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The Utilization of Technology-Based Media in Physical Education Learning Strategies at Madrasah Ibtidaiyah

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ABSTRACT

Purpose – This study examines the use of technology-based media in Physical Education learning at Madrasah Ibtidaiyah (MI) and Elementary School (SD) levels. It addresses the limitations of conventional instruction in explaining complex movement concepts and the need for more interactive, visual, and student-centered learning strategies in the digital era.

Methods – A qualitative literature review was conducted using a systematic review procedure adapted from the PRISMA 2020 framework. Searches were carried out in Google Scholar and ERIC for publications from 2015 to 2025. From 145 initial records, 18 studies met the inclusion criteria and were synthesized qualitatively.

Findings – The review shows that instructional videos, animations, simulations, interactive multimedia, mobile applications, and exergames can support students' movement understanding, motivation, engagement, and participation in Physical Education learning. These media help present movement concepts visually and flexibly. However, their implementation is constrained by limited technological infrastructure, unequal access to digital resources, and insufficient teacher competence in integrating technology into movement-based instruction.

Research implications – The findings suggest that technology integration should be supported by adequate infrastructure, teacher training, and pedagogical strategies that maintain active physical participation. Since this study is literature-based, its findings should be interpreted as synthesized evidence rather than direct empirical proof.

Originality – This study provides a focused synthesis of recent literature on technology-based media in MI/SD Physical Education and identifies its pedagogical potential, implementation challenges, and future research directions.

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INTRODUCTION

Physical Education, Sports, and Health is an important component of primary education, including Madrasah Ibtidaiyah (MI) and Elementary School (SD), because it supports students' physical health, motor-skill development, character formation, social-emotional development, and healthy-living orientation [1], [2]. Through structured physical activities, students can develop movement skills as well as values such as discipline, cooperation, responsibility, and sportsmanship [3], [4]. Compared with classroom-dominant subjects, Physical Education has distinctive characteristics because learning occurs through direct bodily movement, repeated motor practice, psychomotor development, active participation, and social interaction in physical activity settings [1], [2].

However, the implementation of Physical Education learning at the MI/SD level still faces several instructional challenges. Conventional teaching methods that rely heavily on verbal explanations and direct demonstrations are often insufficient to explain complex movement patterns, body coordination, and physiological concepts effectively [5], [6]. Some movement skills occur too quickly or involve abstract processes that are difficult for students to observe repeatedly during classroom instruction. As a result, students may experience difficulties in understanding learning materials, become less motivated, and participate less actively in the learning process.

These challenges are closely related to the developmental characteristics of MI/SD students. According to Piaget's cognitive development theory, elementary school students are generally in the concrete operational stage, where they learn more effectively through visual, concrete, and directly observable representations [7]. Therefore, learning media that provide visual demonstrations, repeated observation, and interactive learning experiences are considered highly relevant in Physical Education learning contexts.

Along with the development of digital technology in education, various forms of technology-based media have increasingly been used to support learning processes. In this study, technology-based media refer to digital tools and multimedia resources used to support instruction and student learning activities in Physical Education. These media include instructional videos, animations, interactive multimedia, simulations, mobile learning applications, and digital game-based activities such as exergames [8]. Each type of media has different instructional functions and pedagogical implications. Instructional videos and animations, for example, are commonly used to demonstrate movement techniques visually, while interactive applications and exergames can increase student participation and engagement through active learning activities [9].

Recent studies indicate that technology-based learning media can support more interactive and student-centered learning environments in Physical Education. Visual and audiovisual media allow students to observe movements repeatedly and independently, helping them understand motor skills more clearly and improving learning motivation [8], [10]. In addition, digital learning media can provide more flexible learning opportunities that accommodate differences in students' learning styles and abilities. Nevertheless, the implementation of technology-based media in Physical Education remains uneven, particularly in primary education settings with limited infrastructure and digital resources.

