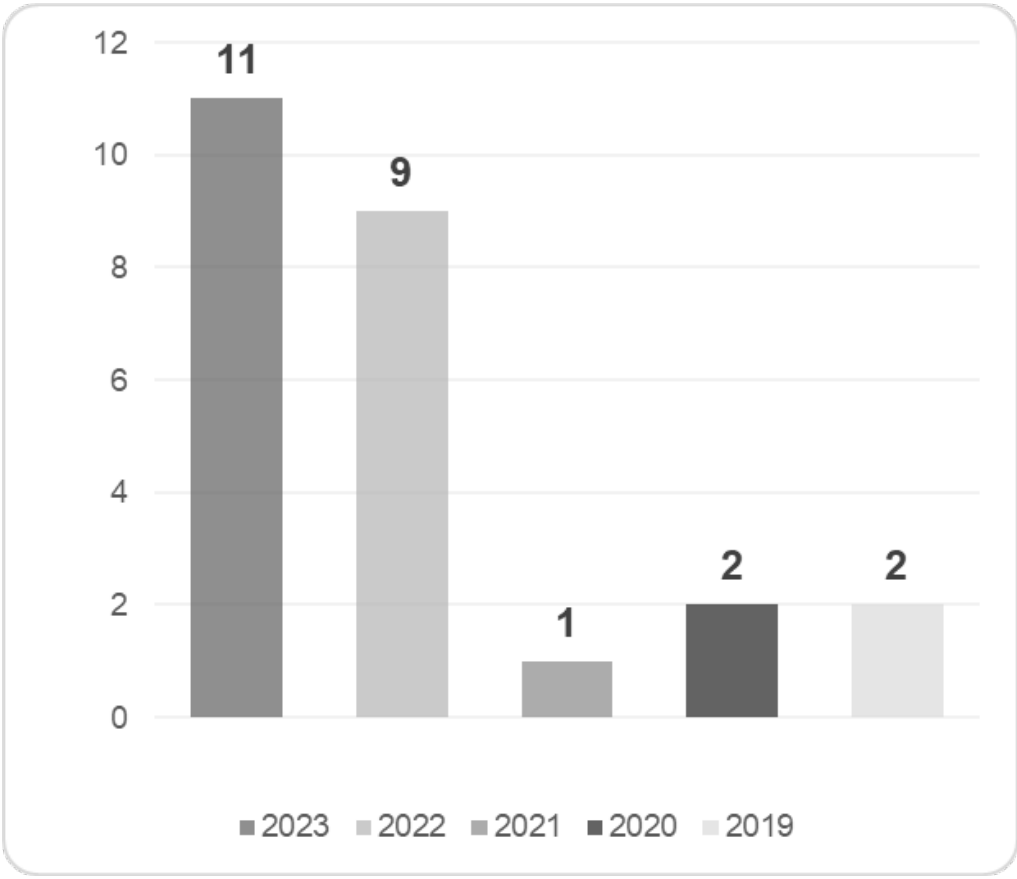

Figure 2: Results by Year

A steady increase (Fig. 2) in the number of publications can be observed from 2022 to 2023, indicating a trend of growth in research related to the research topic. It is important to keep in mind that these data reflect the situation up to the date of June 2023, so it is possible that there are additional publications after that period that are not included in this study. This fact highlights the dynamism and continuous advancement of the research field, as new knowledge is constantly being generated and more research is being conducted around digital transformation through virtual reality applying cardboard.

Twenty-five articles were found, where the most important information of each one of them was highlighted in relation to the research being carried out.

Table 6
Items with description

N°	Title	Description
1	Digital transformation towards sustainability in higher education: state-of-the-art and future research insights	A systematic review was carried out in the study using the Scopus database. A total of 672 publications were analyzed using VOSviewer software to visualize and understand the structure of the data. Subsequently, a content analysis was performed on 72 selected publications using ATLAS.ti and Zotero software. The purpose of this study was to investigate how educational institutions may benefit from digital transformation in order to become more environmentally responsible. [1]

