

# Enhancing Primary School Students' Motor Skills through Interactive Digital Learning Media: A Quasi-Experimental Study in Physical Education

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## ABSTRACT

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The integration of digital technology in education has opened new opportunities to enhance student engagement and learning outcomes. In physical education, interactive digital learning media offers potential to improve motor skills among primary school students, a critical developmental aspect often overlooked in technology-based learning. This quasi-experimental study investigated the effect of interactive digital learning media on the motor skills of fourth- and fifth-grade students in a public elementary school in Majalengka Regency, Indonesia. A total of 60 students were purposively selected and divided equally into experimental (n=30) and control (n=30) groups. The experimental group used interactive digital media, while the control group received conventional instruction. Motor skills were measured through agility, coordination, and balance tests. Additional data were collected via questionnaires and teacher-student interviews. Independent t-tests were used for statistical analysis, and thematic analysis was applied to qualitative data. The experimental group showed significantly higher improvement in all motor skill areas ( $p < 0.05$ ) compared to the control group. Thematic findings revealed that students experienced greater motivation, enjoyment, and understanding through digital simulations and feedback. Teachers also reported improved engagement and ease in delivering motor skill instruction. The findings confirm that interactive digital media can effectively enhance motor skills and learning motivation in primary physical education, aligning with multimedia learning theory. These results support integrating technology into physical education to promote cognitive, affective, and psychomotor development.

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## 1. INTRODUCTION

The development of digital technology in the modern era has had a major impact on various aspects of life, including education. Technology-based innovations now make the learning process more interesting, interactive, and adaptive to the needs of students. One field that has begun to transform with the use of digital technology is physical education (PJOK). Learning activities that were previously synonymous with physical activities in the field can now be integrated with various interactive digital learning media that provide simulations, motion visualisations, and direct feedback on student activities. For example, (Gao & Chen, 2020) found through meta-analysis that digital physical education applications have a positive impact on increasing students' physical activity and fitness. Similarly, (Lee & Kim, 2022) reported that virtual reality-based platforms can significantly improve children's motivation and motor skills.

Interactive digital learning media is a form of innovation that combines technology with two-way interactive learning activities. Unlike conventional media such as books or ordinary videos, this media allows students to be directly involved in the learning process through activities such as clicking, swiping, performing motion simulations, or receiving automatic responses from the system. The integration of technology in physical education learning in primary schools has the potential to increase student engagement and the effectiveness of the learning process (Daly & Weaver, 2021). Relevant forms of interactive media for physical learning include animation-based tutorial videos, digital physical exercise simulations, motion-based educational games, and augmented reality (AR) applications that can display body movements in three dimensions. In line with Mayer's Cognitive Theory of Multimedia Learning (2020), multimedia-based learning that combines visual, verbal, and kinesthetic elements simultaneously can significantly increase student motivation and understanding, as it enables an active, meaningful, and sustainable learning process. Media designed by harmoniously integrating short texts, audio narration, and movement demonstrations allows students to process motor and conceptual information simultaneously without cognitive overload. Thus, the application of interactive digital media in physical education has the potential to increase students' motivation, movement understanding, and motor skills in a more in-depth and sustainable manner, as long as the media design aligns with multimedia learning principles that emphasize active and meaningful learning. This is supported by research findings (Smith & Baker, 2023) which suggest that interactive game-based exercises can significantly improve the fitness and engagement of primary school students compared to traditional methods.

Physical education itself plays a central role in shaping children's character and developing their motor skills. According to the Ministry of Education and Culture (2020), the main objectives of physical education at the primary school level are to develop physical fitness, motor skills, and social and sporting attitudes through planned and enjoyable physical activities. The use of augmented reality technology in sports education can strengthen children's basic motor learning outcomes through three-dimensional motion visualisation (Johnson & Green, 2019). However, the reality in the field, including in several primary schools in Majalengka Regency, shows that the implementation of PJOK learning still faces obstacles. Preliminary interviews with PJOK teachers revealed that limited sports facilities, a lack of variety in learning methods, and minimal integration of technology hinder optimal learning. As a result, students tend to get bored quickly and are less motivated to participate in physical activities.

