Innovative teaching methods in physical fitness education: integrating technology and gamification to improve student engagement-a systematic review

Métodos de enseñanza innovadores en educación física: integración de la tecnología y la gamificación para mejorar el compromiso de los estudiantes: una revisión sistemática

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Abstract

Background: Physical education plays a vital role in students' holistic development, yet it often faces low engagement due to monotonous teaching approaches. The integration of technology and gamification has emerged as a promising strategy to enhance motivation and participation in physical fitness education. Objective: This study systematically reviews empirical research on how technology and gamification contribute to student engagement in physical fitness education. Methods: A systematic review method was employed to analyze studies published in the last 15 years, retrieved from academic databases including Google Scholar, PubMed, and Scopus. Inclusion criteria focused on studies involving students and addressing technology and/or gamification in physical fitness education. Results: The review identified multiple studies showing that fitness apps, wearable devices, and virtual reality can significantly enhance motivation and allow real-time performance tracking. Gamification elements such as badges, points, levels, and leaderboards were found to increase participation and foster a competitive yet collaborative learning atmosphere. Several studies reported a 20–30% increase in engagement. However, findings also revealed variation in outcomes depending on context, implementation quality, and access to resources. Some unintended effects, such as performance anxiety from competitive features, were also documented.
Conclusion: Technology and gamification hold strong potential to improve engagement in physical fitness education. However, successful implementation depends on infrastructure, teacher readiness, and thoughtful design. Broader and long-term research is recommended to evaluate sustainability and scalability across diverse educational contexts.

Keywords

Innovative teaching methods, physical fitness education, technology integration, gamification in learning, student engagement.

Resumen

Antecedentes: La educación física desempeña un papel vital en el desarrollo integral de los estudiantes, sin embargo, a menudo se enfrenta a un bajo compromiso debido a los enfoques de enseñanza monótonos. La integración de la tecnología y la gamificación ha surgido como una estrategia prometedora para aumentar la motivación y la participación en la educación física.
Objetivo: Este estudio revisa sistemáticamente la investigación empírica sobre cómo la tecnología y la gamificación contribuyen al compromiso de los estudiantes en la educación física.
Métodos: Se empleó un método de revisión sistemática para analizar los estudios publicados en los últimos 15 años, recuperados de bases de datos académicas, incluyendo Google Scholar, PubMed y Scopus. Los criterios de inclusión se centraron en estudios que incluyeran a estudiantes y abordaran la tecnología y/o la gamificación en la educación física. Resultados: La revisión identificó múltiples estudios que muestran que las aplicaciones de fitness, los dispositivos portátiles y la realidad virtual pueden mejorar significativamente la motivación y permitir el seguimiento del rendimiento en tiempo real. Se descubrió que los elementos de gamificación, como insignias, puntos, niveles y tablas de clasificación, aumentan la participación y fomentan un ambiente de aprendizaje competitivo pero colaborativo. Varios estudios señalaron un aumento del compromiso del 20-30%. Sin embargo, los hallazgos también revelaron variaciones en los resultados dependiendo del contexto, la calidad de la implementación y el acceso a los recursos. También se documentaron algunos efectos no deseados, como la ansiedad por el rendimiento derivada de las características competitivas. Conclusiones: La tecnología y la gamificación tienen un gran potencial para mejorar la participación en la educación física. Sin embargo, el éxito de su aplicación depende de la infraestructura, la preparación de los profesores y un diseño bien pensado. Se recomienda una investigación más amplia y a largo plazo para evaluar la sostenibilidad y la escalabilidad en diversos contextos educativos.

Palabras clave

Métodos de enseñanza innovadores, Educación física, Integración de la tecnología, Gamificación en el aprendizaje, Compromiso de los estudiantes

Introduction

Physical education plays a central role in promoting students' holistic development, including their physical, mental, social, and emotional well-being. Throughout this study, the term "physical education" is used in line with international standards to avoid ambiguity. Specifically, the study focuses on strategies for enhancing and monitoring students' cardiorespiratory fitness within physical education programs, which aligns with contemporary goals for health-promoting schools. As provided for by the World Health Organization (Bull et al., 2020), optimum physical fitness is associated with better health, decreased disease risk, and an overall better quality of life. Nonetheless, one of the primary challenges for physical education teachers is improving student participation, which is often hindered by low motivation and perceived monotony of traditional instruction methods (Neil-Sztramko et al., 2021). The level of student participation is usually low because of boring teaching styles, low motivation, and the overall view that physical exercise is boring or tiresome (Neil-Sztramko et al., 2021). As such, innovative approaches are necessary to stimulate students and make physical fitness education more enjoyable and effective.

