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Augmented Reality's Impact on Learning Motivation In Physical Education: A Systematic Review

Mochamad. Ridwan[1], Nadia. Aswanda[1*], Sumarno[2], Farruh. Ahmedov[3], Adi. Pranoto[4]

1 Department of Physical Education, Health and Recreation, Universitas Negeri Surabaya, Surabaya, Indonesia.
2 Faculty of Education, Universitas Madani Indonesia, Blitar, Indonesia.
3 Department of Physical Education and Sport, Samarkand State University, Samarqand, Uzbekistan.
4 Department of Sports Coaching Education, Faculty of Sports and Health Sciences, Universitas Negeri Surabaya, Surabaya, Indonesia.

Corresponding author email address:
mochamadridwan@unesa.ac.id

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ABSTRACT

Objective: This study investigates the potential of AR to improve learning motivation in physical education.

Methods and Materials: A systematic review method was conducted, analyzing articles from leading databases like PubMed, focusing on the effectiveness of AR in physical education. The inclusion criteria were articles published in the last five years, discussing interval learning and cardiorespiratory improvements through AR.

Findings: The results revealed that AR had an impact on student achievement, with effects becoming more pronounced over time. Factors such as the integration of mobile devices and multimedia-based content were identified as key enhancers of AR's effectiveness. The study also highlighted AR's ability to provide personalized learning experiences, making it especially beneficial for students with diverse abilities and needs. This research makes a significant contribution to the academic literature by providing strong evidence of AR's potential to increase motivation and improve learning outcomes in physical education. It also offers practical implications for educators and policymakers, suggesting that AR can be effectively integrated into education curriculum to create engaging and interactive learning environments. The findings underscore the importance of exploring new technologies to enhance the quality of education and suggest directions for future research, such as investigating the long-term effects of AR and its integration with other emerging technologies. Given the urgency of improving physical education to promote healthy lifestyles among young generation, this study is both timely and relevant.

Conclusion: It provides valuable insights for the development of innovative teaching practices that can lead to better student engagement and success. As such, this article is a worthy contribution to the field of educational technology.

Keywords: Augmented reality, motivation, physical education.

Introduction

Augmented reality is rapidly growing in Education technology (AR) is a technology that combines virtual elements with the real world, allowing direct interaction between physical and digital objects standing out as a transformative tool that could greatly improve the educational process (Dinh et al., 2023; Lin et al., 2024). Studies on augmented reality (AR) in relation to hands-on learning is a very relevant and important topic to study deeper (Loeb et al., 2023). In the current digital era, the integration of technology in education has become a necessity to improve the quality and effectiveness of learning. Physical education is a unique field due to its practical and immediate nature, often facing challenges in terms of student motivation and participation (Sultoni et al., 2022). AR technology offers innovative solutions to increase student engagement by creating interactive and engaging learning environments (Ramos & Júnior, 2024). Through AR, students can experience realistic sports simulations, get immediate feedback, and feel more engaged in physical activities (Alkhabra et al., 2023). Given the potential of AR in transforming physical education pedagogy, this research will not only make a significant contribution to the academic literature, but also provide practical implications for educators and policymakers for adopting this technology in educational curricula (Avila-Garzon et al., 2021). Although existing literature has explored the benefits of AR, research specifically examining its impact on motivation in physical education is still limited. Thus, this article is worthy of publication in a Scopus indexed journal as it offers new insights that have a high impact on educational innovation and technological development in the learning environment (Chugh et al., 2023).

These findings reveal a moderate positive impact of AR on student achievement in STEM fields, and the impact becomes more pronounced over time (Laurens-Arredondo, 2022). The study also identifies factors such as the integration of mobile devices and multimedia-based content as enhancing AR's effectiveness in improving student outcomes in science and mathematics (Wen et al., 2023). Summarizing the literature, AR has proven effective in increasing motivation, providing realistic simulations, and creating interactive learning environments in various educational contexts. Specific to physical education, studies highlight AR's potential in supporting motor skills development, enhancing engagement in physical activities, and fostering student autonomy. In conclusion, the reviewed research papers provide strong evidence of the potential of augmented reality to increase motivation and improve learning outcomes in physical education from improving motor skills to supporting students with learning disabilities (Loeb et al., 2023). AR has shown promise in changing the way physical education is taught and experienced. As technology advances, further research and application of AR in education, particularly in STEM fields, has great potential to increase student engagement and achievement (Elford et al., 2022).

