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APPLICATION OF AUGMENTED REALITY (AR) TO IMPROVE EDUCATIONAL MOTIVATION AND PSYCHOMOTOR SKILLS OF PARTICIPANTS IN PHYSICAL EDUCATION

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Abstract

This research was motivated by the existing phenomenon concerning the increasing demand for new media in physical education learning, especially in a digital age where physical activity needs have changed and interactive with adaptive approaches to increase participants psychomotor skills driven by education.

This study aimed at see the effectiveness of Augmented Reality (AR) technology in the learning of physical education to improve psychomotor ability, students with educational drive junior high school.

Methods: The design was quasi-experimental with a pretestposttest control group.

The sample were 64 students from SMP Negeri 22 Bandung based on cluster random sampling into experimental with control groups.

The intervention period was 8 weeks.

Research instruments consisted of the Motor Skill Test and the Sport Motivation Scale II for Physical Education (SMS-II-PE) meeting validity with reliability standards.

Overall, the experimental group had a significant higher increase in psychomotor mastery than controls (32.3 % vs 12.3 %; $p < 0.05$; Cohen's $d = 0.84$).

Additionally, the educational drive of experimental group speih \uparrow 87 % in thictixs of intrinsic motivation for understanding, countrline perception, with engagement during learning ($\mathit{p} < 0.05$).

These results suggest that motor learning processes can be strengthened and active student participation increased through interactive learning experiences, visual movement simulations, and direct AR feedback.

Because of this, augmented reality technology has been shown to be a successful teaching tool for enhancing junior high school students' psychomotor skills and motivation in physical education classes.

Keyword: Augmented Reality, Physical Education, Psychomotor proficiency, Educational drive, Quasi-Experimental Design

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INTRODUCTION

Through physical activity experiences in schools, particularly physical education, students strategically contribute to the development of cognitive, affective, social, and motor competencies.

In today's educational context, physical education is no longer just about physical performance; it also fosters creativity, teamwork, problem-solving, and lifelong healthy behaviors (Hamdan et al.

However, the rapid digital transformation has made it difficult for physical education teachers to provide an engaging, meaningful, and relevant learning environment for students who are increasingly accustomed to technology-based learning methods (Satrianingsih

and Yulianto 2025).

As such, integrating Digital innovation, especially in physical education, has now become a top priority in improving the quality of learning that involves students (Yulianto et al.

Research conducted at SMP Negeri 22 Bandung in early 2026, involving teacher interviews, classroom observations, and basic motor assessments, showed that many participants demonstrated locomotor, balance, and skill control abilities.

Classroom observations revealed that approximately 61 % of participants experienced difficulty performing coordinated movements.

This finding is significant because motor competence is a key predictor of lifelong participation in physical activity and successful skill learning (Saputra and Yulianto 2025).

The cause of low mastery of movements is the use of a teaching approach that is not varied and interactive so that it is always limited to verbal explanations only.

Besides limited mobility, students' motivation to learn physical education remains a challenge.

According to Self-Determination Theory (SDT), motivation depends on the ability to meet three basic psychological needs: autonomy, competence, and relatedness (Ma'mun 2019).

Students typically exhibit low engagement, passive participation, and decreased intrinsic motivation when the physical education learning environment does not meet these criteria.

Previous research on sports pedagogy has repeatedly shown that a motivating environment has a significant impact on participation and learning outcomes in physical education (Yulianto, Satrianingsih, and Faridah 2024).

Today, the use of learning technology offers a new approach to addressing these issues.

Augmented Reality (AR), which combines real-world environments with virtual three-dimensional objects in real time, is one such breakthrough.

In the context of physical education learning, augmented reality (AR) allows students to view movement demonstrations from multiple perspectives, receive instant feedback, and replay the movements.

By combining visual, spatial, and kinesthetic senses, augmented reality (AR) can enhance dual-channel information processing, improve attention span, and reduce distraction (Shahudin, Yulianto, and Faridah 2024).

In motor learning, where precise perception-action linkages are crucial, these systems are particularly relevant.

