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PAPER

Expanding an Education-based Collision Detection System Created on Virtual Reality and Augmented Reality

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ABSTRACT

Virtually enhancing the real environment with augmented reality (AR) has lots of potential but is still in the early stages of research. The definition of appropriate user interfaces (UIs) is complicated by the absence of standards and the growing complexity of interaction opportunities. Several educators have discussed the advantages of XR for students as well as the use of AR and VR in the laboratory. Utilizing AR and VR to create immersive learning experiences is challenging since it takes time and effort to construct instructional AR and VR tools, apps, or educational settings. Because of this, even though these new technologies are said to help today's students, their implementation in education may be postponed or stopped. In this research, the usage of XR technologies in education has been investigated through the examination of websites, technical papers, reports, and mobile app stores. This research study proposes a collision detection algorithm (CDA) utilizing machine learning. In order to aid in the identification of the meeting of two objects in the virtual environment, the collision detection method is employed in applications that support augmented reality and simulated reality technologies. In this study, mean, standard deviation and error parameters were utilized to analyze competitions that were related to augmented reality and virtual reality.

KEYWORDS

augmented reality (AR), User Interfaces (UIs), collision detection algorithm (CDA), virtual reality (VR)

1 INTRODUCTION

Mobile content is being created and consumed across society, business, and culture, and the mobile community has recently grown quickly. VR is a fundamental technology that will impact how we live in the future and is one of the Fourteenth Industrial Revolution's cornerstones. Due to the growing interest of many businesses, VR will be applied to a variety of industries, including safety, defense, medicine,

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games, and learning. By creating a virtual environment on a computer, a technology known as VR enables users to perceive and fully immerse themselves in reality.

Simply described, it alludes to the relationship between people and computers that provides a unique environment, a circumstance that utilizes a computer, and allows users to participate with and experience reality. To emphasize the significance of "user knowledge", "immersion", and "the truth" in VR, which creates a virtual environment with a 3D virtual backdrop created by a computer, these terms should be used. In other words, a fully immersive scene on which VR users can focus and a natural environment devoid of any sense of heterogeneity are the essence of virtual reality.

Virtual reality is a technique that uses graphics to create a virtual environment rather than a real one, allowing the user to explore the virtual world. It is described as an interface that allows a person to engage with a computer as though they were doing so in the real world by turning a particular location or situation into a computer. Realistic content is anticipated to gain popularity as 5G, the next-generation network, and VR gain commercial traction. The entertainment industry, namely video games and movies, makes the most use of virtual reality technologies. It is employed in the realm of education for learning materials and abstract learning concepts that are challenging to directly see in a setting or context or that are challenging to convey in written or visual materials. Additionally, it is applied to risky or expensive research as a way to create a learning environment and boost learning outcomes [1].

Virtual reality-based instructional materials are more realistic and immersive than traditional educational materials. Education in virtual reality allows for exploratory and active involvement, encourages collaboration and instructional motivation among students, and makes it possible to study in virtual reality what is not possible in fact.

