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The Influence of Augmented Reality Technology Models on Floor Exercise Movement Skills in Junior High School Students

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Abstract. The achievement of a movement learning process will run well and maximally if it includes the influence of new media or teaching and is accompanied by appropriate technology. The aim of this research is to find out the effectiveness of Augmented Reality (AR) in floor exercise. This research method uses an experimental approach with a randomized control group pretest and posttest design. The subjects in this study consisted of 10 children in each control and experimental group, making a total of 20 children aged 13-14 years. The results of this research show an average value of 40.90 in the control group and 100.50 in the experimental group. It can be concluded that there was an increase in floor exercise movement skills for front rolls and back rolls in both groups by 59.6%. In the paired samples test, the Sig (2-tailed) value was $0.000 < 0.005$, indicating significant differences in floor exercise skills between the control and experimental groups. This research demonstrates the effectiveness of AR models in improving floor exercise skills. The novelty of this research lies in its application of AR technology in physical education, which has not been extensively explored. The implications of this study suggest that AR technology can significantly enhance learning experiences and outcomes in physical education, providing a valuable tool for educators and students alike.

Key words: augmented reality, floor exercise, movement skills, physical education, educational technology

Abstract in Indonesia. Ketercapaian sebuah proses pembelajaran gerak akan berjalan dengan baik dan maksimal jika di dalamnya terdapat pengaruh media atau pengajaran yang baru serta disertai dengan teknologi yang tepat guna. Tujuan penelitian ini adalah untuk mengetahui efektivitas Augmented Reality (AR) dalam senam lantai. Metode penelitian ini menggunakan pendekatan eksperimental dengan desain kelompok kontrol acak pretest dan posttest. Subjek dalam penelitian ini terdiri dari 10 anak di setiap kelompok kontrol dan eksperimen, dengan total 20 anak berusia 13-14 tahun. Hasil penelitian ini menunjukkan nilai rata-rata sebesar 40,90 pada kelompok kontrol dan 100,50 pada kelompok eksperimen. Dapat disimpulkan bahwa terdapat peningkatan keterampilan gerak senam lantai untuk guling depan dan guling belakang di kedua kelompok sebesar 59,6%. Pada uji sampel berpasangan, nilai Sig (2-tailed) sebesar $0,000 < 0,005$, yang menunjukkan adanya perbedaan signifikan dalam keterampilan senam lantai antara kelompok kontrol dan eksperimen. Penelitian ini menunjukkan efektivitas model AR dalam meningkatkan keterampilan senam lantai. Kebaruan dari penelitian ini terletak pada penerapan teknologi AR dalam pendidikan jasmani, yang belum banyak dieksplorasi. Implikasi dari penelitian ini menunjukkan bahwa teknologi AR dapat secara signifikan meningkatkan pengalaman dan hasil belajar dalam pendidikan jasmani, memberikan alat yang berharga bagi pendidik dan siswa.

Kata Kunci: realitas tertambah, senam lantai, keterampilan gerak, pendidikan jasmani, teknologi pendidikan

INTRODUCTION

Education has always been a necessity that must be owned by every individual. With education, humans could interact with their environment and increase their knowledge and skills in broader and better directions (Klochko et al., 2020; Moreno-Guerrero et al., 2020; Rassy & Mokmin, 2023; Ruiz-Ariza et al., 2018; Ziagkas et al., 2020). Within the scope of education, the teaching and learning process, or PBM (Proses Belajar Mengajar), was an inseparable and interrelated component. PBM represented a series of interactions between teachers and students aimed at achieving the desired learning objectives. Physical Education and Health were subjects that included various types of physical activity learning

materials, one of which was floor exercise. Floor exercise, characterized by tumbling movements that utilized various forms of flexibility and balance, played a crucial role in physical education (Ariel & Costa, 2015; Cheng, 2021; Xie et al., 2016). It had several benefits, including physical development, such as muscular endurance and cardiac endurance, and the development of motor skills, including improved coordination, agility, balance, and power. Floor gymnastic skills were divided into static and dynamic skills. Static skills included movements that did not change location, such as kayaking, candles, and splits, while dynamic skills involved movements that changed location, such as forward rolls, back rolls, elastic rolls, and cartwheels (Guerrero et al., 2020; Jumareng et al., 2022; Mast, Bosman, Schipper, Diederiks, et al., 2017).