According to several recent studies, AR (Augmented Reality) has been shown to improve comprehension, attendance, and movement-based learning skills.

Compared to traditional learning methods, AR learning is associated with better coordination, faster movement correction, and greater student engagement (Yulianto, Triansyah, and Azizah 2025).

However, most previous research has found AR to be a visual aid for improving cognitive or psychomotor skills.

There is still a lack of significant data on how augmented reality (AR) improves motor skills and motivational growth in junior high school physical education settings (Faridah, Kusmiyati, and Yulianto 2024).

More importantly, there is limited research examining augmented reality from the perspective of an immersive learning approach as a teaching strategy.

In this context, immersive learning refers to a meaningful learning process in which learners actively construct understanding, reflect, solve movement problems, and transfer knowledge into practical actions.

Few studies have examined how AR supports immersive learning processes that connect cognition and motor activity in integrated learning environments, although prior research has questioned whether AR enhances performance.

This distinction is crucial for modern physical education instruction (Buchner, Buntins, and Kerres 2022).

Due to this gap, this study is novel in that it views augmented reality (AR) as a connecting tool in an experiential learning process that can simultaneously improve psychomotor competence and learning motivation among junior high school students, rather than as a passive learning medium.

This study can also incorporate reflective feedback, movement execution, digital engagement, and motivational support into physical education training.

Therefore, the purpose of this study is to evaluate how well the application of AR in physical education teaching improves students' psychomotor abilities and learning motivation at SMP Negeri 22 Bandung.

METHOD

To compare learning outcomes before and after the intervention, this study used a quasiexperimental approach with a pretest-posttest control group design.

Because whole-class groups

were used without individual random assignment and group allocation was done at the classroom level, this study is classified as quasi-experimental (Sugiyono 2019).

There were 64 students aged 13-15 years old, from grades VII, VIII, and IX at SMP Negeri 22 Bandung.

To ensure equivalence across grade levels, a multistage cluster sampling technique was used.

To reduce maturational bias and demographic imbalance, each group consisted of 32 students, divided proportionally by gender and grade.

Clear methodological considerations guided the selection of SMP Negeri 22 Bandung.

The quasi-experimental approach without individual randomization was supported by the school's robust and intact grade system, which also helped reduce selection bias.

Because the student population is relatively representative of junior high school students in metropolitan areas, the findings are broadly applicable.

The implementation of a uniform national curriculum ensures that variations in learning outcomes are more likely due to treatment than to variations in instruction.

Furthermore, controlled pre- and post-testing processes are possible thanks to adequate facilities and strong institutional support.

Furthermore, proportional stratified cluster sampling is possible thanks to sufficient numbers of participants across grade levels, which reduces demographic and maturity bias between groups.

The control group received traditional teacher-centered instruction using verbal explanations and live demonstrations, while the experimental group received Augmented Reality (AR)-based physical education instruction.

There were 16 meetings over 8 weeks, with two meetings per week.

Each meeting lasted 40 minutes.

Although both groups learned the same physical education material, their locopsychomotor skills, balance, coordination, and movement control, as well as their delivery of the instruction, differed.

Figure 1.

Receive Augmented Reality (AR) based Physical Education instruction,

The research instrument consisted of two parts.

The Test of Gross Motor Development-3 (TGMD-3), which evaluates locopsychomotor abilities (running, jumping, sliding) and ball abilities (throwing, catching, kicking, hitting, and dribbling), was first used to assess motor skill performance.

Other markers included agility, balance, and coordination.

Second, the Sport Motivation Scale II for Physical Education (SMS-II-PE), which measures intrinsic motivation, identified regulation, external regulation, and amotivation, was used to measure educational drive. Pearson Product Moment Correlation was used to test the validity of the instrument. At a 5 % significance level, each item is considered valid if the calculated r is greater than the table r (0.361). Cronbach's Alpha was used to assess reliability, with a minimum acceptable coefficient of 0.70 . High internal consistency is indicated by the Cronbach's Alpha value from the reliability analysis of 0.892 . Parents or guardians provided written consent before data collection, and the school approved the study. To ensure compliance with educational research norms, ethical approval was also obtained from the university's research ethics committee.