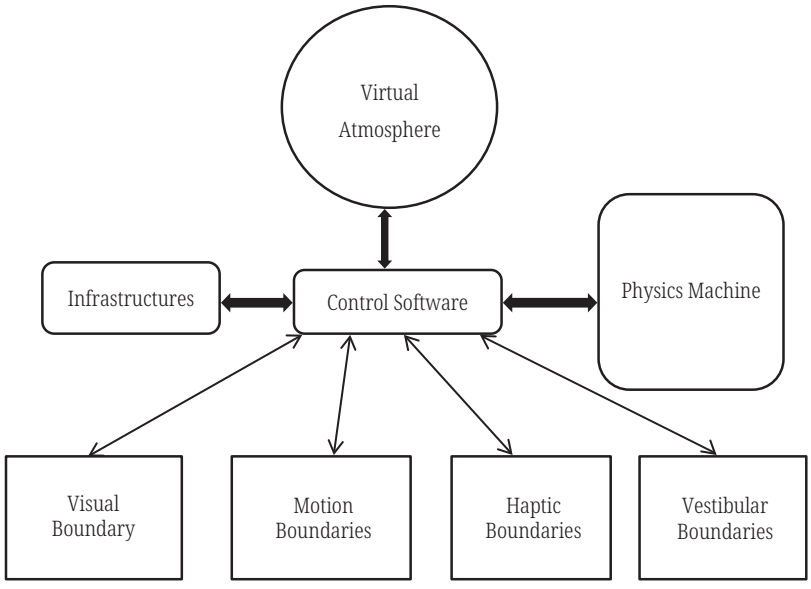

Fig. 1. An illustration of a VR system

Potential components and connections between them in a virtual reality simulation system are shown schematically in Figure 1. The control software is the brains of this machine. The communication between the interface layer and the virtual world is controlled by the user's actions, which updates the world as needed.

Additionally, it regulates when a scene should be drawn on display devices (such as visual and haptic displays). A crucial element for collaboration or multi-user systems is the ability of the control application to use the internet to connect with the outside world [2]. The model of the real world and a depiction of its inhabitants make up the virtual environment module. This depiction includes details about the state and position in addition to the look. These things could be static, dynamic things like moving things or even avatars. Within the virtual environment concept, dynamic entities must constantly be updated. The simulated setting module is a database that contains information about each component of the virtual world, including its form, location, and other characteristics.

In the end, students are better equipped with a comprehensive knowledge base and make better career choices in VR/AR development. To achieve this goal and answer the aforementioned study questions, over the course of one semester, a virtual reality course was painstakingly developed for pupils [3]. As a result, this study makes the following contributions to the literature:

- It examines if creating VR/AR applications is feasible from the perspective of undergraduate learners.
- It removes the difficulties from the learning process for youngsters; and
- It offers insight into student input utilizing a qualitative approach.

In Section 2, this paper provides background information and relevant research on virtual reality (VR) and the metaverse. The suggested system's technology and environment are covered in Section 3 and we contrast the proposed system's instructional efficacy and felt the sensation of presence with those offered by current online schooling. Section 4 wraps up by going over the findings of the experiment, our judgment, and suggested future study possibilities. Section 5 offers the solution.

2 RELATED WORKS

Hassan, S. A., Rahim, T et al. [4] AR is used in a variety of fields, including sports, real estate, and marketing. Children between the ages of 4 and 6 who are not native English speakers have been taught colors, shapes, and connections using AR, as was previously mentioned. AR may be used to enhance the conventional learning process and make it simpler and more effective for kids all around the world. An approach to history instruction that incorporates learner-generated augmentation is offered. The effect of AR on middle school pupils' attitudes and achievements towards scientific education is being investigated. To improve learning, a desktop augmented reality game has been developed for elementary school students that focus on explaining animal names. This helps to increase student interest to acquire and also makes it easier for teachers to give visual information about the animals to their classes.

Raith, A., Kamp, C., Stoiber, C., et al. [5] Techniques for correctly placing patients are an essential component of radiographers' daily clinical tasks. As a result, the second use case shows a working prototype of an interactive augmented reality system for teaching undergraduate cinematography pupils. Without the aid of a lab or a trainer, the AR instruction utility for radiographers (ARTUR) simplifies the teaching of patient positioning for plain radiography. The added benefit of AR-supported training is sometimes disregarded due to the low availability of easily available

software and the higher initial expenses involved with purchasing for comparing augmented reality technology and software to traditional teaching tools.

Kerr, J., & Lawson, G et al. [6] Within informal learning environments, which have embraced AR more quickly than formal educational contexts, there are certain powerful models that educators can employ to create site-based materials. The application of the same fundamental components—defined routes, digital text, photos, videos, audio snippets, and interactivity—can be seen in each of these wide, opposing methods. A clear, practical approach is the most typical, whilst the other is more imaginative and expressive. The 'Garden Guide' mobile application for the Chicago Botanic Gardens represents the pragmatic approach to landscape design, but the 'fairy seeking' app for the Melbourne Botanical Gardens offers a more emotive approach. By providing customized walking tours of the most popular display gardens and utilizing its GPS features to direct visitors to any plant or point of interest, the Garden Guide app enhances a trip to the park.