Alternative solutions are very important to find in understanding the problem. The use of augmented reality media can also make things easier for students with various abilities and needs (Herskovitz et al., 2020). AR can provide students with alternative ways to engage and understand physical activity by incorporating virtual elements into the learning environment. This allows a variety of different learning methods and approaches to be used. For example, AR can increase the safety and accessibility of physical education activities, which enhances the desire to learn and boosts motivation. It may increase the safety and accessibility of physical education learning process in addition to increase the desire to learn and motivation (Chin et al., 2023; Chugh et al., 2023; Delgado-Rodríguez et al., 2023; Kann et al., 2022). Additionally, AR can provide students with a more personalized learning experience as they can adjust the content and difficulty level according to their abilities and needs (Ma, 2019; Nekar et al., 2022). This is especially beneficial for students who may struggle with physical activity as they can receive tailored feedback and support to help them improve their skills. Additionally, complex physical concepts such as biomechanics or movement patterns can be visualized by AR (Laurens-Arredondo, 2022).

This research aims to systematically review the impact of AR on learning motivation in physical education. It will assess how AR can increase active student participation, enhance learning outcomes, and boost engagement in physical activities. This research will assess the extent to which AR can increase active student participation, strengthen learning outcomes, and increase student engagement in physical activity. In addition, this study aims to identify factors that influence

the effectiveness of using AR in physical education and provide practical recommendations for the implementation of this technology in schools.

The urgency of this problem cannot be ignored considering the importance of physical education in forming a healthy and active lifestyle among young generation. However, many students are less motivated to participate in physical activity due to various factors, including a lack of variety and appeal in traditional teaching methods. AR has the potential to revolutionize the way physical education is taught by providing a more dynamic and enjoyable learning experience. Thus, this research will not only make a significant contribution to the academic literature but also provide practical implications for educators and policymakers for adopting this technology in education curriculum. This article is worthy of publication in a Scopus indexed journal because it offers new insights that have a high impact on educational innovation and technological development in the learning environment.

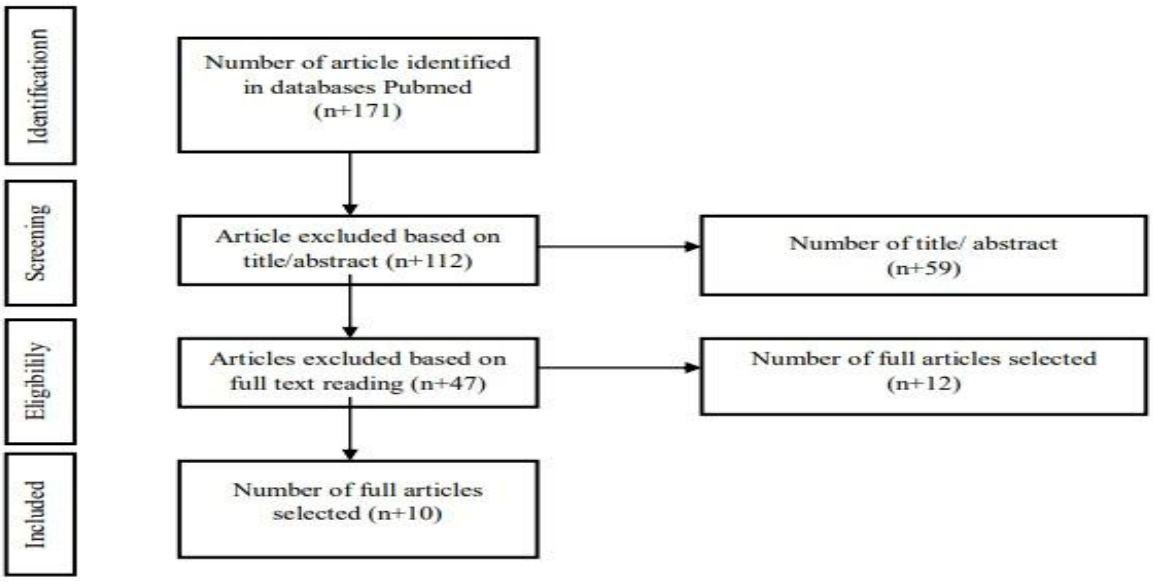
Methods and Materials

Study Design

A systematic review methodology was implemented in this investigation, utilizing prominent global platforms such as Scopus and PubMed for their compilation of scientifically significant and relevant publications. The review process adhered to the guidelines set forth in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses. Commencing with the identification phase, the procedure involved a comprehensive exploration of pertinent literature across diverse databases, including the Web of Science, Scopus, PubMed, and Google Scholar, an academic search engine.