In this context, the use of interactive digital learning media is considered an innovative solution to overcome these limitations (Azzahrah, Budiman, Haryanti, & Mahpudin, 2022; Budiman, Priyono, & Rustandi, 2024). The use of technology allows teachers to present more interesting and varied lessons and gives students the opportunity to learn through experiential learning. For example, game-based exercise applications (fitness games) or interactive videos can help students better understand body movement patterns through a combination of visuals, audio, and real-time instructions. The use of interactive digital learning media in physical education has been proven to increase the effectiveness of the learning process for primary school students. According to (Liang, Chen, & Xu, 2023), the integration of augmented reality in basic movement learning can help students understand techniques

and movement patterns more accurately through three-dimensional visual displays and direct feedback. Thus, physical education is no longer just physical activity on the field, but also a learning process that stimulates creativity, self-reflection, and motivation to learn. In line with this, (Gonçalves et al., 2024) found that motion-based games (exergames) not only improve motor skills but also foster motivation and active participation among students during learning. In fact, (Eng, 2022) emphasises that physical digital games can change students' perceptions of physical activity from a routine activity to a fun and challenging one.

Initial observations at an elementary school in Majalengka Regency show that the use of interactive digital media in physical education is still rarely implemented. Teachers generally rely on manual demonstration methods without technological support, making it difficult for students to understand the correct movement techniques. Through the application of digital media, teachers can demonstrate movements with high precision, display simulations from various angles, and provide opportunities for students to practise independently both at school and at home. This approach has great potential in improving students' motor skills, especially in terms of coordination, balance, and movement accuracy. Furthermore, (V A Goodyear, Armour, & Casey, 2023) adds that the application of digital technology in physical education strengthens social and collaborative aspects, as students interact more actively with both the media and their peers. In general, these findings support the view that digital innovation has great potential in increasing students' cognitive, affective, and motor engagement in physical education.

Motor skills are a person's ability to control and coordinate body movements effectively and efficiently, which are divided into two main categories: gross motor skills (such as running, jumping, and throwing) and fine motor skills (such as catching and controlling small objects) (Khadijah & Amelia, 2020). In physical education, both types of skills need to be developed in a balanced manner so that students can achieve optimal movement abilities in accordance with their stage of development. Interactive digital media has great potential to support the development of these skills because it can provide visual stimuli, automatic corrections, and direct feedback on students' movements (Ali et al., 2024). For example, motion tracking-based exercise applications can detect the speed and accuracy of body position, then provide real-time evaluation of student performance (Budiman, 2024).

Several previous studies have highlighted the potential of utilizing digital technology in Physical Education, Sports, and Health (PJOK) learning, but have shown inconsistent findings. Al Ardha (2022) emphasized that digital learning innovations, including the use of cutting-edge technologies such as the metaverse, provide opportunities for increased student engagement in PJOK learning. However, its implementation still faces challenges related to infrastructure readiness and teacher competency, so its impact on improving students' motor skills has not been conclusively measured. Meanwhile, Ali et al. (2024) comprehensively described the development of interactive learning media in elementary schools and demonstrated the potential for increasing learning motivation. However, this study focused more on the design and development aspects of the media than on empirical evidence of its effectiveness on specific physical education learning outcomes. On the other hand, Azzahrah et al. (2022) reported that the use of Android-based applications can increase student learning motivation, but these findings did not directly confirm improvements in motor skills, leaving a gap in research regarding the effectiveness of interactive digital media on psychomotor PJOK learning outcomes. These inconsistent results indicate the need for further research that empirically tests the influence of interactive digital learning media on students' motor skills in the context of physical education learning.

For primary school students in Majalengka, the application of interactive digital learning media not only helps them understand movement concepts more concretely, but also improves their concentration, body coordination, and confidence in physical activities. Thus, the integration of digital technology in physical education can be a strategic approach to improving the quality of education, particularly in the development of children's motor skills.

Based on this background, this study seeks to answer several main questions, namely: (1) to what extent does the use of interactive digital learning media influence the improvement of motor skills in

primary school students in Majalengka Regency, (2) how do students respond to the application of digital media in physical education learning, and (3) how do teachers view the effectiveness of interactive digital media in improving students' movement skills and motivation. The objectives of this study are to analyse the influence of interactive digital media on students' motor skills, describe students' responses to its application, and describe teachers' perceptions of the effectiveness of this media innovation in the context of physical education in primary schools. The results of this study are expected to provide empirical contributions to the development of more innovative, participatory, and relevant technology-based physical education learning strategies for 21st-century learning needs.