Despite its benefits, floor exercise was often considered unattractive and very difficult for students to perform. Several factors contributed to students' difficulties in learning floor exercise. One significant factor was the teaching methods and models conveyed by teachers, which were not easily understood by students. Additionally, internal factors such as a lack of interest in floor exercise material further complicated the learning process. Learning difficulties were often marked by conditions that arose due to obstacles in achieving learning goals, such as students' abilities to grasp the material and external factors like teachers, learning resources, and environmental influences. Media, as an intermediary, played a vital role in enhancing activity, logical thinking, and problem-solving in the learning process. Learning media could take various forms, including sound, images, animations, and videos. Technological advancements significantly impacted education and societal life, making it essential for everyone to keep up with these developments. One such technological advancement was Augmented Reality (AR), a technology used to display various sketch elements of 3D image objects using markers. AR was known for merging the real and virtual worlds, utilizing markers to project 3D images on smartphones or android devices.

The development of AR in various aspects of physical education, such as pencak silat and floor exercise. However, most of these studies focused on general aspects and did not specifically address the effectiveness of AR in floor exercise material. For instance, research by (Al Rian et al., 2021; Asrori, 2022; Muktiani et al., 2022) primarily emphasized the development of AR in martial arts and general physical activities. Another study by Chang et al., (2020) discussed the use of AR in enhancing motor skills and motivation among elementary school students but did not provide a comprehensive analysis of its impact on floor exercise skills. These research gaps highlighted the need for studies that specifically examined the effectiveness of AR in floor exercise, addressing both the potential benefits and the practical implementation challenges. The existing studies indicated that AR technology could serve as an effective medium in physical education. However, the lack of specific research on its application in floor exercise left a significant gap in the literature.

AR technology, with its ability to merge real and virtual environments, offered a promising solution to the challenges faced in teaching floor exercise. By providing interactive and engaging 3D visualizations, AR could help students better understand and perform complex movements such as forward rolls and back rolls (Baş et al., 2023; Bernate & Fonseca, 2023; Burov O.Y. et al., 2020). The importance of this research lay in its potential to demonstrate the effectiveness of AR in enhancing floor exercise skills, thus providing valuable insights for educators seeking to improve physical education methodologies. The aim of this research was to determine the effectiveness of AR in teaching floor exercise. This study used an experimental approach with a randomized control group pretest and posttest design, involving 10 children in each control and experimental group, totaling 20 children aged 13-14 years. The research was conducted at SMP Negeri 1 Karangploso, with students participating in both pretests and posttests to measure their performance in forward rolls and back rolls. The results showed significant improvements in the experimental group compared to the control group, indicating the positive impact of AR on floor exercise skills.

This research provided clear evidence of the benefits of AR in physical education. The use of AR technology significantly improved students' performance in floor exercises, demonstrating its effectiveness as a teaching tool. The novelty of this research lay in its application of AR specifically in floor exercise, an area that had not been extensively explored before. The implications of this study suggested that AR technology could revolutionize the way physical education was taught, offering new possibilities for enhancing student engagement and learning outcomes. The benefits of this research extended beyond the immediate educational context, highlighting the broader potential of AR technology in various fields. By demonstrating the effectiveness of AR in physical education, this

research contributed to the growing body of knowledge on educational technology and its applications. It also underscored the importance of integrating advanced technologies into teaching methodologies to address the challenges and limitations of traditional approaches.

This research provided valuable insights into the effectiveness of AR in teaching floor exercise, filling a significant gap in the existing literature. The findings underscored the potential of AR technology to enhance physical education, offering a powerful tool for educators to improve student learning outcomes. The study's implications extended to the broader field of educational technology, highlighting the need for continued research and development in this area. The use of AR in physical education represented a significant advancement, demonstrating the importance of leveraging new technologies to enhance teaching and learning experiences. This research not only contributed to the academic understanding of AR's impact on physical education but also offered practical solutions for educators seeking to improve their teaching practices. The results of this study could inform future research and policy decisions, supporting the integration of AR technology into educational curricula to maximize its benefits for students and society.

METHODS

This research employed an experimental approach with a randomized control group pretest and posttest design. The participants in this study consisted of 20 students aged 13-14 years from SMP Negeri 1 Karangploso, Malang Regency, divided into two groups: control and experimental. Each group comprised 10 students. The research aimed to assess the effectiveness of Augmented Reality (AR) technology in enhancing floor exercise skills, specifically focusing on forward rolls and back rolls.

The study commenced with the selection of participants and the formation of the control and experimental groups through random assignment. Initially, both groups underwent a pretest to evaluate their baseline floor exercise skills. The pretest involved performing forward rolls and back rolls, with each participant being required to perform these movements three times. The researchers recorded the best score out of the three attempts for each participant.

Following the pretest, the experimental group received an AR intervention. The AR application, designed to assist with floor exercise skills, was installed on each student's smartphone. The application featured 3D animations and videos demonstrating the correct techniques for performing forward rolls and back rolls. The researchers conducted an orientation session, providing instructions on how to use the AR application. Students were given the freedom to explore the application independently for 10-15 minutes, allowing them to familiarize themselves with the content and practice the movements virtually.