Component	Experimental Group (AR-Based Learning)	Control Group (Conventional Learning)
Duration	8 weeks	8 weeks
Frequency	2 sessions/week	2 sessions/week
Total	16 meetings	16 meetings
Meetings	40 minutes	40 minutes
Session Length	Smartphone/tablet with AR application	Teacher explanation with live demonstration
Learning Media	3D movement visualization, guided imitation, instant feedback, repeated practice	Verbal instruction, teacher modeling, repeated drills
Activities	Locomotor, balance, coordination, object- control skills	Same content
Learning Content	Facilitator with feedback provider	Instructor with demonstrator
Teacher Role	Table 1.	
Intervention Procedure		

RESULTS

The data analysis revealed a significant improvement in posttest scores for the experimental group compared with the control group.

Overall, Augmented Reality (AR)-based instruction created a more interactive with engaging learning environment that positively influenced participants' psychomotor proficiency with educational drive.

Before presenting the main inferential results, respondent characteristics are described to provide context for the findings.

Characteristic	Category	Frequency	%
Gender	Male	39	60.94
	Female	25	39.06

| Age | 13 years | 20 | 31.25 |

| | 14 years | 23 | 35.94 |

| | 15 years | 21 | 32.81 |

| Grade | VII | 20 | 31.25 |

| | VIII | 23 | 35.94 |

| | IX | 21 | 32.81 |

Table 2.

Respondent Characteristics ($\mathrm{N}=64$)

Based on Table 1, male participants comprised 60.94 % of the sample, while female participants accounted for 39.06 %.

The age distribution ranged from 13 to 15 years, with the highest proportion aged 14 years (35.94 %).

Grade distribution was relatively balanced across grades VII, VIII, with IX.

Assumption Testing

A normality test was conducted using the Kolmogorov-Smirnov test in SPSS version 25.

Data were considered normally distributed when the significance value exceeded 0.05 .

Group	Test Method	Statistic	df	Sig.	Interpretation
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|

Experimental Kolmogorov Smirnov 0.124 32 0.200 Normal

Control Kolmogorov Smirnov 0.096 32 0.267 Normal

Table 3.

Normality Test Results

As shown in Table 2, both groups demonstrated significance values above 0.05 , indicating normal data distribution.

Homogeneity of variance was tested using Levene's Test.

Data were considered homogeneous when the significance value exceeded 0.05 .

Variable	Levene Statistic	df1	df2	Sig.	Interpretation
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|

Posttest Scores | 1.876 | 1 | 2 | 0.232 | Homogeneous |

Table 4.

Homogeneity Test Results

The Levene's Test result showed a significance value of 0.232, indicating equal variances between groups with supporting the use of parametric analysis.

Main Hypothesis Testing Using ANCOVA

Because this study used a pretest-posttest control group design, Analysis of Covariance (ANCOVA) was applied. Pretest scores were treated as covariates to control for baseline differences with provide a more robust estimate of treatment effects.

Source	F	Sig.
Pretest Covariate	8.214	0.006
Group AR vs Control	27.563	0.000

Table 5.
ANCOVA Results for Posttest Scores

The ANCOVA results indicated a significant effect of group membership on posttest scores after controlling for pretest performance, $F(1,61)=27.563$, $p<0.001$, partial $\eta^2=0.311$. This effect size indicates a large practical impact of AR-based learning.