Figure 1

PRISMA flowchart of the article selection process



Eligibility Criteria

The inclusion criteria in this study were articles published in the last 5 years and articles discussing Interval Learning and Cardiorespiratory. The exception to this research is articles published in well-known journals.

Process

Article titles, abstracts, and complete texts were vetted, validated, and transferred into Mendeley software. 171 articles from the Pubmed database were collected in the first step. The adequacy of the title and abstract was the basis for the subsequent screening of 59 articles in the second stage. Twelve products were ordered for additional processing during the third stage.

At this point, we screen articles based on their general suitability. Eleven papers that comply the inclusion criteria were then chosen for a final round of analysis using systematic observation. This study adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Assessment guidelines for standard operations.

Findings and Results

The study results show that the use of augmented reality (AR) technology in physical education has a positive impact on students' learning motivation and critical thinking abilities.

Table 1

Summary of Review Articles

Author	Sample Characteristics	Study Design	Intervention	Results
(Chen & Lai, 2021)	275 valid samples were gathered in museums using augmented reality experiences. The findings show that, in comparison to 41.82% of males, 58.18% (94.55%) of the total samples held a degree from a university, college, or above. In terms of age distribution, the majority of participants are between the ages of 41 and 51 (27.64%), followed by 19 and 29 (26.91%), 52 and older (22.91%), and 30 and 40 (21.09%). The proportion of participants in augmented reality exhibition activities, whose weights are less than five, are as high as 77.82%.	Path analysis	Between December 1st, 2020, and December 30th, 2020, a random sampling of 299 participants/entries was gathered. 275 valid entries (partially completed) remained after 24 invalids were removed, yielding an effective recovery percentage of 91.97%.	According to the results, 58.18% of the samples were female and 41.82% were male, with 94.55% of the samples having a college degree or higher. The age group is mainly distributed among those who are 41–51 years old (27.64%), followed by those who are 19–29 years old (26.91%), 52 years old and above (22.91%), and those who are 30–40 years old (21.09%). Less than five participants used augmented reality while engaging in exhibition activities that weighed up to 77.82%.
(Laurens-Arredondo, 2022)	There were 96 students that participated in total; 68,7% of them were men and 31,3% were women. 51,2% of the group's high school graduates came from subsidized institutions, 3,7% came from private schools and 45,1% from public institutions. Students in the sample ranged in age from 19 to 25.	Cross-sectional study	No interventions were reported	Finally, the findings show a positive correlation between mAR and students' attained learning level. Due to hygienic constraints during the implementation of the mAR, there was no indication of any negative impacts under the specific conditions that were established.
(Dutta et al., 2023)	To ascertain the effect of the augmented reality learning system on students' critical thinking abilities, learning motivation, and information acquisition, an experimental study including 128 undergraduate engineering students was carried out. Two groups of students were formed: the experimental group (N = 64) and the control group (N = 64).	Experimental	At the beginning of the experiment, students were divided into two groups at random: the experimental group (N = 64) and the control group (N = 64). Randomly dividing the kids, the other teacher did not know about the several interventions that were employed during the study. Before class, the experimental group watched movies to get a knowledge of the principles of digital electronics through the use of an augmented reality learning system. During class, they can use the augmented reality learning system to finish homework.	The results of the trial show that using augmented reality (AR) technology significantly improves students' critical thinking abilities, motivation to learn, and information gain. Additionally, the study discovered a strong positive association between students' knowledge growth in the experimental group and their critical thinking abilities and enthusiasm to learn.
(Zhao et al., 2022)	Using cluster random selection, sixty third-graders from a single They were selected from Hebei Province, China's public primary schools. There was a balanced gender ratio of 27 girls to 33 boys. With a range of 8 to 11 years old (two students aged 8, 38 students aged 9,19 students aged 10, and one student aged 11), the average age was 9.32 years old (SD = 0.57). Every participant spoke Mandarin as their primary language and had either normal or corrected vision.	Experimental	The subjects were first randomly split into six groups, each consisting of 10 people: text restudying, text retrieval practicing, text drawing, AR restudying, AR retrieval practicing, and AR drawing. This was done to assure the randomization of the learning materials and learning methodologies used. A vocabulary exam comprised of questions was utilized to screen every participant. To ensure that everyone started from the same place, subjects who could dictate any word in English were excluded.	The findings demonstrated that (1) Deep motivation was significantly impacted by learning methodologies. Compared to self- generated drawing strategies and restudying strategies, retrieval practice techniques considerably increased the deep motivation. (2) The relationship between education and materials and learning strategies was marginally significant.
(Nielsen et al., 2016)	48 physically active males, aged 18 to 35, engaged in leisure physical activities were enlisted. They were randomly assigned to four groups: the control group, therapist-based training (TBT), mirror visual feedback training (MVFT), and augmented reality-based training reality (ART). The entire course of instruction lasted for four weeks. The intrinsic motivation inventory-22, the sit-and-reach test, the Y balance test, and the isokinetic dynamometer were used to gauge the results before and after the intervention.	Experimental	Research Design: This study was carried out at Sunmoon University on healthy adult males using a pretest-posttest randomized control trial design. Pre- and post-intervention outcome assessments were part of a four- week intervention program in which study participants were divided intofour groups at random.	The results of the study showed that after a four-week intervention, all groups' muscle strength, endurance, and balance significantly improved, with the exception of the control group. The ART group showed the most improvement in muscle strength, muscle endurance, and balance when compared to the other groups. The following order of the three feedback groups' increased motivation was observed: ART group>MVFT group>TBT group>control group. The most effective at-home training method that may be applied during and after the pandemic was described in this study.