2	Digital Learning and Digital Institution in Higher Education	The purpose of this research is to present an overview of major components of the process of implementing digital transformation in higher education institutions. This will be accomplished via the use of both primary and secondary sources. Nevertheless, it acknowledges the need for more study in order to get a deeper comprehension of the means by which these organizations may confront the digital transition and meet the requirements of the Fourth Industrial Revolution. [11]
3	Managing Digital Transformation: A Case Study in a Higher Education Institution	The study analyzes the essential factors that drive and facilitate this transformation from the point of view of the internal stakeholders involved. The case method is used as the methodological approach due to the complexity of the phenomenon. The results show the need to implement appropriate technological innovations, establish effective communication channels and transform the traditional culture into a digital culture. [12]
4	How does interactive virtual reality enhance learning outcomes via emotional experiences? A structural equation modeling approach	According to the findings, presence and pleasure play an important role in the process. These findings support IVR (Interactive Virtual Reality) based instructional design and have practical implications for the application of IVR in experiential and group teaching, as well as for digital transformation and improvement in education. [5]
5	The Need of Integrating Digital Education in Higher Education: Challenges and Opportunities	The article highlights the challenges facing higher education and describes technological resources and methodologies used to embrace digital transformation. It aims to offer ideas for the digitization of higher education in the present and future. [15]
6	Asynchronous industrial collaboration: How virtual reality and virtual tools aid the process of maintenance method development and documentation creation	A proof of concept for the COVE-VR platform is offered here. This proof was built via a partnership between academia and industry, and it was assessed with the assistance of subject matter experts. The virtual reality (VR) platform provides users with access to virtual settings as well as the tools necessary to interact with virtual prototypes and create digital content. The results demonstrate that the proposed solution is pertinent to the requirements of the various industrial divisions and that it is able to facilitate asynchronous communication. [16]

7	Visualization of Digital Transformation of Industrial Production into the Educational Process	Twinmotion, Bigscreen and 3D Vista Virtual Tour Pro software environments are used to create a virtual production space and a digital prototype of a machinery manufacturing plant. Immersive 3D visualization is leveraged for various activities such as online discussions, staff training, emergency drills and educational missions. [17]
8	The Influence of Competency-Based VR Learning Materials on Students' Problem-Solving Behavioral Intentions—Taking Environmental Issues in Junior High Schools as an Example	This study investigates the effects of an interactive virtual reality (VR) course on learners' course identity and behavioral intentions, single-group pre-test and post-test designs were employed to gather and analyze data on learners' responses before and after the installation of a virtual reality (VR) learning course, the outcome reveals that it has beneficial impacts on both the identity of the course and learners' behavioral intents to absorb and issue solve. [18]
9	Transforming Higher Education Using WebVR: A Case Study	The research highlights that the use of WebVR tools in education can be an effective strategy to enhance the student experience and foster skills development. However, it is important to ensure adequate technical resources and promote the acquisition of digital skills to take full advantage of these emerging technologies. [19]
10	The Influence of Digital Transformation on Intelligent	This article provides an analysis of the evolution of intelligent architecture design in China as a result of the ongoing success of China's social economy as well as advancements in science and technology. In the current digital age, where real and virtual surroundings coexist, digital transformation also has a long-lasting influence on intelligent building design, which helps shape a new paradigm for the development of cities. [20]
11	Development of digital transformation technologies for university practical learning in industrial area	In this article, several methodologies and tools were used, such as foresight, the theory of decision making under uncertainty, the risk management approach, the techniques used to develop databases and the technologies associated with the web and virtual reality. The analysis reveals that university practical learning has distinctive characteristics of digital transformation.[21]
12	Investigating science teachers' intention to adopt virtual reality through the integration of diffusion of innovation theory	This study investigated the relationship between social and personal factors and the intention to use virtual reality in education. The results revealed that attitude, social

	and theory of planned behaviour: the moderating role of perceived skills readiness	norms, and perceived control have an impact on intention to use, with attitude being the most influential factor. In addition, relative advantage was found to affect attitude, while compatibility and observability have no significant effect. Perceived readiness reinforces the relationship between virtual reality features and attitude. The importance of teachers' readiness to use virtual reality in the educational setting, especially in the science classroom, is highlighted. [22]
13	Virtual reality in chemical and biochemical engineering education and training	There is an increasing interest in the use of virtual reality in the subject of chemical engineering among academics, as well as among professionals working in the field. It is widely acknowledged that virtual reality is an effective medium for distance education. Although they cannot totally take the place of real-world encounters, virtual reality technologies provide a workable alternative in circumstances when such encounters are impossible to organize. [23]
14	The modality effect reverses in a virtual reality learning environment and influences cognitive load	Current evidence suggests that virtual reality requires additional cognitive capabilities. Identifying these capabilities and how to support them in the future is an important goal for future research on virtual reality learning. [24]
15	Virtual reality enhances active student learning	In this article, the benefits of using virtual reality (VR) headsets and settings like Second Life (SL) to inspire students and promote active learning are discussed. Visualization and interaction in a three-dimensional environment are highlighted as key benefits of VR. Research results and examples of problem-based learning activities in SL are also presented, as well as creative ideas for using VR headsets in lessons. [25]
16	A virtual reality classroom to teach and explore crystal solid state structures	A virtual reality educational application designed to help students understand the internal structure of crystals is presented. Teachers can use it to teach in a shared virtual environment, both remotely and locally. The application has been validated with human subjects and has received positive feedback. [26]
17	A low-cost mobile vr walkthrough system for displaying multimedia works based on Unity3D	Virtual walkthrough system is widely used in university education. This research focuses on an interactive system based on Maya and Unity3D that allows walking, interacting and replaying works. The system facilitates the