## 2. METHODS

This study employed a quantitative approach with a quasi-experimental design, involving two different treatment groups to determine the effect of interactive digital learning media on elementary school students' motor skills. This approach was chosen because it allowed researchers to objectively measure changes in learning outcomes based on the treatment provided. Furthermore, this study utilized descriptive interviews as supporting data to strengthen the quantitative findings and provide a more in-depth overview of student and teacher experiences in implementing interactive digital learning media during physical education learning.

The population in this study was all fourth and fifth-grade students at a public elementary school in Majalengka Regency, totaling 120 students. From this population, researchers used a purposive sampling technique to select 60 students as the research sample. The sample was divided into two groups: an experimental group of 30 students who learned using interactive digital media, and a control group of 30 students who learned using conventional methods. Group selection was based on equivalence of initial abilities, relatively homogeneous classroom conditions, and student readiness for physical education learning activities. Inclusion criteria included: (1) active students in grades IV and V, (2) no physical impairments or medical conditions that hinder physical activity, and (3) written permission from a parent or guardian was obtained. Exclusion criteria included students who did not participate in the entire learning process or were absent from any of the measurement sessions. Sample homogeneity was confirmed through the results of the motor skills pretest, which showed no significant differences between the experimental and control groups before treatment. Based on these criteria, 60 students were selected as the study sample, divided into two groups of 30 students each. Group assignments were conducted in parallel classes within the same school, with one class designated as the experimental group and the other as the control group. This assignment was made without individual randomization to maintain class integrity and the stability of the learning process, thus categorizing this study as a quasi-experimental study. The experimental group participated in physical education lessons using interactive digital learning media, while the control group participated in lessons using conventional methods using direct teacher instruction.

The research instruments consisted of a motor skills test, a student perception questionnaire, and interview guidelines for teachers and students. The motor skills test measured three main aspects: agility (shuttle run), coordination (throwing and catching a ball), and balance (standing on one leg). A questionnaire was used to assess students' motivation and interest in interactive digital media-based learning, and interviews explored teachers' perspectives and students' experiences in its implementation. The research was conducted in three stages: preparation (designing and testing the interactive digital media), implementation for four weeks in two groups (experimental and control) using the same material, and evaluation through tests, questionnaires, and interviews. Quantitative data were analyzed using an independent t-test to examine differences in results between the two groups, while qualitative data were analyzed descriptively thematically to identify themes such as media effectiveness, student engagement, and impact on learning motivation. The results provided a comprehensive overview of the influence of interactive digital media on physical education learning in elementary schools.

The research was conducted in three stages: (1) preparation, including the design and testing of the interactive digital learning media; (2) implementation, which lasted four weeks with the same learning material for both groups but with different media treatments; and (3) evaluation, through posttests, questionnaires, and interviews. Quantitative data were analyzed using SPSS version 26. Statistical analysis was performed using an independent t-test to identify differences in motor skill outcomes between the experimental and control groups. In addition to statistical significance, this study also calculated the effect size (Cohen's *d*) to determine the magnitude of the influence of interactive digital learning media. This study has obtained ethical approval from the school and written permission from the students' parents or guardians. All participants were given an explanation of the research objectives, procedures, and guaranteed data confidentiality, and student participation was voluntary without coercion.

### 3. FINDINGS AND DISCUSSION

This section presents the results of the study and a discussion of the effect of using interactive digital learning media on improving the motor skills of primary school students in Majalengka Regency. The analysis was conducted quantitatively through motor skill tests covering three main indicators, namely agility, coordination, and balance, and was supported by qualitative data from interviews with teachers and students to strengthen the interpretation of the findings. The discussion focused on comparing the results between the experimental group that used interactive digital media and the control group that followed conventional learning. Through this analysis, a comprehensive picture was obtained of the extent to which digital media innovation plays a role in improving students' motor skills, as well as how teachers and students perceive the effectiveness of its application.

In addition to presenting statistical data from t-tests, this section also outlines descriptive findings that describe students' responses, learning experiences, and motivation during physical education learning activities. Thus, this discussion not only explains the numerical measurement results but also interprets their meaning in the context of pedagogy and 21st-century learning innovation, particularly in efforts to integrate digital technology into physical education in primary schools. Before testing the hypothesis, the results of the descriptive analysis were presented to illustrate the trends in the data from the students' motor skills tests in both groups, namely the experimental group that used interactive digital learning media and the control group that followed conventional learning. The descriptive analysis included the mean, standard deviation (SD), and minimum and maximum values for each aspect of motor skills.