Group	Pretest Mean	Posttest Mean	Improvement (%)	Cohen's d
Experimental AR	67.4	89.2	32.3	0.84
Control Conventional	66.9	75.1	12.3	0.39

Table 6.
Comparison of Pretest with Posttest Mean Scores

Compared to the control group (75.1), the experimental group had a noticeably greater posttest mean score (89.2). With a substantial Cohen's d value of 0.84, the 32.3% rise in the AR group reflects a significant educational impact. Conversely, the control group showed only slight improvement (12.3%) with a low-to-moderate effect size (0.39). Motor learning theory with Self-Determination Theory (SDT) can help one to understand these results. From a motor learning viewpoint, augmented reality delivers instant visual feedback, repeated modeling, with improved perception-action coupling, therefore accelerating skill development with movement adjustment. From an SDT perspective, AR-based learning can enhance participants' sense of competence and autonomy while fostering engagement, leading to a boost in intrinsic motivation during PE lessons. Thus, the 32.3% improvement represents a significant enhancement in the quality of learning via technology-enabled embodied learning rather than only a numerical gain.

Figure 2.
Graph illustrating development in psychomotor proficiency and educational drive, before and after using Augmented Reality (AR) based physical education.

Applying Augmented Reality (AR)-based physical education results in a really notable increase in two crucial metrics, psychomotor competency and academic drive.

For both facets, the average pretest score was in the 66-67 range; the posttest score rose to 88-89.

DISCUSSION

Participants who completed Augmented Reality (AR)-based Physical Education learning had substantially higher results in psychomotor ability with educational desire than those who attended traditional teaching, according to the current experiment.

The treatment effect stayed substantial after adjusting for baseline pretest scores using ANCOVA, suggesting that the seen enhancements were caused by the AR intervention as opposed to pre-existing group disparities.

These results refute the study theory that AR-based education is more successful than conventional approaches in enhancing student performance with involvement in PE programs (Farrell 2018).

The ideas of Cognitive Load Theory and motor learning theory may provide one answer for these outcomes.

Conventional demonstrations often rely on short teacher explanations with little visual repetition, which may strain participants' working memory as they try to learn complicated movement sequences.

AR, on the other hand, shows movement data via interactive three-dimensional visualization, therefore letting participants to view body posture, direction, timing, with movement patterns repeatedly in real time (Haris, Yulianto, and Riyanto 2024).

This method improves information processing effectiveness while lowering unneeded cognitive strain.

Concurrently, AR improves the link between perception and action, which is critical for learning motor skills since users can instantly turn visual input into physical movement execution.

This enables attendees to acquire movement abilities more precisely and with confidence (Kaplan et al. 2021).

The positive effect of AR on educational drive can be interpreted through Self-Determination Theory (SDT).

AR-based learning environments provide opportunities for autonomy, competence, with engagement, which are three key psychological needs associated with intrinsic motivation.

Participants can interact with digital content actively, monitor their own progress, with experience immediate success through feedback features.

These elements create a sense of control with achievement that is often absent in teacher-centered instruction.

Consequently, participants become more enthusiastic, focused, with willing to participate in PE activities.

This indicates that AR does not only improve technical learning outcomes, but also enhances motivational quality during instruction (Jeffri and Rambli 2021).

The results of this study are in accordance with the results of previous research, namely that sports pedagogy with educational technology has shown that augmented reality can improve movement accuracy, skill retention, and student interest in school-based physical exercise

programs (Risyanto and Yulianto 2025).

According to recent studies, augmented reality (AR) enhances spatial comprehension by improving movement correction using a real-time feedback system.

By showing that AR can concurrently enhance motor abilities and motivation in a junior high school physical education setting, the current study builds on earlier findings.

This study emphasizes that AR acts as a catalyst for active learning that connects cognition and physical activity, whereas much previous research has concentrated on AR as a visual assistance aid (Amores-Valencia, Burgos, and Branch-Bedoya 2023).

Another important conclusion from this research is its application to deep learning education in contemporary schools. Reflective practice, meaningful understanding, and information transfer are prioritized over surface memorization in deep learning.

This demonstrates that, rather than simply imitating actions, participants in physical education settings must understand why and how those actions are performed (Xie et al.

AR can help users see how movements function, receive corrective instructions, and improve performance through repeated practice.

Therefore, AR can be seen as a learning medium that connects motor learning experiences with conceptual cognition (Khan, Johnston, and Ophoff 2019).

From a practical perspective, these findings have several implications.