(Chang et al., 2020)	We conducted a comparison between a control group consisting of 48 candidates and an experimental group consisting of 52 test subjects. Through the use of MAR technology, learning indicators like as efficacy, confidence, contentment, and learning interest have been used to gauge the students' motivation for	Experimental	We applied John Keller's Attention, Relevance, Confidence, and Satisfaction (ARCS) learning motivation model to validate our solution to examine the students' willingness and verify the ability of students to improve learning through MAR technology. We compared a sample experimental group of N = 52 test-subjects with a sample of N = 48 candidates in a control group. Learning indicators as learning interest, confidence, satisfaction and effective have been utilized to assess the students' learning motivation through the use of MAR technology. The learning results have been determined by the independent sample t testing.	The research results clearly show that the reference group that utilized MAR technology as a learning aid showed higher learning effectiveness as the control group. Therefore, we conclude that MAR technology does improve students' learning ability in interior design and making appropriate design decisions.

Overall, AR proved effective in increasing the engagement of diverse students, including those with limited experience with the technology. The majority of participants (58.18%) were female, and 94.55% had at least a university-level education. The age distribution showed a predominance of participants aged 41–51 years (27.64%), followed by those aged 19–29 years (26.91%). Most participants (77.82%) had limited prior experience with AR, indicating the novelty of the technology for this cohort.

Discussion and Conclusion

The positive correlation between AR implementation and enhanced learning outcomes supports previous research findings (Chin et al., 2023) underscoring the potential of AR to transform traditional teaching methodologies. Experimental designs involve the investigator controlling subject assignment and usually include a control group, allowing for randomization. In contrast, observational designs do not control subject assignment, may not have a control group, and cannot establish causality.

The experimental outcomes indicate a substantial improvement in Critical thinking abilities and motivation for learning among students exposed to AR technology. Across multiple studies, the use of AR has consistently been linked with improvements in motivation and student engagement in physical education Dutta et al. (2023), who observed a significant positive impact of AR on students' critical thinking and motivation in a controlled study environment (Dutta et al., 2023). The enhanced motivation and critical thinking skills are crucial for students' overall academic success and can lead to improved learning outcomes across various subjects.

This study confirms that the integration of AR technology in education not only increases students' interest in the learning process but also encourages the development of analytical skills that are essential for future academic success. Furthermore, these results support the idea that AR implementation can be an effective strategy to encourage student engagement in the classroom, especially in the context of physical education, where motivation and active participation are often major challenges.