Han, L et al. [7] The majority of interfaces used in studies examining the effects of hypermedia on second language acquisition are those that only allow for audio, text inputs, and scrolling. Vieira Monteiro and Ribeiro conducted an exploratory study with 17 colleges, 8 students enrolled in a private school studying English course to determine the viability of using virtual reality to teach additional language vocabulary. Research on computer-based stent-defining recommendations created for IVR is scarce. Despite the numerous advantages of adopting VR in education, several difficulties and restrictions have led to the ineffectiveness or abuse of the technology.

Kim, S. Y., Shin, B. S et al. [8] This special issue's goal is to discuss how a virtual reality-based educational system might improve students' drive, involvement, immersion, happiness, and learning transference. Four papers were chosen to be featured in this special issue out of a large number that was submitted for evaluation. Excellent and unique research papers covering research successes, methodologies, theoretical frameworks, and challenges for mobile virtual reality education platforms may be found in this special issue. These research projects provide vital information for comprehending and using virtual reality from a diverse standpoint. In our perspective, the papers included in this special issue introduce readers to the most current advancements in the field.

Huang, B. R., Lin, C. H et al. [9] Systems that offer enhanced efficiency in terms of computing time are of interest for this endeavor. The majority of the aforementioned works perform all of the calculations on a single machine, like a PC or PMD. Even with technological advancements, running the entire system on a single device degrades system performance. As a result, this study and recent research utilize the client-server approach to merge AR and cloud computing. The aim is to reduce the overall computation and storage requirements of the clients by moving the heavy work, such as searching databases and complicated algorithms, to the clustered server environment.

Al Farsi, G., Yusof, A. B. M., Romli et al. [10] claimed that quick technological advancements had made distance learning simple. Education is seen as essential for society, and Covid 19 has had an impact on the field, changing the educational model totally to one that is conducted fully online. The study explores the value of distance education and how to overcome e-learning difficulties. The goal was to enhance education, learn new skills that promote lifelong learning, and understand the advantages and disadvantages of creativity and growth. Furthermore, a Plan B for teaching must be in place to address technical issues such as download issues, software installation issues, sign-in issues, and audio issues. Likewise, training should be flexible, participatory, and necessary.

3 METHODS AND MATERIALS

In this research, publications based on virtual reality applications that are efficient and have a significant impact on learning and academic performance are chosen after a review of recent studies available on open-access database systems. The overall goal of the current study was to determine whether using VR and augmented reality technologies in the classroom was feasible from the viewpoint of the pupils. Students must work quickly and with minimum background knowledge to adapt cutting-edge developers of VR/AR gear, and software can create apps based on their own preferences and expertise. In order to solve this issue, a properly designed teaching plan should be developed to maximize student learning and extend the learning curve. According to our method of course design, the most important elements influencing learning results are students' motivation and engagement.

3.1 Virtual reality

- Disagreement about what an invention actually entails can cause confusion in the early phases of the creation of any new idea or technique [17]. Any description of virtual reality is further complicated by assertions that it is not an instrument but rather a collection of new phenomena made possible by a different group of quickly evolving technologies and influenced by a different complex set of sociocultural variables. Virtual reality is a fast-evolving group of computer-generated phenomena that lacks a clear definition.
- The VR abilities of today are unconnected to how VR is commonly portrayed in media (such as advertisements and movies). However, it appears that the only obstacle to the present press's fantasy dreams being realized is the technology's primitive status.
- There are three main types of virtual reality: text-based, desktop computers, and sensory-immersive VR. In text-based connected virtual reality, users engage with one other by typing instructions and "explain" by typing messages on their computer laptops in real-time worlds that are textually defined on the Internet. This has been helpful for remote learning. Workstation VR is a development of multimedia interaction that uses three dimensional pictures and enhances the user experience without being categorized as immersive.
- High-resolution picture generators that provide current rendering are essential for VR, as are programmers that enable localized surround sound and, in certain circumstances, scent and voice recognition. The virtual world must also be refreshed as the user interacts with it.