In the context of Madrasah Ibtidaiyah (MI), the integration of technology into Physical Education learning faces additional challenges related to institutional conditions, teacher readiness, and facility availability. Compared to general elementary schools, some MI institutions may have more limited access to digital infrastructure and educational technology resources. In addition, teachers' digital competence and experience in integrating technology into movement-based learning activities vary significantly across schools. These conditions create difficulties in implementing technology-based learning media effectively and consistently in MI Physical Education classes.

Although previous studies have discussed educational technology and digital learning media, research specifically examining the use of technology-based media in Physical Education learning at the MI/SD level remains limited. Existing studies also tend to focus on general educational technology without sufficiently discussing the characteristics of movement-based learning, motor skill development, and active physical participation in Physical Education contexts. Therefore, a more

focused literature review is needed to synthesize current findings regarding the forms, benefits, and implementation challenges of technology-based media in Physical Education learning at the MI/SD level.

Based on this background, this study aims to examine the use of technology-based media in Physical Education learning at the MI/SD level by identifying the types of media commonly used, their potential contributions to learning processes, and the challenges encountered during implementation. The study is expected to provide conceptual and practical insights for educators in developing more innovative, interactive, and contextually appropriate Physical Education learning strategies in the digital era.

METHOD

This study employed a qualitative literature review design to examine and synthesize previous studies related to the use of technology-based media in Physical Education learning at the Madrasah Ibtidaiyah (MI) and Elementary School (SD) levels. The review focused on identifying the types of technology-based media used in Physical Education, their potential contributions to learning processes, and the challenges associated with their implementation in primary education contexts. A systematic review approach adapted from the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework was applied to guide the processes of literature identification, screening, eligibility assessment, and synthesis [11].[12]

The literature search was conducted between January and March 2025 using academic databases including Google Scholar and ERIC. The search process used several keywords and keyword combinations, such as “technology-based media in Physical Education,” “digital learning in elementary Physical Education,” “instructional media in sports education,” “multimedia learning in Physical Education,” and “Physical Education learning at primary school.” The search focused on publications published between 2015 and 2025 to ensure the relevance of recent technological developments in education.

The source universe of this study consisted of academic publications discussing technology integration in Physical Education learning at the primary education level. The inclusion criteria included: (1) studies focusing on Physical Education learning in MI/SD or equivalent primary education settings; (2) studies discussing the use of technology-based learning media, such as instructional videos, animations, simulations, interactive multimedia, mobile applications, or exergames; (3) peer-reviewed journal articles, conference proceedings, and academic books relevant to educational technology and Physical Education; (4) publications written in English or Indonesian; and (5) studies published within the last ten years. The exclusion criteria included studies unrelated to Physical Education, higher education contexts, non-academic publications, duplicate records, and studies with insufficient methodological information.

The screening process was conducted in several stages. First, titles and abstracts were reviewed to determine their relevance to the topic. Second, duplicate and irrelevant records were removed. Third, full-text screening was conducted to evaluate whether the selected studies met the predetermined eligibility criteria. The literature selection process resulted in a smaller corpus of studies considered relevant to the objectives of this review. The stages of identification, screening, eligibility assessment, and inclusion were organized following the PRISMA review structure, although this study did not conduct a statistical meta-analysis. During the identification stage, a total of 145 records were retrieved from Google Scholar and ERIC databases. After removing 23 duplicate records, 122 studies remained for title and abstract screening. Following the screening process, 74 articles were excluded because they were not directly related to Physical Education learning at the primary education level or did not discuss technology-based learning media. The remaining 48 articles underwent full-text eligibility assessment. After full-text review, 30 studies were excluded due to insufficient methodological information, inappropriate educational context, or lack of relevance to the research objectives. Finally, 18 studies were included in the qualitative synthesis of

this review. The literature selection process is summarized in Figure 1 following the PRISMA 2020 framework [12],