**Table 1.** Statistical Description of Motor Skills Test Results

Motor Skills Aspect	Group	N	Mean	SD	Min	Max
Agility (Shuttle Run)	Experimental	30	85.6	5.2	75	95
	Control	30	74.3	6.1	62	86
Coordination (Ball Throw and Catch)	Experimental	30	83.2	5.5	70	93
	Control	30	75.1	5.9	64	86
Balance (One-Legged Stand)	Experimental	30	82.5	4.7	74	90
	Control	30	76.4	5.0	65	86

Based on Table 1, it can be seen that the average motor skills scores of students in the experimental group were consistently higher than those in the control group in all aspects measured. In terms of agility, the experimental group had an average of 85.6 with a standard deviation of 5.2, while the control group only had an average of 74.3 with a standard deviation of 6.1. This difference of 11.3 points indicates a significant improvement in agility after the implementation of interactive digital learning media. In terms of coordination, the experimental group achieved an average of 83.2 with a standard deviation of 5.5, while the control group had an average of 75.1 with a standard deviation of 5.9. This

shows that interactive digital media helps students understand and coordinate body movements better through attractive visualisations and motion simulations.

Meanwhile, in terms of balance, the experimental group obtained an average of 82.5 with a standard deviation of 4.7, while the control group only achieved an average of 76.4 with a standard deviation of 5.0. These findings indicate that digital media-based learning contributes to improving the ability to maintain body stability, as students can imitate movement examples with clear and interactive visual guidance. Overall, the descriptive analysis results show that the application of interactive digital learning media can provide a more effective and enjoyable learning experience for students. The visualisation of movements and immediate feedback provided by the media helped students improve their movements independently and increase their confidence in physical activities. These results provide a strong basis for continuing inferential analysis using independent t-tests to determine the statistical significance of the differences in motor skills between the two groups.

**Table 2.** Independent t-test Results for Motor Skills

Motor Skill Aspect	t-value	df	Sig. (p)	Description
Agility (Shuttle Run)	6.82	58	0.000	Significant
Coordination (Ball Throw and Catch)	5.64	58	0.000	Significant
Balance (One-Leg Stand)	4.38	58	0.001	Significant
Total Motor Skills Average	5.61	58	0.000	Significant

Based on the statistical analysis results in Table 2, it is known that all aspects of motor skills show significance values ( $p < 0.05$ ), so it can be concluded that there is a significant difference between the experimental group and the control group. The group that participated in physical education learning with interactive digital media obtained a higher average score than the control group that used conventional methods.

In detail, the greatest improvement occurred in the agility aspect, where the experimental group obtained an average score of 85.6, while the control group only obtained 74.3. This shows that the visualisation of movements and interactive simulations on digital media helps students understand movement techniques and body response speed more effectively. In terms of coordination, the difference in average scores of 8.1 points indicates that interactive media-based exercises can improve the synchronisation between students' eyes and hands, especially through simulated throwing and catching activities in the application. Meanwhile, in terms of balance, an increase of 6.1 points shows that students were able to control their posture better after practising using visual guides provided by digital media.

Interviews with physical education teachers and students were conducted to reinforce the quantitative findings regarding the effectiveness of interactive digital learning media in improving the motor skills of primary school students. The interviews were conducted in a semi-structured manner, involving one physical education teacher and six students from the experimental group who were purposively selected based on their level of active participation during the learning process.

The qualitative analysis process was carried out using thematic analysis techniques, namely through the stages of data reduction, data presentation, and conclusion drawing. Based on the interview transcripts, three main themes were found that described the experiences of teachers and students in the application of interactive digital media, namely: (1) ease of understanding movement techniques, (2) increased motivation to learn, and (3) active involvement and self-confidence of students.

**Table 3.** Results of Thematic Analysis of Interviews

Main Theme	Data Source	Description of Findings	Implications for Motor Skills
Ease of understanding movement techniques	Teachers & Students	Teachers state that animated guides and 3D visualisations in the media help students understand basic movement techniques such as jumping, throwing and running more quickly and accurately.	Students can imitate movements with greater accuracy, leading to improved agility and coordination.
Increased motivation to learn	Teachers & Students	Students find physical education more enjoyable because the media is equipped with challenges or 'game levels' that make them want to keep trying.	Increased emotional engagement and consistency in exercise, which contributes to continuous improvement in motor skills.
Active involvement and self-confidence	Students	Students feel more confident in performing movements because they can see correct animated examples and correct their mistakes based on feedback from the media.	Helps develop balance and body control, and speeds up adaptation to new movements.