		dissemination of works through Google Cardboard and is useful for learning, although it lacks full interaction and flexibility. [27]
18	Digital Transformation and Technological Innovation on Higher Education Post-COVID-19	The results of the VOS viewer are closely related to empirical data and areas such as engineering education. Teachers recognize the importance of incorporating training strategies that foster flexible virtual learning environments using advanced digital technologies. [28]
19	Pupils' opinions on an educational Virtual Reality game in terms of flow experience	In the study, the flow experience in an educational virtual reality (VR) game was evaluated by considering several aspects. These included the balance between challenge and skills, integration of action and awareness, clarity of goals, clear feedback, task focus, sense of control, loss of self-consciousness, perception of time, and overall experience. [29]
20	Creation of Virtual Reality for Education Purposes	Virtual reality allows virtual exploration, presenting interesting places and objects. This allows students to visualize information in new ways, thus improving their ability to retain it. With the help of the ISTAGING system, the aim is to introduce students to the facilities of their future professional training, showing information, equipment and work procedures. [30]
21	A Virtual Reality Laboratory for Blended Learning Education: Design, Implementation and Evaluation	The study evaluates a virtual reality workshop given by the JANUS project who had the objective of maintaining virtual reality workshops. Since they have a significant impact on education, research and society. By providing interactive experiences, they improve student engagement, motivation and learning outcomes. [31]
22	Impact of VR Application in an Academic Context	The study included 117 students, where 97 watched a recorded video and 20 used virtual reality (VR) headsets, while another 20 students used traditional learning methods. The results showed a high level of satisfaction and confidence in the VR experience. The study demonstrates that VR is an excellent alternative to transform conventional education. [32]
23	A qualitative exploration of cardboard architecture in post-pandemic schools	For the purpose of this case study of the Unboxy project, a set of cardboard shapes and connections was sent to a total of 18 educational institutions located throughout Australia. The use of qualitative research demonstrates how this cardboard

		architecture project assisted students in their transition from summer to fall classes. The findings show that students built safe places for group work and safety structures throughout the epidemic, utilizing the tools at their disposal to verbalize how they felt about the situation. [33]
24	The Implementation of Interactive VR Application and Caching Strategy Design on Mobile Edge Computing (MEC)	The results were obtained by using a mosaic selection model, FoV caching and coverage, and applying a heuristic algorithm to solve the problem. [34]
25	Utilising Google Cardboard Virtual Reality for Visualization in Multivariable Calculus	According to the findings, using Google Cardboard is more effective than using PowerPoint presentations in encouraging positive attitudes and active participation among students in the process of learning multivariable calculus. In addition, the usefulness of Google Cardboard as a content distribution technology does not seem to be very different from that of PowerPoint presentations. [35]

The graphic shows the geographical distribution of the publications (Fig. 3), highlighting the diversity and international scope of the research topic. The countries with the highest number of publications, according to the table, are Saudi Arabia, China, Russia and Taiwan, each with two publications. This suggests significant interest or investment in the field of study in these regions. Although the subject of these publications is not specified, their geographic distribution indicates a wide relevance and applicability of the subject worldwide.

The rest of the countries listed, including Brazil, Spain, Finland, Mexico, Malaysia, the United States, Germany, Japan, Italy, Canada, Peru, Turkey, Slovakia, Greece, Romania, Australia and Singapore, all with one publication each, also contribute to this field of study. The presence of these countries in the list shows that the topic of study is of global interest, covering a wide variety of cultural and economic contexts.