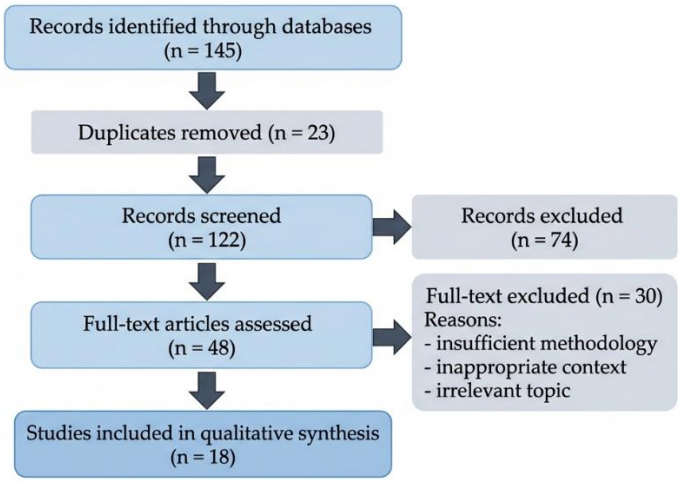

Figure 1. PRISMA 2020 Flow Diagram of Literature Selection Process

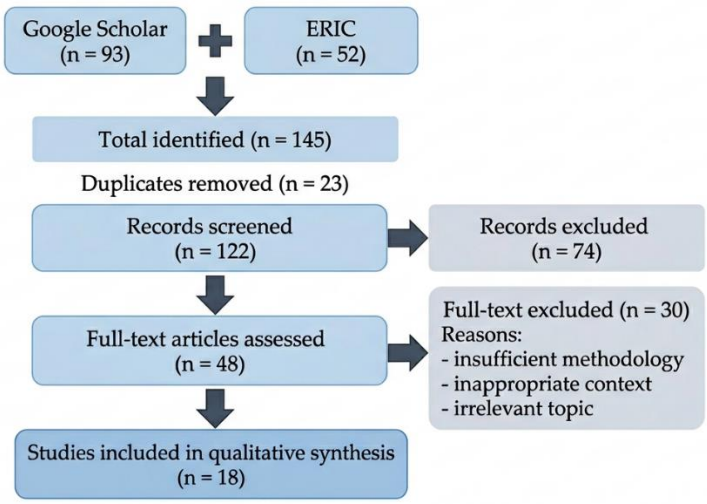

Figure 2. Identification of Studies through Google Scholar and ERIC Databases

To organize and synthesize the selected literature systematically, a data extraction table was developed. The extracted information included author and publication year, country of study, educational level, type of technology used, research design, research findings, and reported limitations. The extracted data were then categorized into several major themes, including visual-based learning media, interactive multimedia, mobile learning applications, exergames, and implementation challenges in technology-based Physical Education learning.

Table 1. summarizes all 18 studies included in the qualitative synthesis

Author	Year	Country	Educational Level	Technology Type	Research Design	Sample	Main Findings	Limitations
Putri	2022	Indonesia	Elementary School	Gamification	Experimental	60 students	Increased student motivation and participation	Limited duration of intervention
Yudhianto & Pratama	2024	Indonesia	Primary School	AI-based media	Qualitative	2 schools	Improved engagement and	Small sample size