Qualitative analysis shows that the use of interactive digital learning media has a positive impact on the physical learning process, particularly in improving students' understanding, motivation, and participation. Teachers assess that animations and visual simulations can overcome the limitations of manual demonstrations commonly carried out in the field, especially when there are many students. With the help of 3D visuals and automatic feedback, students can see their movement errors directly and make corrections independently.

From the students' perspective, digital media provides an enjoyable and motivating learning experience, as physical activities are presented in the form of games (game-based learning). This makes students who were previously passive become more enthusiastic and actively participate in physical activities. These findings support the quantitative results in Table 1, which show a significant improvement in agility, coordination, and balance. The integration of quantitative data and interview results confirms that interactive digital learning media innovation is not only statistically effective but also pedagogically and psychologically relevant. Such media can create an engaging, adaptive learning environment that supports the development of motor skills and active character in primary school students.

The findings of this study reinforce (Mayer, 2020) theory of multimedia learning, which states that technology-based interactive learning can increase students' cognitive and affective engagement through more meaningful learning experiences. In the context of physical education, the use of interactive digital media provides simultaneous visual and kinesthetic stimuli, helping students process movement information more quickly and accurately. This media provides visual guidance in the form of 3D animations and interactive simulations that allow students to imitate movements accurately and receive immediate feedback on any mistakes made.

These results are also in line with the views of (Gallahue & Ozmun, 2019), who emphasise the importance of varied, interesting, and challenging motor exercises to optimise children's motor skill development. Interactive digital media effectively provides a variety of physical activities tailored to students' abilities through game level features, point systems, and progressive challenges. This variety encourages repetition with feedback, which is one of the keys to developing gross motor skills, such as agility, coordination, and balance.

Furthermore, the interview results support the quantitative findings by highlighting an increase in student motivation and engagement during learning. Teachers stated that interactive digital media was able to change the paradigm of physical learning, which was usually monotonous, to be more

dynamic and enjoyable. Meanwhile, students admitted that they were more enthusiastic about participating in physical activities because digital media provided a 'play while exercising' experience. This is in line with the self-determination theory from (Owon et al., 2024), which emphasises that students' intrinsic motivation can be increased through learning that provides freedom to explore and positive experiences.

In today's digital era, learning is no longer limited to conventional classrooms but has transformed into a more interactive and engaging process through the use of technology. In the context of Physical Education learning, the use of interactive digital media has become an important innovation to increase student participation and skills (Al Ardha, 2022). Digital learning media allows students to learn actively through movement simulations, educational games, and direct feedback that encourages their emotional and cognitive engagement. The use of interactive digital learning media applications in this study is designed to support the development of basic motor skills in primary school students, which include agility, balance, and coordination.

With attractive visuals and simple navigation, this media is expected to motivate students to actively engage in every physical learning activity. This application also makes it easier for teachers to manage the learning process and monitor student progress digitally. Every feature in it, from the main menu to motor skill exercises, is systematically arranged to suit the characteristics and needs of primary school-aged students. The following is a display and explanation of the use of the interactive digital learning media application developed in this study:



**Figure 1.** Display of Interactive Digital Learning Media

Interactive digital learning media is an innovation in the world of education that integrates technology with the teaching and learning process to create a more dynamic, participatory, and meaningful learning experience (Putra & Pratama, 2023). Through this medium, students are no longer passive recipients of information as in traditional learning methods, but become active subjects who can interact directly with learning materials through various digital features that involve visual, audio, and kinesthetic elements. The interactivity offered allows students to experiment, respond to challenges, and receive immediate feedback on every action taken during the learning process (Ali et al., 2024). Thus, interactive digital media not only serves as a means of delivering material but also as a virtual learning environment that encourages the overall cognitive and affective engagement of students.

In the context of physical education, interactive digital learning media plays a very strategic role in developing the motor skills of primary school students. Through motion simulations, 3D animations, and interactive videos, students can systematically observe, imitate, and practise basic motor movements such as agility, coordination, and balance (Lesmawan et al., 2025). For example, students can follow movement instructions in the form of games or challenges tailored to their ability levels, making the learning process more adaptive and enjoyable. Digital feedback in the form of points, scores, or reward animations further strengthens students' intrinsic motivation to continue learning and practising. In addition, this medium allows teachers to monitor student progress in real time, provide more objective evaluations, and adjust learning activities based on student performance results.