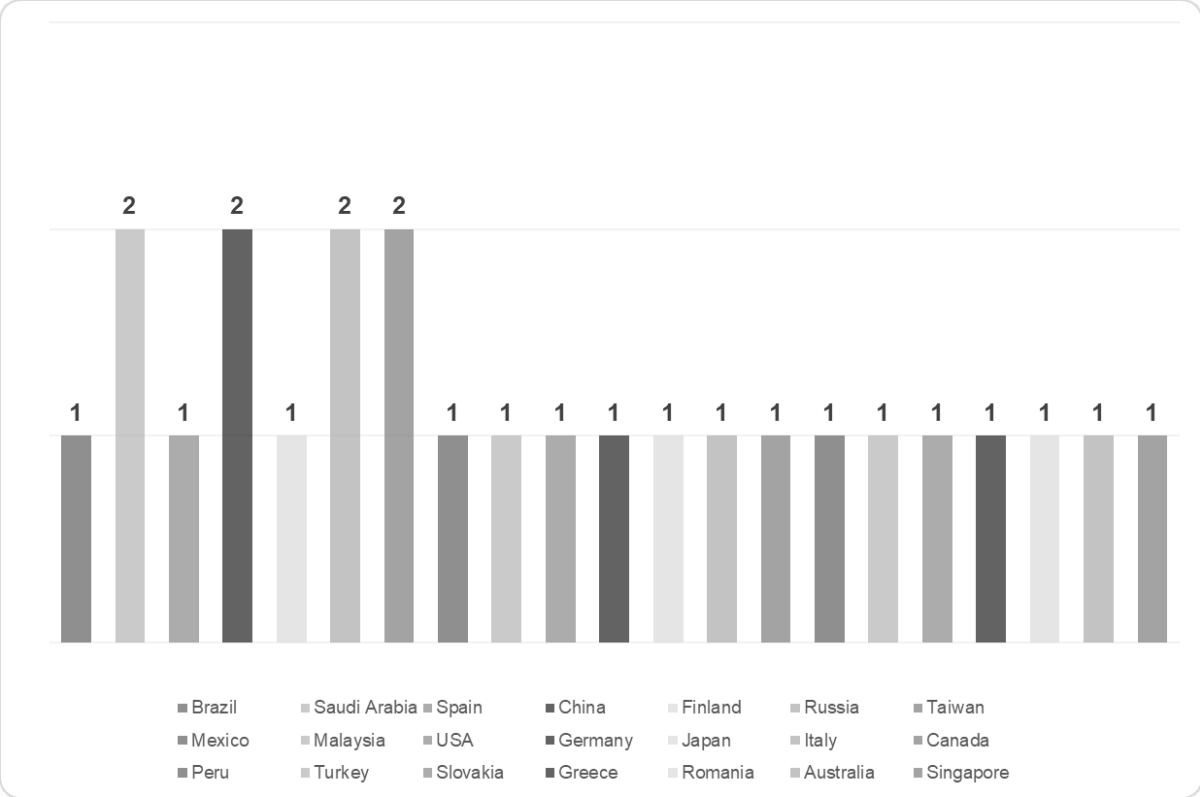

Figura 3: Results per Countries

The information organized into eight study categories (Fig. 4) reveals a diversified approach to research on the use of virtual reality in education. Among these, "Applied Research" stands out with six studies, focused on applying virtual reality to solve specific problems in educational contexts. The "Critical Analysis" and "Quantitative Research" studies, with three and four studies respectively, examine the effectiveness and implications of virtual reality in learning from analytical and data-driven perspectives. "Experimental Studies," with five examples, test hypotheses about how virtual reality can enhance teaching and learning. "Qualitative Research," also with four studies, delves into students' experiences and perceptions. On the other hand, the categories "Literature Review", "Descriptive" and "Case Study", although less frequent, provide theoretical contexts, detailed descriptions and in-depth analysis of specific instances of the use of virtual reality in education.