Increasing student creativity in the Industry 4.0 era is important to implement through Augmented Reality (AR). They highlighted that AR can help visualize abstract concepts for better understanding and foster critical and creative thinking among students. The use of AR in educational settings can help create a more engaging and effective learning environment (Hsiao et al., 2012). As research has been conducted by António Faria with the title "Augmented reality and teaching strategies in the study of volcanism in elementary and secondary schools" which states that the use of AR in conjunction with traditional instruction does not improve student learning outcomes about volcanism compared to using AR alone.Focusing on the development of interactive flipbooks for early childhood education, elementary, and secondary school students, they emphasized the importance of innovative learning tools such as interactive flipbooks to improve literacy skills and engage students in learning. This study aims to analyze the feasibility and effectiveness of using interactive flipbooks on various levels of education (Nielsen et al., 2016). It develops AR applications for physics education to improve learning motivation. Likewise, the Influence of Augmented Reality Media on Learning Motivation (Saidin et al., 2015). Studies have shown that AR, VR, and MR have a positive or somewhat positive impact on learning outcomes. Highlighting the use of interactive and current learning media to improve student motivation. In addition, Augmented Reality as a 3D Interactive Learning Media (Ebadi & Ashrafabadi,

2022) emphasizes the role of AR in enhancing learning motivation among digital native students. Overall, the literature suggests that Augmented Reality can be a valuable tool in enhancing learning motivation in physical education (Franke et al., 2021). By incorporating AR technology into educational practices, educators can create more engaging and interactive learning experiences for students, ultimately leading to improved motivation and learning outcomes (Gholizadeh & Rahimi, 2023; Harley et al., 2023).

Augmented Reality (AR) is increasingly recognized as a technology that has the potential to enhance learning motivation in various educational settings (Ma, 2019) developed the Ecosystems Augmented Reality Learning System (EARLS) and compared with traditional teaching methods by highlighting the importance of exploring new approaches in education (Kann et al., 2022) identified image-based AR and location-based AR as the main approaches in science education are suggesting future research directions in utilizing AR technology. Saidin et al. (2015) emphasized the need for technology to promote critical thinking and metacognition to avoid passive learning. processes. This review paper underlines the importance of considering the impact of AR on learning outcomes (Liao & Kuo, 2020), the researchers conduct a study on students' cognitive load, motivation, and attitude towards reading AR books and highlight the relationship between these factors on learning performance (Gholizadeh & Rahimi, 2023), the writer discusses the transformative potential of AR and Virtual Reality (VR) in education, highlighting the benefits of integrating these tools into educational environments (Ramos & Júnior, 2024). The research focuses on integrating AR technology with game-based learning to enhance motivation and effectiveness in learning English vocabulary, showcasing the potential of AR in engaging learners (Chen & Zhao, 2022). The researchers investigate the educational potential of AR technology from the perspective of instructional designers and practitioners, providing insights into the experience of utilizing AR in an Educational context (Silén et al., 2022), the writer conducts a survey on nursing students' perceptions of AR in biomedical education, demonstrating the positive impact of AR in improving the quality of Education (Harley et al., 2023), the research explores the use of AR to enhance learning motivation in cultural heritage studies, highlighting the role of AR in engaging students in learning cultural topics (Dinh et al., 2023). Overall, the literature suggests that AR has the potential to enhance learning motivation across a range of educational domains, including science, language learning, and cultural heritage studies. By leveraging the interactive and immersive nature of AR technology, educators can create engaging learning experiences that enhance student motivation and learning outcomes. This study has a number of shortcomings, including the database's limits and the inability to further analyze the publications' content. Consequently, it is advised that more study be done using a wider range of data sources and delving deeper into the publications' content.

In conclusion, this study shows that AR can significantly enhance motivation in Physical Education. The integration of AR technology offers a promising avenue for enhancing and transforming physical education and achieving better succesful student engagement. The practical recommendations derived from this research can guide the effective implementation of AR in physical education, contributing to the ongoing development of innovative teaching practices that can lead to forming students' motivation in their study.

Given the promising results, suggests conducting longitudinal studies to determine the long-term impact of AR on motivation and engagement over time. Studies could investigate the integration of AR with other emerging technologies, such as artificial intelligence, to further enhance personalized learning experiences that can be used for different needs. Additionally, research should focus on integrating AR with other emerging technologies, to ensure wider adoption and impact.

The practical ramifications of the study's findings are noteworthy for educators and policymakers. By combining AR into physical education curricula, schools can create more engaging and interactive learning environments that cater to the diverse needs of students. The tailored feedback and support provided through AR can particularly benefit students who struggle with traditional physical education methods, thereby promoting inclusivity and equal learning opportunities.

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Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

Not applicable.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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Authors' Contributions

All authors equally contributed to this study.

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