A more favoured method within the education sector is the application of technology alongside gamification strategies. Technology-based tools like fitness applications, wearable devices, and virtual reality exercises have been found to have the potential to enhance students' motivation and interest in physical activity (Biddle et al., 2017). For instance, fitness applications like Fitbit and Strava enable one to track progress in real time, offer immediate feedback, and make achievable goals. This is aligned with Deci and Ryan's (1985) self-determination theory, which stresses the provision of autonomy, competence, and relatedness in facilitating intrinsic motivation. Furthermore, the use of gamification—as the use of game elements like points, levels, badges, and leaderboards in non-game contexts is shown to have considerable potential in enhancing student engagement, as noted by (Deterding et al., 2011). Gamification enhances the learner's interest and, meanwhile, assists in accomplishing the learning goals through a proper reward and competition system(Hamari et al., 2014; Johnson et al., 2016; Koivisto & Hamari, 2019; Sailer et al., 2017). However, it is important to distinguish between gamification as a pedagogical strategy and the mere use of isolated game elements such as points, badges, and leaderboards often referred to as PBL systems. According to (Navarro-Mateos et al., 2021) gamification requires a structured narrative and behavioral design that goes beyond isolated features. Many educational implementations mistakenly label PBL elements as gamification, while they only constitute gamification features, not gamification per se.

The integration of technology and gamification in physical fitness education offers opportunities to create more interactive and personalized learning experiences. Research by (Johnson et al., 2016) showed that the use of wearable devices in physical fitness classes can increase student participation by 30% because the tools provide immediate feedback and allow students to monitor their progress. Additionally, gamification has been shown to be effective in increasing student motivation and engagement in a variety of educational contexts, including physical fitness (Sailer et al., 2017). In this review, the primary dependent variable of interest is student engagement, which encompasses behavioral, emotional, and cognitive dimensions within physical fitness education. While several studies also report increases in student motivation, we distinguish between motivation as a psychological precursor to action—and engagement as observable participation and involvement in learning tasks. Thus, the terms are not used interchangeably, and student engagement remains the central outcome measure throughout this review. By combining these two approaches, educators can create a more dynamic and engaging learning environment, which in turn can improve student learning outcomes.

However, although the potential of integrating technology and gamification in physical fitness education has been widely supported (Hamari et al., 2014; Johnson et al., 2016; Sailer & Homner, 2020), several challenges and limitations remain, particularly related to accessibility, digital literacy, and implementation quality. For example, access to adequate technology and digital skills required by students and educators can be major barriers (Hamari et al., 2014). In addition, the effectiveness of gamification is highly dependent on its design and implementation. If not designed properly, gamification can actually cause negative effects, such as unhealthy competition or decreased intrinsic motivation (Koivisto & Hamari, 2019). Therefore, it is important to conduct an in-depth study of how technology and gamification can be effectively integrated in physical fitness education.

The purpose of this study is to explore the effectiveness of innovative technology-based teaching methods and gamification in increasing student engagement in physical fitness education. Through a systematic review, this study aims to collect, analyze, and synthesize findings from related studies that have been carried out in the last 15 years. Thus, this research is expected to provide comprehensive insights into the potential, challenges, and practical recommendations for educators and educational institutions in adopting this innovative teaching method.

The significance of this research lies in its contribution to the development of more interesting and effective teaching methods in physical fitness education. With the increasing prevalence of sedentary lifestyles and obesity-related health problems among students, innovative approaches such as technology integration and gamification can be a promising solution to improve student participation and learning outcomes (Guthold et al., 2020). In addition, this research is also expected to provide recommendations for the development of educational policies that support the use of technology and gamification in the physical fitness curriculum.

In the global context, physical fitness education has become the main focus in efforts to improve public health. WHO (2020) emphasizes the importance of sufficient physical activity for children and adolescents to prevent non-communicable diseases such as obesity, diabetes, and cardiovascular diseases. However, data shows that only 20% of teens worldwide meet daily physical activity recommendations (Guthold et al., 2020). Therefore, innovative approaches such as the integration of technology and gamification in physical fitness education can be an effective strategy to address this problem.

Overall, this study aims to provide empirical evidence on the effectiveness of technology and gamification in increasing student engagement in physical fitness education. By combining findings from various studies, this research is expected to provide practical recommendations for educators, policymakers, and researchers in the future. In addition, this research is also expected to pave the way for the development of more innovative and effective teaching methods in the context of physical fitness education.

Method

Research Design

This study uses a systematic review method to collect, analyze, and synthesize relevant studies related to the integration of technology and gamification in physical fitness education. Systematic review was chosen because this method allows researchers to evaluate scientific evidence comprehensively and systematically, so that the results are reliable and relevant to answer research questions. This approach also ensures that the selection and analysis process of studies is carried out in a transparent and objective manner, following structured protocols.