Author	Year	Country	Educational Level	Technology Type	Research Design	Sample	Main Findings	Limitations
Chen	2021	China	Elementary Education	Virtual Reality	Meta-analysis	25 studies	individualized feedback VR improved movement visualization	High infrastructure requirements
Holmes & Bialik	2022	USA	General Education	Artificial Intelligence	Literature Review	Secondary data	AI supports adaptive learning	Limited empirical evidence
Calderón et al.	2020	Spain	Pre-service PE	Digital technology	Quantitative	University students	Improved motivation and learning climate	Limited generalizability
Kim & Lee	2020	South Korea	Elementary	Gamification / Exergames	Experimental	Elementary students	Higher participation	Short duration
Hayotte et al.	2021	France	Physical activity program	Mobile technology + videoconference	RCT protocol	120 participants	Technology supports PA maintenance	Protocol stage only
Blount et al.	2021	USA	Physical activity intervention	Wearable technology	Systematic Review	14 studies	Improved physical activity and wellbeing	Specific population only
Liu et al.	2023	China	Physical activity context	Technology-based intervention	Mixed Methods	300 participants	Improved activity and mental health	Adult population
Cui et al.	2024	China	Physical Education	Digital learning tools	Time-lagged quantitative	513 students	Higher engagement and fitness	Higher education setting
Omarov et al.	2024	Kazakhstan	Sports Education	Augmented Reality	Experimental	60 students	Higher motivation and activity	Short intervention
Sitorus et al.	2025*	Indonesia	Learning context	Technology-based media	Literature Review	Secondary data	Technology supports learning	Need empirical evidence
Arufe-Giráldez et al.	2023	Spain	Physical Education	Digital tools	Empirical Study	School students	Increased participation	Technology dependence
Wallace et al.	2023	International	Physical Education	Interactive technology	Review	Multiple studies	Supports engagement	Implementation variation
Østerlie et al.	2023	Norway	Physical Education	Fitness trackers	Empirical	School students	More active participation	Infrastructure issue
Timotheou et al.	2023	International	Education	Educational technology	Systematic Review	Multiple studies	Improved instructional support	Context variability
Goodyear et al.	2023	United Kingdom	Physical Education	Digital integration	Review	Multiple studies	Technology complements PE	Teacher readiness required
Maksimović & Lazić	2023	Serbia	Physical Education	Digital-supported education	Theoretical Review	Secondary data	Teacher competence is essential	Conceptual evidence

The literature selection process and study screening stages are summarized in Figure 1 following the PRISMA review framework.

The analysis process employed qualitative thematic analysis techniques. Coding was conducted inductively by identifying recurring concepts, patterns, and findings across the selected studies. Similar findings were grouped into broader themes to facilitate interpretation and comparison between studies. The synthesis process focused on identifying how different types of technology-based media support learning processes, student engagement, motivation, and movement understanding in Physical Education contexts. Comparative analysis was also conducted to examine similarities and differences in findings across studies and educational settings.

To improve methodological transparency, the selected literature was also evaluated based on relevance, clarity of research objectives, appropriateness of research methods, and consistency of findings. Studies with unclear procedures or insufficient descriptions of implementation were not prioritized in the synthesis process. However, because this study relied entirely on secondary data, several limitations remained. Differences in research contexts, methodologies, and sample characteristics across studies may affect the consistency and generalizability of findings. In addition, publication bias may occur because studies reporting positive findings are more likely to be published than studies reporting neutral or negative results.

Despite these limitations, this literature review provides a structured synthesis of recent studies concerning the integration of technology-based media in Physical Education learning at the MI/SD level and offers a conceptual foundation for future empirical research and educational practice.

RESULTS

The reviewed literature indicates that various forms of technology-based media have been implemented in Physical Education learning at the MI/SD level. The identified media include instructional videos, animation-based learning, interactive multimedia, mobile learning applications, exergames, wearable technology, and immersive technologies such as virtual reality (VR) and augmented reality (AR). However, the reviewed studies show that each type of technology has different instructional functions, implementation requirements, and levels of suitability for elementary Physical Education contexts.

Table 1 summarizes the characteristics of the studies included in this review, including the educational context, technology type, research design, and key findings.

Visual Media for Movement Demonstration

Several reviewed studies indicate that instructional videos, animation-based media, and digital demonstrations support students' understanding of movement concepts in Physical Education learning. Visual media allow students to observe movement sequences repeatedly and help simplify complex motor activities into more concrete and understandable forms. This approach is particularly beneficial for elementary school learners who require visual and observable learning experiences.

The reviewed studies further suggest that visual-based media contribute to increased attention, motivation, and participation in learning activities. However, visual media are considered most effective when combined with direct physical practice rather than functioning as passive observation tools alone. Therefore, visual demonstrations should complement active movement experiences in Physical Education learning.