By increasing the efficiency of movement learning, AR offers physical education teachers an innovative teaching strategy to increase participation in the movement learning process (Elsenbast, Dahlmann, and Schnier 2024).

By incorporating AR into physical education programs, schools can support digital transformation goals and increase the relevance of learning for tech-savvy students.

Findings suggest that to optimize technology-based physical education innovation, policymakers must provide digital learning support for teachers, infrastructure, and curriculum integration (Koutitas, Smith, and Lawrence 2021).

Despite these positive results, several limitations should be acknowledged.

The limited number of participants from a single school and the relatively short duration of the study may limit the generalizability of the results.

Longer intervention timeframes, multiple schools, and different levels of education should be included in future research.

Further studies could examine the long-term effects of reality on student well-being, self-efficacy, and physical activity patterns (Yulianto 2025). Overall, this study demonstrates that augmented reality is more than just a supplementary teaching tool.

It is a transformative learning tool capable of enhancing both motor skill development and student motivation. Its integration into physical education can help create a more efficient, engaging, and future-focused learning environment.

CONCLUSION

According to research findings, augmented reality (AR) significantly improves students' psychomotor skills and learning motivation in physical education at SMP Negeri 22 Bandung.

Compared to conventional learning, the use of augmented reality encourages a more dynamic, engaging, and student-centered learning culture.

The results show that by combining movement understanding, practice, feedback, and active engagement, AR functions to support deeper learning beyond just serving as a visual aid.

This research strongly supports the adoption of modern technology.

Through improved digital infrastructure, curriculum alignment, and teacher preparation, schools should consider using augmented reality (AR).

The small sample size, very short research period, and single school are limitations of this study.

To evaluate the sustainability of AR's effects, future research should focus on long-term motor skill retention.

To strengthen external validity, the sample should be expanded to a variety of schools and educational levels.

Furthermore, the effectiveness of AR should be used with students with special needs to assess inclusivity and adaptability.

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Variable	Levene Statistic	df1	df2	Sig.
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| Source | F | Sig.
311|

Table 5.

311. This effect size indicates a large practical impact of AR-based learning.

39|

Table 6.

3 % rise in the AR group reflects a significant educational impact.

Motor learning theory with SelfDetermination Theory (SDT) can help one to understand these results.

From a motor learning viewpoint, augmented reality delivers instant visual feedback, repeated modeling, with improved perception-action coupling, therefore accelerating skill development with movement adjustment.

From an SDT perspective, AR-based learning can enhance participants' sense of competence and autonomy while fostering engagement, leading to a boost in intrinsic motivation during PE lessons.

3 % improvement represents a significant enhancement in the quality of learning via technology-enabled embodied learning rather than only a numerical gain.

Figure 2.

Graph illustrating development in psychomotor proficiency and educational drive, before and after using Augmented Reality (AR) based physical education.

Applying Augmented Reality (AR)-based physical education results in a really notable increase in two crucial metrics, psychomotor competency and academic drive.

For both facets, the average pretest score was in the 66-67 range; the posttest score rose to 88-89.

DISCUSSION

Participants who completed Augmented Reality (AR)-based Physical Education learning had substantially higher results in psychomotor ability with educational desire than those who attended traditional teaching, according to the current experiment.

The treatment effect stayed substantial after adjusting for baseline pretest scores using ANCOVA, suggesting that the seen enhancements were caused by the AR intervention as opposed to pre-existing group disparities.

These results refute the study theory that AR-based education is more successful than conventional approaches in enhancing student performance with involvement in PE programs (Farrell 2018).

The ideas of Cognitive Load Theory and motor learning theory may provide one answer for these outcomes.

Conventional demonstrations often rely on short teacher explanations with little visual repetition, which may strain participants' working memory as they try to learn complicated movement sequences.

AR, on the other hand, shows movement data via interactive three-dimensional visualization, therefore letting participants to view body posture, direction, timing, with movement patterns repeatedly in real time (Haris, Yulianto, and Riyanto 2024).