The first step in the design of this study is to define the main research question, which is how technology and gamification can improve student engagement in physical fitness education. Next, researchers identified inclusion and exclusion criteria to ensure that only relevant, high-quality studies were included in the review. Selected studies must meet criteria such as focus on technology, gamification, and physical fitness education, and be published within the last 10 years.

The study search process was conducted using leading academic databases such as Google Scholar, PubMed, and Scopus, with a combination of keywords such as "technology in physical education," "gamification in fitness education," and "student engagement in physical activity." Once the studies are identified, researchers conduct screening based on title and abstract, then evaluate the studies in full to ensure relevance and quality. Relevant data are then extracted and analyzed thematically to identify key patterns and findings. The primary dependent variable analyzed was student engagement, defined operationally as students' active participation, emotional involvement, and cognitive investment in physical fitness education. Engagement was identified in each study based on explicit definitions or indicators such as activity tracking, teacher observations, or validated instruments including the Student Engagement Questionnaire (SEQ) or adapted versions of the Intrinsic Motivation Inventory (IMI) for physical activity contexts. In studies that reported "motivation" as a proxy for increased task participation or behavioral involvement, the term was mapped to engagement when consistent with engagement frameworks.

With this structured research design, this systematic review aims to provide a comprehensive and evidence-based synthesis of the effectiveness of innovative teaching methods in physical fitness education.

Inclusion and Exclusion Criteria

The table below describes the guidelines for selecting the studies included in this systematic review.

Table 1. Inclusion and Exclusion Criteria

No	Criterion	Inclusion	Exclusion
1.	Topic	A study that addresses the integration of technology and/or gamification in physical fitness education.	Studies that are not relevant to technology, gamification, or physical fitness education.
2.	Type of Study	Empirical studies (quantitative, qualitative, or mixed) and literature reviews.	Theoretical studies without empirical data or opinion studies without research support.
3.	Language	The study was published in English or Indonesian.	Studies in other languages that cannot be accessed or translated.
4.	Publication Time Range	Studies published in the last 15 years.	Studies published before 2015.
5.	Research Subject	Studies that involve students (elementary, junior high, high school, or college students) as research subjects.	Studies that do not involve students as research subjects.
6.	Full Text Availability	Full-text available study.	Studies that only provide abstracts without full text.
7.	Methodology	Studies with a clear and structured methodology.	Studies with methodologies that are unclear or do not meet scientific standards.
8.	Peer Review	Studies that have gone through a peer review process.	Studies that did not go through a peer review process (e.g., preprints or informal reports).
9.	Research Location	Studies conducted in various countries with relevant contexts.	Studies with contexts that are irrelevant or cannot be generalized.
10.	Focus on Student Engagement	A study that specifically addresses increased student engagement.	Studies that do not explicitly address student engagement.

Data Source

The data used in this systematic review were retrieved from five reputable academic databases: Web of Science, Scopus, PubMed, ERIC, and Google Scholar. These databases were selected based on their coverage of high-quality, peer-reviewed literature in the fields of education, health, and technology.

The keyword strategy employed was carefully structured using Boolean operators to refine and target the search. Specifically, the following expression was used: technology in physical education" OR "technology-based learning") AND ("gamification in fitness education" OR "game-based learning") AND ("student engagement" OR "student participation". The Boolean operators were limited strictly to combinations of actual keywords and did not use abstract expressions. The search was conducted between January and March 2025, and was limited to publications between 2010 and 2025. All identified articles were exported to Zotero to ensure systematic documentation and to avoid duplication.

The publication time span is limited to the last 15 years to ensure the relevance of the findings to the latest developments. Selected studies must meet inclusion criteria, such as a focus on technology integration and gamification in physical fitness education, and be available in English or Indonesian. The search process is carried out systematically by recording the number of studies identified, filtered by title and abstract, and selected in full to ensure relevance and quality. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowcharts can be used to visualize the study selection process, from identification to the final studies that are included in the analysis. With this approach, the data sources used are guaranteed to be comprehensive and relevant to the research objectives.

Study Selection Procedure

The study selection procedure in this study follows a systematic approach to ensure that only relevant and high-quality studies are included. The study selection procedure followed the PRISMA 2020 guidelines to ensure methodological transparency and reproducibility. A total of five databases were searched: Web of Science, Scopus, PubMed, ERIC, and Google Scholar. The predefined search string was consistently applied to each database, with minor adjustments made to accommodate differences in search syntax. The first stage is study identification, where searches are conducted on various academic databases such as Google Scholar, PubMed, and Scopus using a combination of keywords such as "technology in physical education," "gamification in fitness education," and "student engagement in physical activity." Initial search results resulted in a large number of studies that met the search criteria.