3.2 Education using AR

Today, AR is used in a wide range of business industries [11]. One economic sector that is utilizing the potential of AR technology is tourism for promotional and instructive purposes. Another industry which gains from AR is education, and by looking through books, one can find a variety of solutions that have been used at different levels of schooling.

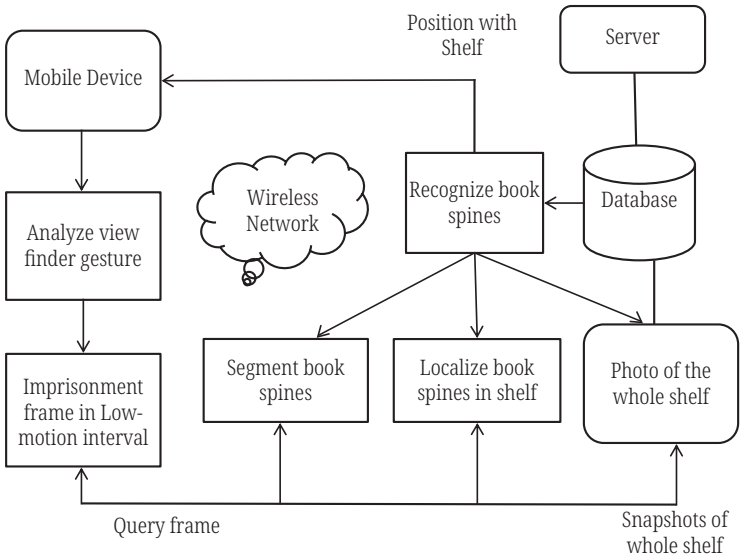

Fig. 2. A block diagram of our smartphone augmented reality technology

Figure 2 depicts a block diagram of our mobile augmented reality system. Motion analysis is done on viewfinder frame on the mobile device, and a query frames is sent to a server every time there is a period of low motion [12]. Applications for augmented reality are being created, for instance, for primary, intermediate, and postsecondary education. Adult learner education and special needs education both make use of augmented reality. As may be observed from a recent literature review, AR has also been utilized to assist a variety of disciplines. Language acquisition, arithmetic, chemistry, technological engineering, physics, history, STEM topics, biology, and environmental education are some of these disciplines. The usage of augmented reality (AR) improves reading comprehension, vocabulary development, and even conversation comprehension between children and adults, demonstrating the incentive that augmented reality may create [13].

There was a notable surge in research papers on AR in educational settings between 2012 and 2018, based on a relatively recent topical systematic review and meta-analysis. This research found that numerous studies discussed the benefits of utilizing augmented reality in educational contexts. These advantages include improvements in learning outcomes, inspiration, imagination, and autonomy, as well as favorable effects on learning gains and student attitudes. However, some drawbacks were also mentioned in the studies this review paper looked at. The intricacy of using AR, particularly when the target audience was children, was the most frequently mentioned drawback. New technology, like augmented reality, might be difficult to utilize, especially if the users lack technical knowledge. The remaining problems are linked to this complexity as well.

Teachers who used augmented reality in their classes noted technical issues. Multitasking was another issue that was raised. Students complained that these applications require too much focus, which may lead them to miss important instructions. Additionally noted as a problem is instructor opposition, despite the advantages of AR apps in terms of learning gains and drive, as some teachers prefer having complete control over the content. AR has also demonstrated success in communicating and educating about cultural heritage. Various initiatives in this area use augmented reality (AR) to improve tourist experiences and knowledge of cultural assets. With the transition from marker-based to marker-less and GPS-triggered overlays, advances in AR technology have increased the appeal of the technology for this industry.

3.3 Implementation methodology

It was necessary to review and assess related studies in order to determine the advantages of a combined platform for integrating virtual and augmented reality.