Exergames and Movement Engagement

Previous empirical studies indicate that exergames can support students' engagement in Physical Education by increasing opportunities for active movement, enjoyment, and repeated motor practice. In an elementary school Physical Education context, Sun found that exergaming lessons increased students' in-class physical activity intensity, although students' situational interest decreased over time, suggesting that the motivational effect of exergames may depend on instructional design and sustained novelty [13]. Sheehan and Katz also reported that a six-week school-based exergaming curriculum improved postural stability among fourth-grade students, indicating that exergames may support selected motor-related outcomes such as balance[14]. In addition, gamification-based Physical Education interventions have been associated with increased intrinsic motivation, enjoyment, social interaction, challenge, and perceived learning among school-aged students [15]. These findings suggest that exergames and game-based instructional elements may function as complementary tools in Physical Education, particularly when used to increase participation and provide additional movement practice rather than replace teacher guidance and direct physical exercise."

The reviewed literature also suggests that visual media can support movement learning when they are integrated with active physical practice. Video-based visual feedback has been found to enhance motor learning in Physical Education and appears more effective than verbal feedback alone, although its implementation depends on school conditions such as class size, available lesson time, technical equipment, and teachers' digital competence [5]. Therefore, videos and animations should not be used merely as passive viewing materials. Since Physical Education lessons are expected to provide substantial active movement time, excessive use of passive media may reduce opportunities for students to practice movement directly. A systematic review also shows that students often do not meet the recommended level of moderate-to-vigorous physical activity during PE lessons, reinforcing the need to balance media use with active participation [16]. Thus, visual media are most appropriate when used as brief movement demonstrations, visual feedback tools, or pre-practice learning aids followed by direct physical practicees.

Interactive Multimedia and Mobile Learning Applications

The literature further indicates that interactive multimedia and mobile learning applications support more student-centered learning environments. Interactive features such as quizzes, gamified activities, and digital simulations encourage students to engage actively with learning materials rather than passively receiving information. Several studies reported that mobile learning applications provide flexibility for students to revisit instructional materials independently according to their learning pace and individual needs.

The reviewed studies also show that multimedia learning environments can improve students' attention, motivation, and engagement in Physical Education learning. However, the effectiveness of these technologies depends heavily on teacher guidance, students' digital literacy, and the availability of technological facilities. In schools with limited internet access or insufficient digital devices, the implementation of interactive multimedia remains difficult. In addition, younger learners still require teacher supervision to ensure that digital learning activities remain focused on educational objectives rather than entertainment alone.

Exergames and Technology Supporting Physical Activity

Exergames and movement-based digital activities represent another category of technology frequently discussed in recent literature. Unlike passive multimedia, exergames combine digital interaction with physical movement activities. Several reviewed studies reported that exergames can increase students' motivation to participate in Physical Education activities while also supporting motor skill development and physical activity engagement. Exergames are considered particularly useful for increasing students' enthusiasm and participation during learning activities because they integrate game elements into movement practice [17].

Nevertheless, the literature also highlights several limitations. Exergames often require specialized equipment, stable technological infrastructure, and teacher competence in managing technology-assisted activities. Some studies also warn that technology-based games may shift students' focus toward screen interaction rather than movement quality if activities are not designed carefully. Therefore, the reviewed literature emphasizes that exergames should function as complementary tools that support physical activity rather than replace direct movement practice.

Wearable Technology, VR, AR, and AI-Based Tools

Recent literature shows that digital technologies such as wearable devices, virtual reality (VR), augmented reality (AR), mixed reality (MR), and artificial intelligence (AI) are increasingly discussed in Physical Education learning. A systematic review by Jastrow et al. identified several categories of digital media used in PE, including exergames, video, mobile devices, wearable technologies, and other digital tools, with reported benefits for motivation, motor skill learning, feedback, and assessment [18]. In relation to immersive technology, Pérez-Muñoz et al. found that VR, AR, and MR have been applied in compulsory Physical Education and may support motor skill learning, physical fitness, motivation, social interaction, and inclusive learning experiences [19]. Meanwhile, Zhou et al. systematically reviewed the application of AI in Physical Education and reported that AI has been

used to support teaching, learning, assessment, feedback, and physical activity monitoring in PE contexts [20].