This method improves information processing effectiveness while lowering unneeded cognitive strain.

Concurrently, AR improves the link between perception and action, which is critical for learning motor skills since users can instantly turn visual input into physical movement execution.

This enables attendees to acquire movement abilities more precisely and with confidence (Kaplan et al. 2021).

The positive effect of AR on educational drive can be interpreted through Self-Determination Theory (SDT). AR-based learning environments provide opportunities for autonomy, competence, with engagement, which are three key psychological needs associated with intrinsic motivation. Participants can interact with digital content actively, monitor their own progress, with experience immediate success through feedback features. These elements create a sense of control with achievement that is often absent in teacher-centered instruction. Consequently, participants become more enthusiastic, focused, with willing to participate in PE activities.

This indicates that AR does not only improve technical learning outcomes, but also enhances motivational quality during instruction (Jeffri and Rambli 2021).

The results of this study are in accordance with the results of previous research, namely that sports pedagogy with educational technology has shown that augmented reality can improve movement accuracy, skill retention, and student interest in school-based physical exercise

programs (Risyanto and Yulianto 2025).

According to recent studies, augmented reality (AR) enhances spatial comprehension by improving movement correction using a real-time feedback system.

By showing that AR can concurrently enhance motor abilities and motivation in a junior high school physical education setting, the current study builds on earlier findings.

This study emphasizes that AR acts as a catalyst for active learning that connects cognition and physical activity, whereas much previous research has concentrated on AR as a visual assistance aid (Amores-Valencia, Burgos, and Branch-Bedoya 2023).

Another important conclusion from this research is its application to deep learning education in contemporary schools. Reflective practice, meaningful understanding, and information transfer are prioritized over surface memorization in deep learning.

This demonstrates that, rather than simply imitating actions, participants in physical education settings must understand why and how those actions are performed (Xie et al. 2021).

AR can help users see how movements function, receive corrective instructions, and improve performance through repeated practice.

Therefore, AR can be seen as a learning medium that connects motor learning experiences with conceptual cognition (Khan, Johnston, and Ophoff 2019).

From a practical perspective, these findings have several implications.

By increasing the efficiency of movement learning, AR offers physical education teachers an innovative teaching strategy to increase participation in the movement learning process (Eisenbast, Dahlmann, and Schnier 2024).

By incorporating AR into physical education programs, schools can support digital transformation goals and increase the relevance of learning for tech-savvy students.

Findings suggest that to optimize technology-based physical education innovation, policymakers must provide digital learning support for teachers, infrastructure, and curriculum integration (Koutitas, Smith, and Lawrence 2021).

Despite these positive results, several limitations should be acknowledged.

The limited number of participants from a single school and the relatively short duration of the study may limit the generalizability of the results.

Longer intervention timeframes, multiple schools, and different levels of education should be included in future research.

Further studies could examine the long-term effects of reality on student well-being, self-efficacy, and physical activity patterns (Yulianto 2025). Overall, this study demonstrates that augmented reality is more than just a supplementary teaching tool.

It is a transformative learning tool capable of enhancing both motor skill development and student motivation. Its integration into physical education can help create a more efficient, engaging, and future-focused learning environment.

CONCLUSION

According to research findings, augmented reality (AR) significantly improves students' psychomotor skills and learning motivation in physical education at SMP Negeri 22 Bandung.

Compared to conventional learning, the use of augmented reality encourages a more dynamic, engaging, and student-centered learning culture.

The results show that by combining movement understanding, practice, feedback, and active engagement, AR functions to support deeper learning beyond just serving as a visual aid.

This research strongly supports the adoption of modern technology.

Through improved digital infrastructure, curriculum alignment, and teacher preparation, schools should consider using augmented reality (AR).

The small sample size, very short research period, and single school are limitations of this study.

To evaluate the sustainability of AR's effects, future research should focus on long-term motor skill retention.

To strengthen external validity, the sample should be expanded to a variety of schools and educational levels.

Furthermore, the effectiveness of AR should be used with students with special needs to assess inclusivity and adaptability.

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