Creation of an educational environment based on VR and AR learning items. An algorithm was created throughout the development stage and will be deployed using various VR technologies. The writers chose two different forms of virtual reality: augmented reality and three-dimensional technology. Virtual worlds and practically all contemporary computer games are now built on three-dimensional (3D) technologies. Many educators and educational institutions see significant potential in the utilization of games and simulations from three-dimensional simulations for teaching and studying various disciplines. During the conceptual teaching and learning process, students find it challenging to visualize and comprehend how packages, moves, and protocols operate due to computer network ideas and protocols. The study of computer networks is very conceptual and technical. Students must be familiar with the foundational ideas and applications of computer networks to complete the teaching and learning process [15]. In the contemporary teaching method, student understanding of the material depends on their imagination and inventiveness.

There are many different types of augmented reality experiences. The majority of this sort of augmented reality resembles three-dimensional reality. The augmented reality experiences are not fully immersive for the user. Webcam-based augmented reality uses a computer webcam to capture a real-world environment and display an augmentation on a screen, such as a computer workstation or screen, allowing users to easily control the augmented reality information.

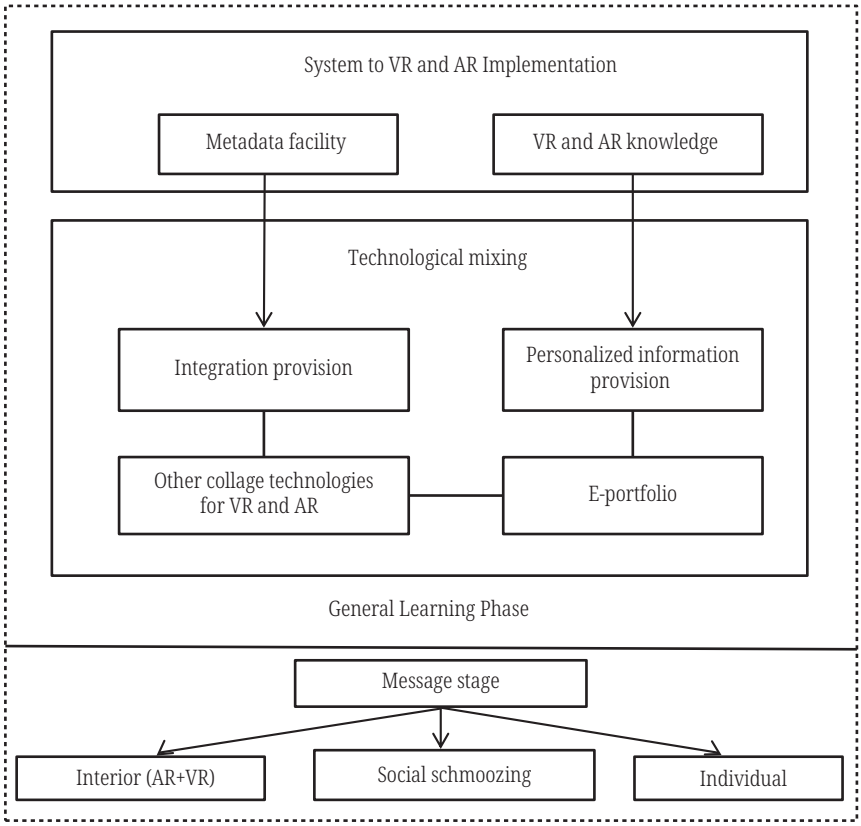

Fig. 3. Based on the use of VR and AR, an educational environment for teaching things

The inclusion of educational materials (including learning objects in various formats), testing, and material development will be ensured by the educational environment's functionality in Figure 3 [14]. This includes the creation of digital content and metadata descriptions, the design of learning objects, the creation of courses, and the leadership of open access. It also includes the creation of tests and assignments and their connections to the relevant program, as well as a virtual learning environment and user management. By utilizing freely available resources (VR and AR) created and integrated into the educational setting, the learning environment built on the Drupal content administration system will guarantee a self-directed learning method.