Through this approach, physical education does not only focus on physical activities on the field, but also incorporates technology to broaden the learning experience (Masgumelar & Mustafa, 2021). The combination of real movements and digital interaction encourages students to think critically, develop creativity, and improve their ability to reflect on their own movement performance. Thus, interactive digital learning media contributes not only to improving motor skills but also to strengthening 21st-century competencies, including digital literacy, collaboration, and problem-solving.



**Figure 2.** Interactive Digital Learning Media Login Screen

Figure 2. The initial screen and login system on interactive digital learning media serve as the main gateway for students to access all learning content and activities. Each student receives a username and password set by the teacher, so this authentication process ensures that each user is individually identified. The login system not only serves to maintain data security and prevent account misuse, but also plays an important role in supporting the concept of personalised learning. Through this mechanism, the system can continuously record and monitor the development of students' motor skills, including exercise results, scores, agility levels, coordination, and balance (Oktarifaldi et al., 2019). The stored data is then used to adjust the difficulty level of the next exercise according to the individual abilities of the students. Thus, each child will receive a different learning experience tailored to their individual needs and physical abilities. This approach is in line with the principles of modern learning that emphasise differentiation and adaptability, where technology is used to create a more inclusive, efficient, and learner-centred learning process.



**Figure 3.** Display of Interactive Digital Learning Media Features

Figure 3. Display of Interactive Digital Learning Media Features shows the main structure of the application designed to facilitate physical education learning in an interesting and focused manner. In this display, students are presented with a main menu consisting of three main components, namely the Agility Menu, Coordination Menu, and Balance Menu. Each menu contains a series of interactive activities that can be accessed according to the motor skill indicators to be trained. For example, in the Agility Menu, students can watch movement simulations through the 'View Movement' feature, then try to do the exercises by pressing the "Start" button, and repeat the attempts if necessary through the 'Try Again' feature. These features are designed so that students can learn actively and independently, with easy-to-understand visual guidance. In addition, the 'Next' button allows students to move on to the next stage of the exercise in sequence, so that the learning process is systematic. This simple yet interactive design supports the principle of learning by doing, where students not only observe but also directly practise the movements repeatedly, thereby helping to improve their mastery of basic motor skills in a fun and adaptive way that suits each individual's learning pace (Martha, 2025).

In addition to contributing to the improvement of motor skills, the use of interactive digital learning media also has a significant impact on the development of students' 21st-century skills. Through interaction with technology, students not only train their bodies but also hone their critical thinking, collaboration, creativity, and digital literacy skills (Putri, Agusdianita, & Desri, 2024). In learning activities based on interactive digital media, students are involved in decision-making processes, such as determining strategies to complete virtual challenges or analysing movement errors based on feedback from the application. This process encourages them to think reflectively and critically about their own performance and that of their peers.

The practical implication of this study is that physical education teachers need to position themselves not only as physical trainers but also as digital learning facilitators who are able to creatively integrate technology into physical activities. The use of interactive digital media can be used as a tool to enrich the learning experience, provide variety in activities, and bridge the gap between the digital world and physical activities (Resti, Wati, Ma'Arif, & Syarifuddin, 2024). However, the use of media must still consider the balance between digital interaction and direct activities in the field so that physical learning objectives can still be achieved optimally. Teachers in the digital era not only act as coaches who focus on physical aspects, but also as digital learning facilitators who are able to integrate

technology creatively and contextually. Mastery of interactive digital media enables teachers to design learning that is adaptive to the learning styles of modern students who tend to be visual, interactive, and experiential learners (Gonçalves et al., 2024).

In addition, digital media-based learning also fosters collaborative skills, as students often work in small teams to complete physical tasks combined with digital simulations (Abdurahman et al., 2024). These activities not only strengthen social relationships between students, but also instill the values of sportsmanship, responsibility, and effective communication, core values in physical education. Meanwhile, digital literacy develops when students interact with application interfaces, understand technology-based instructions, and use digital devices productively for learning purposes, not just entertainment. The use of digital media should not replace physical activities on the field, but rather complement them through a blended learning approach that combines virtual experiences and real-world activities. Thus, the main objectives of physical education, namely the development of physical fitness, motor skills, and positive character in students, can still be optimally achieved while preparing them to face the challenges of life in the digital age.