However, the reviewed literature also indicates that these technologies are not yet easily transferable to most MI/SD Physical Education contexts. Digital technology implementation in PE is often constrained by class size, limited access to media, technical support, lesson time, teacher expertise, and budget [18]. For immersive technologies, the literature on VR, AR, and MR in PE is growing, but further studies are still needed to clarify their implementation, effects, and possible resistance among PE teachers [19]. Similarly, AI-based PE remains an emerging area, and its use in MI/SD contexts should be interpreted cautiously because current evidence does not yet demonstrate broad feasibility across schools with limited infrastructure [20]. Therefore, although wearable devices, VR, AR, MR, and AI show potential for future development, the current evidence does not yet demonstrate that these technologies are widely feasible, affordable, or easily implemented in most MI/SD Physical Education settings.

Challenges in Technology Integration

The literature consistently identifies several barriers to the implementation of technology-based media in Physical Education learning. The most common challenges include limited technological infrastructure, unequal digital access, insufficient teacher digital competence, and limited institutional support [21]. Schools located in rural or underdeveloped areas often experience difficulties in accessing stable internet connections, digital devices, and multimedia facilities. Teacher readiness also becomes an important factor because many teachers still have limited experience in integrating digital technology into movement-based learning activities.

Another important issue identified in the literature is the risk of reducing actual physical activity due to excessive screen-based learning. Several studies emphasize that Physical Education must remain movement-centered and physically active. Technology-based media should support movement learning through visualization, feedback, and instructional assistance rather than replacing direct physical participation. As a result, balanced instructional strategies that combine digital support with active movement practice are considered essential in elementary Physical Education learning.

Table 2 presents the thematic synthesis of technology-based media identified in the reviewed studies, including their instructional functions, reported benefits, implementation limitations, and suitability for MI/SD learning contexts.

Table 2. Thematic Synthesis of Technology-Based Media in Physical Education Learning

Technology Type	Instructional Function	Reported Benefits	Limitations	Suitability for MI/SD
Instructional Videos	Demonstrating movement techniques and motor skills	Improves movement understanding, visual learning, and participation	May reduce active movement time if overused	Highly suitable due to simple implementation
Animation-Based Media	Visualizing body coordination and movement sequences	Supports concrete learning and repeated observation	Requires teacher guidance during use	Suitable for elementary learners
Interactive Multimedia	Providing interactive learning experiences	Increases motivation, attention, and engagement	Requires digital devices and internet access	Moderately suitable depending on infrastructure
Mobile Learning Applications	Supporting flexible and independent learning	Allows students to revisit materials independently	Dependent on device availability	Suitable with supervision
Exergames	Combining physical activity with digital interaction	Increases participation and learning enthusiasm	Risk of excessive screen focus	Suitable as complementary learning media
Wearable Technology	Monitoring physical activity and performance	Supports feedback and activity tracking	High cost and technical requirements	Limited suitability in most MI/SD contexts

Technology Type	Instructional Function	Reported Benefits	Limitations	Suitability for MI/SD
Virtual Reality (VR)	Creating immersive movement simulations	Enhances spatial awareness and visualization	Expensive infrastructure and equipment	Limited implementation feasibility
Augmented Reality (AR)	Integrating digital objects into physical learning	Improves interaction and visualization	Requires technical support	Moderately suitable in technologically supported schools
Artificial Intelligence (AI)	Providing adaptive learning feedback	Supports individualized instruction	Limited empirical implementation evidence	Emerging potential but limited current use

DISCUSSION

The findings of this review indicate that technology-based media can support several learning domains in Physical Education, particularly cognitive understanding, learning motivation, movement visualization, and student engagement. Visual-based media such as instructional videos and animations appear particularly suitable for elementary school students because they align with students' concrete operational developmental stage proposed by Piaget [7]. Elementary students tend to learn more effectively when movement concepts are presented visually and concretely. Repeated observation through multimedia also helps students understand movement sequences and body coordination more clearly.