4 IMPLEMENTATION AND EXPERIMENTAL RESULTS

The frequency and association of the common terms used in the study were displayed using the bibliometric map. Therefore, to gauge the terms used in the manuscripts examined for this research study, the number of the most prevalent terms, their frequency, and the quantity of each were used [16]. The assembly is carried out under Education: Research questions must be defined, search tactics for papers must be used, inclusion and exclusion criteria must be applied, and then final manuscripts must be chosen.

4.1 Results of the student activities awareness assessment

According to statistics, between 2020 and 2021, there will be 8352 university graduates who have no degree in physical education. Students with congenital physical conditions that impede their ability to succeed in sports such as congenital limb disorder, hereditary pulmonary organic illnesses, congenital respiratory functional illnesses, are not allowed to participate.

Table 1. Girls' freestanding long jump, sit-ups, 800 m, and other events are compared

Collection	700 m (min)	Standing	Solid Ball	Sit Ups
Traditional classroom setting	3.02	3.06	6.25	26.37
Technology teaching group for 5G and VR	2.12	2.64	6.21	41.68
value t	6.639	8.264	6.301	2.037
value p	1.123	1.101	1.023	1.101

The outcomes of all girls' 700-meter in 2020 and 2021, gender-specific data from endurance runs, standing long leaps, solid ball tosses, and sit-ups is scientifically analyzed in Table 1 [13]. The data in Table 1 are derived from a retrospective inquiry of students in 2020 and 2021, which included counting and analyzing the number of people who intended to exercise outside of school, the number of people who participated in sports-related interest associations, and the number of people who missed physical education classes. The boys' athletic accomplishments and the numbers in Table 2's results are comparable. Students who use the AR and VR technology smart

sports teaching scheme have greater athletic prowess and endurance than students who use the conventional clever sports instructing scheme, proving the effectiveness of the AR and VR technology smart sports teaching scheme in fostering the growth of students' sporting cells and enhancing their athletic prowess. For details based on the information in Table 1, see Figure 4.

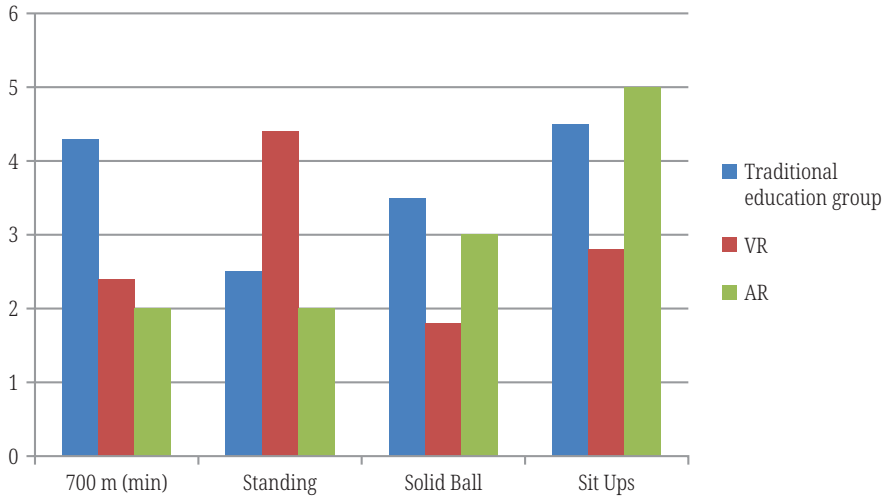

Fig. 4. Comparison of physical performance in response to various instructional strategies

Figure 4 also makes it clear that students who use the AR and students that use the VR technology smart sports teaching scheme outperform those who use the conventional clever sports teaching scheme in sports. This shows that the intelligent sports instruction program using AR and VR technology may be strongly supported and utilized, which is beneficial to students' health.