The control group, on the other hand, continued with the traditional teaching methods provided by their physical education teacher. This included warm-up exercises, direct instruction, and practice sessions without the use of AR technology. The control group also performed forward rolls and back rolls three times, with their best scores being recorded for comparison with the experimental group.

The intervention phase lasted for four weeks, during which the experimental group had regular sessions using the AR application alongside their usual physical education classes. The control group continued their regular physical education classes without any additional technological intervention.

After the four-week intervention period, both groups underwent a posttest to evaluate any improvements in their floor exercise skills. The posttest was conducted in the same manner as the pretest, with participants performing forward rolls and back rolls three times, and their best scores being recorded. The data collected from the pretests and posttests were analyzed using IBM SPSS Statistics 26.

The researchers conducted paired samples t-tests to compare the pretest and posttest scores within each group and independent samples t-tests to compare the differences between the control and experimental groups. The results indicated significant improvements in the experimental group's performance, with a notable increase in their scores for both forward rolls and back rolls. The statistical analysis showed that the experimental group, which utilized the AR application, outperformed the control group, demonstrating the effectiveness of AR technology in enhancing floor exercise skills.

RESULTS AND DISCUSSION

Results

The results of this research aimed to evaluate the effectiveness of Augmented Reality (AR) technology in enhancing the floor exercise skills of junior high school students, specifically focusing on forward rolls and back rolls. The study involved 20 students aged 13-14 years from SMP Negeri 1 Karangploso, divided into two groups: a control group and an experimental group, each consisting of 10 students. The evaluation was based on pretest and posttest scores for both groups.

During the pretest phase, both groups performed forward rolls and back rolls, with each student completing these movements three times. The best score from these attempts was recorded for each student. This initial assessment provided baseline data on the students' skills in executing floor exercises.

The experimental group received an intervention using the AR application, which included 3D animations and videos demonstrating the proper techniques for performing forward rolls and back rolls. Students in the experimental group used the AR application regularly during their physical education classes for four weeks. In contrast, the control group continued with traditional teaching methods provided by their physical education teacher without the use of AR technology.

The posttest phase followed the same procedure as the pretest, with students in both groups performing forward rolls and back rolls three times, and the best scores were recorded. The pretest and posttest scores were analyzed using IBM SPSS Statistics 26 to determine any significant differences between the control and experimental groups.

The paired samples statistics in Table 1 show the mean scores, standard deviation, and standard error mean for both the control and experimental groups. The mean score for the control group was 40.90, with a standard deviation of 3.843, while the mean score for the experimental group was 100.50, with a standard deviation of 7.337. This table indicates a substantial increase in the mean scores of the experimental group compared to the control group, suggesting an improvement in floor exercise skills due to the AR intervention.

Table 1. Paired Samples Statistics

Group	Mean	N	Std. Deviation	Std. Error Mean
Control	40.90	10	3.843	1.215
Experimental	100.50	10	7.337	2.320

Table 2 presents the paired samples test results, including the mean difference, standard deviation, standard error mean, confidence intervals, t-value, degrees of freedom (df), and significance (2-tailed) value. The mean difference between the control and experimental groups was -59.600, with a standard deviation of 6.931. The confidence interval ranged from -64.558 to -54.642, with a t-value of -27.191 and a significance level of 0.000. These results indicate a statistically significant difference in the floor exercise skills between the control and experimental groups, confirming the effectiveness of the AR intervention.

Table 2. Paired Samples Test

Pair	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference
Control - Experimental	-59.600	6.931	2.192	-64.558 to -54.642

The experimental group's significant improvement in posttest scores compared to the control group demonstrated that AR technology effectively enhanced students' floor exercise skills. Students in the experimental group showed better performance in executing forward rolls and back rolls, attributed to the interactive and engaging nature of the AR application.

The detailed analysis of the results showed that the AR application helped students understand and perform the floor exercises more effectively. The 3D animations and videos provided visual and interactive learning experiences, making it easier for students to grasp the correct techniques and practice them. This interactive learning approach was more effective than traditional teaching methods, which often lacked engagement and interactive elements.

The findings of this research indicated that AR technology significantly improved the floor exercise skills of junior high school students. The experimental group outperformed the control group in the posttest assessments, demonstrating the effectiveness of AR as a teaching tool in physical education. The results highlighted the potential of AR technology to enhance learning experiences and outcomes, providing a valuable resource for educators seeking to improve their teaching methodologies and student performance in physical education.

These results contributed to the growing body of knowledge on the application of AR technology in education, particularly in physical education. The significant improvement in the experimental group's performance validated the use of AR in teaching complex physical skills, offering new possibilities for enhancing student engagement and learning outcomes. The study provided a strong case for integrating AR technology into physical education curricula, supporting the advancement of innovative teaching practices that leverage modern technology to improve educational experiences.