The reviewed studies also support Mayer's multimedia learning theory, which suggests that combining verbal explanation with visual representation can improve students' comprehension and attention [22]. In Physical Education contexts, multimedia learning environments appear to support students' cognitive understanding of movement concepts, especially when direct demonstrations alone are insufficient. However, the reviewed literature also suggests that technology should not be viewed solely as a tool for increasing motivation or engagement. In Physical Education, learning outcomes must also involve psychomotor performance, movement competence, teamwork, and physical participation.

The findings of this review can also be interpreted through the Technological Pedagogical Content Knowledge (TPACK) framework, which emphasizes the integration of technological knowledge, pedagogical knowledge, and subject content knowledge in effective teaching practices [23], [24]. In Physical Education contexts, teachers are not only required to understand digital technologies, but also how to integrate these technologies into movement-centered learning activities appropriately. The reviewed literature suggests that technology-based media become more effective when teachers are able to combine visual demonstrations, instructional strategies, and physical practice activities in balanced ways. Therefore, successful technology integration in MI/SD Physical Education depends not only on technology availability, but also on teachers' pedagogical competence in designing meaningful movement learning experiences. The reviewed studies may also be analyzed using the SAMR (Substitution, Augmentation, Modification, and Redefinition) model of technology integration [25], [26]. Most technology applications identified in this review still operate at the substitution and augmentation levels, where digital media mainly function as replacements or enhancements of traditional demonstrations. Instructional videos, animations, and multimedia presentations, for example, primarily support clearer visualization of movement concepts without fundamentally transforming learning activities. More transformative uses of technology, such as VR, AR, and AI-supported adaptive learning, remain limited in MI/SD contexts due to infrastructure constraints and limited teacher readiness. This finding indicates that the integration of advanced educational technology in elementary Physical Education is still developing and has not yet reached transformative implementation stages in most schools [27].

The findings further indicate that different technologies serve different pedagogical purposes. Instructional videos and animations are relatively practical and accessible for most MI/SD schools because they require simpler infrastructure and can easily be integrated into classroom instruction. In contrast, wearable devices, VR, AR, and AI-based technologies require higher levels of

infrastructure, technical support, and teacher competence. Therefore, not all technologies reviewed in this study are equally feasible for all MI/SD settings. Schools with limited digital facilities may benefit more from simpler multimedia tools rather than expensive immersive technologies.

Teacher competence also emerges as a critical factor influencing successful technology integration. The reviewed studies consistently show that technology-based learning becomes less effective when teachers lack digital pedagogical skills. In movement-based learning contexts, teachers must be able to balance digital instruction with active physical practice. Technology should function as instructional support for demonstrating movement, providing feedback, and facilitating learning activities rather than replacing direct movement experiences [28].

Although many reviewed studies reported positive impacts of technology-based media on motivation, engagement, and movement understanding, the methodological quality of the evidence remains varied. Several studies employed small sample sizes, short intervention durations, or descriptive qualitative approaches, limiting the generalizability of findings. In addition, most reviewed studies focused primarily on students' motivation and engagement rather than directly measuring motor skill performance or long-term physical activity outcomes. Some studies also reported that excessive dependence on screen-based activities may reduce active movement time if technology integration is not balanced with direct physical practice. These inconsistencies suggest that current evidence supports the use of technology primarily as a complementary instructional tool rather than a replacement for movement-centered Physical Education learning [29] .

Another important issue identified in this review concerns the balance between digital learning and physical activity. Several studies warn that excessive screen-based learning may reduce students' active movement time if technology is implemented without proper pedagogical planning. This issue is particularly important in Physical Education because the core objective of the subject is physical participation and motor development. Therefore, technology integration should remain aligned with the principles of active, embodied, and movement-centered learning.