Table 2. Comparison of students' extracurricular activity intentions, physical interest, and community involvement rates as well as their participation in physical education activities

Collection	Physical Education Absence Rate (%)	Knowledge of Extracurricular Activities (%)	Participation Rate of Organizations with a Physical Focus (%)
Traditional classroom setting	35.34	28.69	20.32
Technology teaching group for 5G and VR	14.21	49.96	50.56
value t	6.634	9.935	5.514
value p	4.413	7.778	3.311

The data in Table 2 demonstrates that students who participate in the AR and VR intelligent physical education instruction scheme are more aware of and interested in sports than students who participate in the traditional intelligent physical education teaching plan, which significantly reduces the number of students who miss physical education classes. For details based on the information in Table 2, see Figure 5.

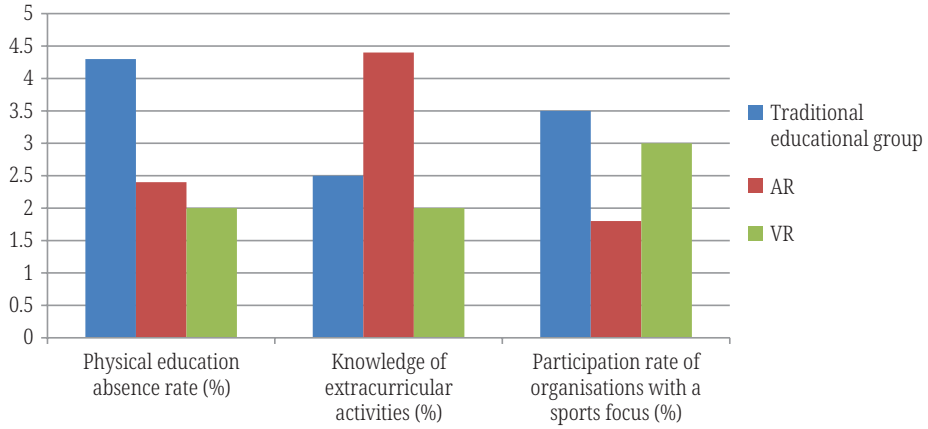

Fig. 5. Comparison of sports awareness under various intelligent physical education programmers

Figure 5 illustrates how the use of AR and VR technology can increase scholars' attention in engaging in recreational and increase their awareness of participating in sports, demonstrating that the use of AR and VR technology in smart sports teaching is an intriguing and worthwhile smart sports teaching strategy.

This study uses high-tech VR high-definition video and AR networking to address the existing intelligent physical education. Students can use their existing mobile phones and VR glasses to access the 3D eagle eye breakdown video in the teaching system, allowing them to exercise as appropriate whenever and wherever they like, improve their awareness of exercise, and build a healthy body all at once. There is still a lot of space for growth in the future because students' knowledge of corporeal activity is still in the stage of leisure and pleasure and because a complete system has not been established. Let's collaborate to develop a concept that combines sports and entertainment.

The results of this study demonstrate that students' physical quality and performance can be enhanced by an intelligent physical education teaching strategy that combines AR communications with VR technology. However, the experiment's findings are not conclusive because there were so few samples used. Therefore, in order to make it the most effective physical education teaching approach for students in the present era, the quantity of field samples will be increased and research technology will be enhanced.

5 CONCLUSION

The next generation is the lifeblood of societal growth and educating them to be physically and mentally healthy is of utmost importance. So, focusing on the physical health of students has sparked the reform of the educational system. The majority of the other VR educational programs had a specific environmental scenario or were designed for particular student populations, and most of them had success increasing students' academic and learning interests. This study, as opposed to earlier studies, concentrated on experiential learning for general students.

The bulk of the other VR educational programs had a particular ecological scenario or were created for certain student demographics, and most of them were successful in piquing students' interests in academics and learning. In contrast to past research, this one focused on experiential learning for all pupils. In terms of learning efficacy and sense of acquisition, the research's outcomes were impressive. The fact that there are so many VR and AR apps with so many different topics

shows that students have the resources they needed to create courses that suited their interests.

As a result, we would say that VR and AR are not a fad. Future research will involve conducting a more thorough user study on students' VR/AR applications to more thoroughly and accurately assess student learning outcomes using the extended acceptance model for technology with task technology, viewed visual design, perceived utility, perceived ease of use, self-efficacy, and desire to use.

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