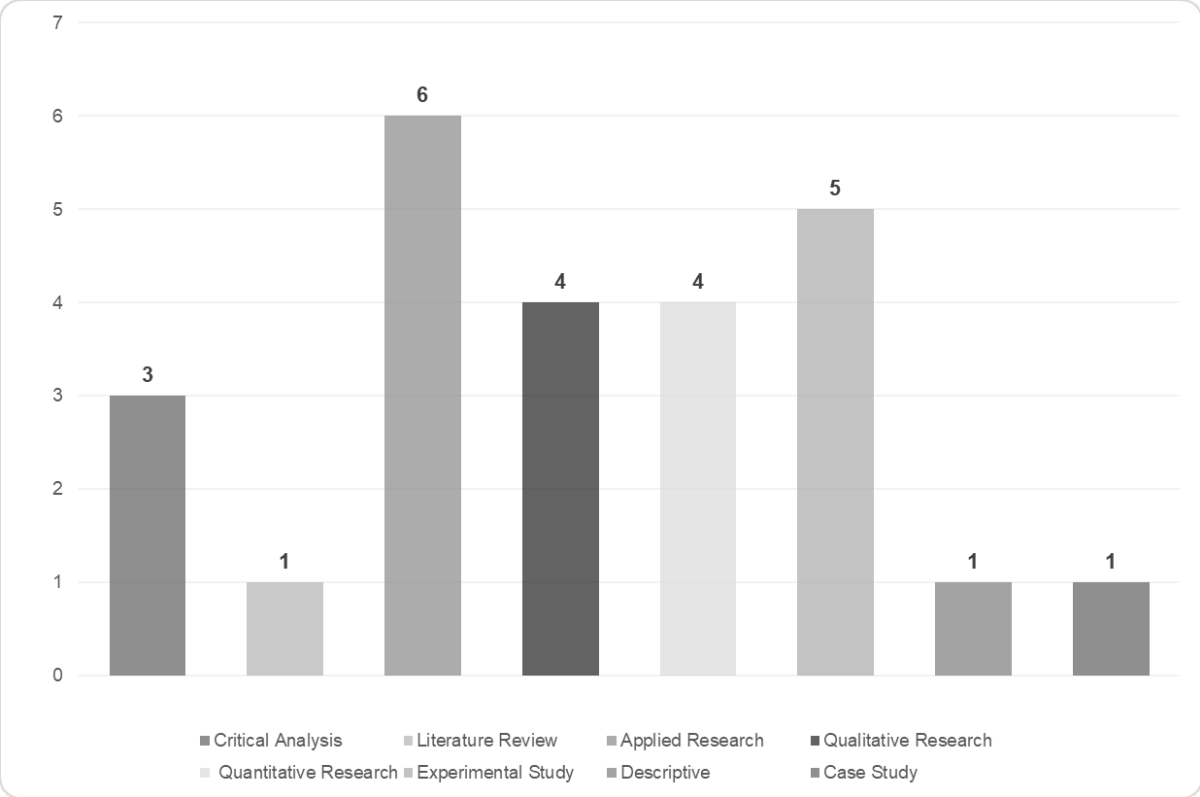

Figura 4: Results by Methods

4. Discussion

The implementation of virtual reality in the secondary education sector has generated a growing interest in the educational community and has raised the following research question: How does the integration of virtual reality with cardboard contribute to digital transformation in the secondary education sector?

The collected articles highlight different aspects of this transformation and offer interesting perspectives for discussion.

Compared to the main points of discussion would be how digital transformation can contribute to sustainability in secondary education institutions. The first article highlights the importance of exploring how digital transformation can promote sustainability in the educational context. Also, the role of virtual reality in improving learning outcomes. It also highlights the positive influence of virtual reality on learning and teaching. It would be interesting to discuss how the emotional experiences and interactivity of virtual reality can be maximized to improve education. In addition, several articles highlight the need to adopt technological resources and digital methodologies in educational institutions, to manage the challenges and opportunities of integrating digital education in higher education.

Collaboration and cooperation have been significantly improved as a result of the use of cardboard in higher education. Students are given the chance to discuss what they have learned and share their experiences using virtual reality, which encourages students to communicate with one another and contributes to the expansion of their group's collective knowledge. In addition, teachers may utilize the cardboard to create and distribute individualized instructional material that caters to the need of their pupils in a manner that can be easily shared. This makes it possible for more tailored and enriching instruction, which in turn improves the quality of education received as a whole.

5. Conclusions

According to the findings of the study, the research had a good impact not only on the students' comprehension of the many topics covered in the courses, but also on the students' behavioral intentions about problem-solving. In other words, students' perceptions, engagement, and ease of learning were all boosted by the usage of virtual reality, as was their drive to study.

It is necessary to have sufficient technical resources and to encourage the acquisition of digital competencies in order to take full advantage of emerging technologies in education. This not only involves the adoption of new tools and technologies, but it also involves a change in the culture and mentality of educational institutions.

The introduction of virtual reality experiences built with cardboard in this new age of digital change in the educational system paves the way for new possibilities to enhance classroom instruction and student education. On the other hand, it is very necessary for instructors to acquire training in information technology (IT) so that they may incorporate their own expertise into the lessons they teach their pupils. In this sense, key factors that drive and facilitate digital transformation in education have been identified, such as the implementation of technological innovations, effective communication and the transformation of the traditional educational culture towards a digital culture.

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