The research findings underscored the importance of adopting advanced technologies like AR to address the limitations of traditional teaching methods. By providing interactive and engaging learning experiences, AR technology can enhance students' understanding and performance in various subjects, including physical education (Mokmin & Ridzuan, 2022; Saenz et al., 2015; Shin et al., 2021; Yekimov et al., 2023; Yevtuch et al., 2021). The results of this study could inform future research and policy decisions, promoting the widespread adoption of AR technology in education to maximize its benefits for students and educators alike.

Discussion

The results obtained from this research revealed significant insights into the effectiveness of Augmented Reality (AR) technology in enhancing the floor exercise skills of junior high school students. The study, conducted with a sample of 20 students aged 13-14 years from SMP Negeri 1 Karangploso, used a randomized control group pretest and posttest design to measure the impact of AR on students' ability to perform forward rolls and back rolls. The critical analysis of these results, supported by recent literature, demonstrates the novelty, benefits, and broader implications of the research.

The significant difference in the posttest scores between the control and experimental groups provided clear evidence of the effectiveness of AR technology. Table 1 showed that the mean score of the control group was 40.90, while the experimental group, which used the AR application, had a mean score of 100.50. This substantial increase highlighted the enhanced performance of the experimental group. Further analysis in Table 2, which presented the paired samples test results, indicated a mean difference of -59.600 with a significance level of 0.000. These statistical results confirmed that the use of AR significantly improved the floor exercise skills of the students in the experimental group compared to those in the control group.

The in-depth analysis of these findings suggests several reasons for the observed improvements. AR technology provides an interactive and engaging platform for students to learn and practice floor exercises. The 3D animations and videos in the AR application offered a visual and dynamic learning experience, making it easier for students to understand and replicate the movements. This aligns with previous studies that highlighted the benefits of AR in educational settings. For instance, Di Serio et al., (2013) found that AR systems significantly increased student motivation in visual art courses, while Ibáñez et al., (2014) demonstrated that AR could enhance educational effectiveness by providing immersive learning experiences.

The novelty of this research lies in its application of AR technology specifically to floor exercise in physical education, an area that had not been extensively explored before. While AR has been used in various educational contexts, its use in physical education to improve motor skills presents a new dimension of its utility. Primarily focused on AR in theoretical or less physically demanding subjects, making this study unique in its approach and contributions (Stoffová & Zboran, 2023; Wang et al., 2020; Yu, 2022; Zhang & Huang, 2023). By demonstrating the effectiveness of AR in teaching complex physical skills such as forward rolls and back rolls, this research filled a critical gap in the existing literature.

The benefits of this research extend beyond the immediate educational context. For educators, the findings provide a strong case for integrating AR technology into physical education curricula. AR can serve as a powerful tool to enhance student engagement, improve learning outcomes, and make physical

education classes more interactive and enjoyable. For students, the use of AR can make learning physical skills more accessible and less intimidating, potentially increasing their interest and participation in physical activities. This could have long-term benefits for their physical health and fitness.

The implications of this research suggest that AR technology could be applied to other areas of physical education and sports training (Campos-Mesa et al., 2022; Gedera & Zalipour, 2021; Liang et al., 2023; Mast, Bosman, Schipper, & De Vries, 2017; Zhao et al., 2022). The ability of AR to provide real-time feedback, visualize complex movements, and offer personalized instruction could revolutionize how physical skills are taught and learned. This aligns with the findings of Liu et al., (2022), who noted that AR technology had shown promising results in enhancing student and teacher involvement in sports and physical education

The contribution of this research to science and society is significant. By validating the effectiveness of AR in physical education, this study provides a foundation for future research and development in this area. It encourages the exploration of new technological applications to improve educational practices and outcomes. Additionally, the broader adoption of AR technology in education could lead to more personalized and effective learning experiences, benefiting students and educators alike.

CONCLUSION

This research demonstrated that Augmented Reality (AR) technology significantly improved the floor exercise skills of junior high school students, specifically in performing forward rolls and back rolls. The study, which involved a randomized control group pretest and posttest design, revealed a substantial increase in the experimental group's performance compared to the control group. The statistical analysis confirmed the effectiveness of AR, showing that the interactive and engaging nature of the AR application provided a more effective learning platform than traditional methods. This study highlighted the novelty of applying AR in physical education to enhance motor skills, filling a critical gap in existing research. The findings underscored the potential of AR technology to revolutionize physical education by making learning more accessible and enjoyable, ultimately benefiting both students and educators. The implications of this research suggest that AR technology can be broadly adopted in educational settings to improve learning outcomes and engagement. Future research could explore further applications of AR in different areas of physical education and other subjects, continuing to advance the integration of modern technology in teaching practices.

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