The findings of this study indicate that the use of interactive digital learning media not only improves students' motor skills but also contributes to the development of 21st-century skills, particularly critical thinking, collaboration, creativity, and digital literacy. Analytically, these results corroborate the findings of (Casey & Goodyear, 2015), who stated that technology integration in physical education can expand the learning function beyond physical exercise to the development of cognitive and social competencies. Digital media-based activities that require students to analyze movement errors, respond to visual feedback, and adjust training strategies encourage a reflective process, aligning with the findings of (Kirk, 2019) who emphasized the importance of reflective practice in modern physical education.

When compared with other international studies, the results of this study are also consistent with the findings of (Gonçalves et al., 2024), who reported that the use of interactive digital media in physical education increases student learning engagement and the quality of interactions, although its effectiveness is highly dependent on the learning design and the role of the teacher. However, in contrast to the findings of (Sutherland, Jarrahi, Dunn, & Nelson, 2020) who found that excessive technology use can actually reduce the intensity of physical activity, this study shows that interactive digital media can have a positive impact when used as a learning support, not as a substitute for physical activity on the field. This difference indicates that the success of technology integration is not solely determined by the type of media, but by how it is positioned pedagogically.

From a pedagogical perspective, these findings emphasize that physical education teachers need to adopt a dual role as facilitators of physical activity and mediators of digital learning. This role requires adaptive pedagogical competencies, particularly in designing blended learning that integrates virtual experiences and real-world practice in a balanced manner. In line with the Technology Pedagogy and Content Knowledge (TPACK) model, teachers are required not only to master technology but also to align it with the objectives of physical education learning and the developmental characteristics of elementary school students (Victoria A. Goodyear, Parker, & Casey, 2019). Practical implications: Teacher training should be directed at developing learning designs that maximize physical interaction while simultaneously utilizing technology as a tool for reflection and feedback.

Furthermore, interactive digital media-based learning in this study was shown to encourage group collaboration and communication among students, which strengthens the social dimension of physical education. This finding aligns with research by (Bailey, Hetrick, Rosenbaum, Purcell, & Parker, 2018), which emphasized that collaborative activities in physical education play a crucial role in instilling social values such as sportsmanship, responsibility, and empathy. Students' digital literacy also developed through interaction with application interfaces and the productive use of digital devices, supporting UNESCO's view of the importance of digital literacy as a core competency for learners in the digital age.

However, this study has several limitations that should be acknowledged. First, the relatively small sample size and its limitation to a single elementary school limit the generalizability of the findings to broader contexts. Second, the intervention duration of only four weeks did not allow for observation of the long-term impact of interactive digital media use on students' physical fitness and motor skill development. Third, differences in teacher competency in operating digital media also have the potential to influence learning outcomes, but were not analyzed in depth in this study.

Therefore, future research is recommended to involve a larger sample size, diverse school contexts, and a longer intervention period. In addition, further studies need to explore the relationship between the intensity of interactive digital media use and students' physical activity levels so that the integration of technology in physical education truly supports the main objectives of learning, namely the holistic development of students' fitness, motor skills, and character.

#### 4. CONCLUSION

This study demonstrates that the use of interactive digital learning media has the potential to strengthen physical education learning in elementary schools, particularly in supporting the development of students' motor skills and improving the quality of learning engagement. These findings confirm that pedagogically designed and used technology integration can be an effective complement to physical education learning that has traditionally focused on conventional physical activity, while also creating space for the development of 21st-century competencies in a more balanced manner. However, this study has several limitations, including the limited sample size in one school, the relatively short duration of the intervention, and the lack of analysis of variations in teacher competency in the use of digital media. Therefore, future research is recommended to involve more diverse school contexts, conduct a longer implementation period, and examine the relationship between the intensity of digital media use, students' physical activity levels, and long-term learning outcomes.

From a practical perspective, the results of this study recommend the need for ongoing training for physical education teachers in designing and implementing interactive digital media that aligns with learning objectives and student characteristics. Furthermore, policy support from schools and educational stakeholders is needed to provide infrastructure, implementation guidance, and to integrate technology into the physical education curriculum. In the future, the development of adaptive, feedback-based, and contextual interactive digital media needs to be continuously encouraged so that physical education learning is not only relevant to the demands of the digital era but also contributes significantly to the holistic development of students' motor skills and character.

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