The review also reveals several research gaps. First, empirical studies specifically focusing on MI contexts remain limited. Most reviewed studies discuss elementary education generally without examining the institutional characteristics, infrastructure realities, and teacher readiness conditions of Madrasah Ibtidaiyah. Second, many studies focus primarily on cognitive and motivational outcomes rather than directly measuring motor skill performance and physical activity outcomes. Third, evidence regarding the long-term effectiveness of advanced technologies such as VR, AR, wearable devices, and AI in elementary Physical Education remains limited. Based on the reviewed evidence, simpler and more accessible technologies such as instructional videos, animations, and interactive multimedia currently appear to provide the most realistic and pedagogically appropriate options for MI/SD Physical Education contexts. Although advanced technologies such as VR, AR, wearable devices, and AI demonstrate promising potential, the available evidence remains limited and implementation challenges remain substantial in many elementary school environments. Therefore, the current literature more strongly supports technology integration approaches that enhance movement visualization, student engagement, and instructional clarity while maintaining active physical participation as the central component of Physical Education learning.

Overall, the findings suggest that technology-based media can support Physical Education learning when implemented appropriately and combined with active movement practice. Effective implementation requires adequate infrastructure, teacher digital competence, pedagogically appropriate media selection, and instructional strategies that maintain the movement-centered nature of Physical Education learning.

CONCLUSION

This study reviewed the use of technology-based media in Physical Education learning at the Madrasah Ibtidaiyah (MI) and Elementary School (SD) levels. The reviewed literature suggests that various forms of technology-based media, including instructional videos, animations, interactive multimedia, mobile applications, and exergames, have the potential to support learning processes in

elementary Physical Education. These media are reported to help students understand movement concepts more clearly, increase learning motivation and participation, and support more interactive and student-centered learning environments.

The findings also indicate that different technologies provide different instructional functions and implementation requirements. Visual-based media such as videos and animations appear to be more practical and accessible for most MI/SD contexts because they can support movement demonstrations and repeated observation with relatively limited infrastructure. In contrast, emerging technologies such as wearable devices, virtual reality (VR), augmented reality (AR), and artificial intelligence (AI) remain limited in implementation due to infrastructure constraints, costs, and teacher readiness. Therefore, the integration of technology in Physical Education should consider school conditions, student characteristics, teacher competence, and the movement-centered nature of Physical Education learning.

In addition, this review highlights several challenges in implementing technology-based media, including unequal digital access, limited technological infrastructure, and insufficient teacher digital competence. The literature also emphasizes that technology should function as a support for movement learning rather than replacing direct physical activity. Maintaining a balance between digital learning and active physical participation remains essential to achieving the core objectives of Physical Education, particularly in developing students' motor skills, physical fitness, and social interaction.

This study contributes by providing a synthesized overview of technology-based media commonly used in elementary Physical Education learning and identifying their potential benefits and implementation challenges in MI/SD contexts. However, because this study relied on secondary data from previously published literature, the findings should be interpreted cautiously. Further empirical research is needed to examine the effectiveness of specific technologies in improving motor skill performance, physical activity levels, and long-term learning outcomes in Physical Education. Future studies are also recommended to explore the readiness of MI institutions, teacher digital competence, and practical implementation strategies for technology integration in movement-based learning environments.

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AUTHOR CONTRIBUTION STATEMENT

F contributed to the conceptualization of the study, literature identification, and manuscript supervision. FA contributed to literature screening, data extraction, and the preparation of the initial manuscript draft. AC contributed to thematic analysis, synthesis of findings, and refinement of the results section. BL contributed to methodological organization, PRISMA-based selection reporting, and revision of the discussion section. MS contributed to manuscript review, academic editing, and final approval of the manuscript.

AI DISCLOSURE STATEMENT

The authors used ChatGPT by OpenAI during the preparation of this work for language refinement, grammar checking, and improvement of manuscript clarity. After using the tool, the authors thoroughly reviewed and edited the content as needed and take full responsibility for the accuracy, originality, interpretation, and final content of the publication.

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