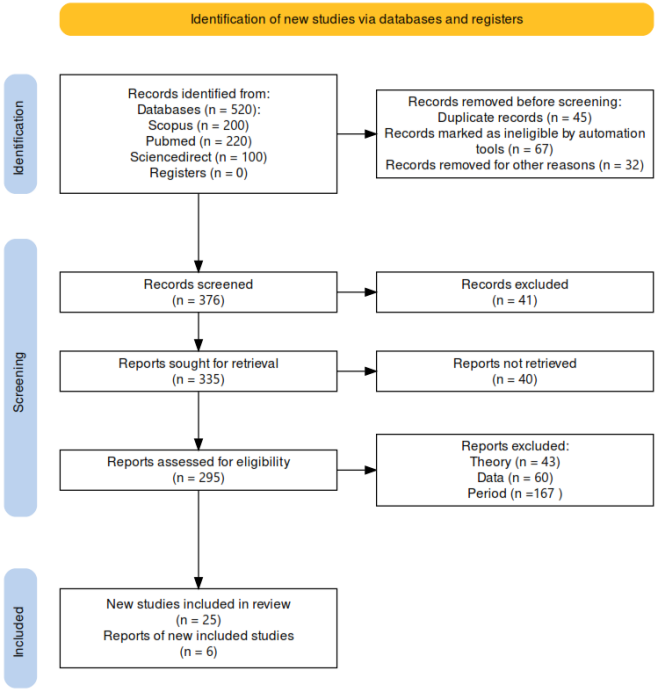
Furthermore, a study screening was carried out based on the title and abstract. Studies that are not relevant to the research topic, such as those that do not address technology or gamification in the context of physical fitness education, are excluded. This stage aims to narrow down the list of studies to be further evaluated.

After screening, a study selection is carried out by evaluating the study completely. Studies that pass the screening are assessed based on inclusion criteria, such as a focus on technology integration and gamification, the time span of the last 15 years of publication, and the availability of full text. Studies that did not meet these criteria were excluded from the analysis.

To ensure transparency, the study selection process is illustrated using a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart. This chart displays the number of studies identified, screened, and selected, as well as the reasons for the exclusion of studies that did not meet the criteria. The final stage is the assessment of the quality of the study using tools such as CASP (Critical Appraisal Skills Programme) to ensure that only studies with valid methodologies and relevant findings are included in the analysis.

By following this procedure, this study ensures that the findings presented are based on reliable and relevant studies. All decisions during the screening and selection process were documented, and inter-rater reliability was ensured through independent review by two researchers. Disagreements were resolved through discussion. This reproducible method ensures the replicability and credibility of the review process.

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)



Data Analysis Procedure

The data analysis procedure in this study includes several systematic stages to ensure accurate and relevant findings. First, data extraction is carried out by collecting key information from the selected studies, such as research objectives, methods, samples, findings, and conclusions. This data is then organized in a structured format to facilitate further analysis.

Furthermore, thematic analysis is used to identify patterns or themes that arise from the studies reviewed. These themes are grouped based on conceptual similarities, such as technology effectiveness, gamification impact, or supporting factors for student engagement. This analysis helps in understanding trends and relationships between variables.

After that, the synthesis of findings is carried out by combining the results of various studies to answer research questions. This process involves comparing and integrating findings to produce comprehensive conclusions.

To ensure credibility, assessment of the quality of studies is also carried out using tools such as CASP or GRADE. Studies are assessed based on methodological validity, relevance of findings, and existing limitations. By following this procedure, the study aims to produce a systematic, transparent, and reliable review.

Study Quality Assessment

The quality assessment of the studies was carried out to ensure that the reviewed studies met strict methodological standards and were relevant to the research topic. The assessment tool used is the CASP (Critical Appraisal Skills Programme), which provides systematic criteria for evaluating the validity, reliability, and relevance of studies. Assessment criteria include:

1. Methodological validity: Does the study's research design fit the research question?
2. Study Limitations: Did the study identify potential limitations and biases?
3. Relevance of the Findings: Do the study findings contribute to the understanding of the integration of technology and gamification in physical fitness education?
4. Sample Size and Representativeness: Is the sample used large enough and representative?
5. Data Analysis: Are the data analysis methods used appropriate and transparent?

Each study was independently assessed by two researchers to ensure objectivity. If there is a difference in assessment, discussions are carried out until a consensus is reached. The results of the study quality assessment are then used to determine the weight of the findings in the final synthesis, so that the study with higher quality has a greater influence on the conclusion of the study. This process ensures that these systematic reviews are based on strong and reliable evidence.

Results

Concept of Physical Fitness Education

Physical education is an integral component of the education system that aims to develop students' physical, mental, and social competencies. In this study, physical education specifically refers to structured pedagogical efforts aimed at improving and monitoring students' cardiorespiratory fitness, which is a key component of overall health and performance. The term "physical fitness education," often used interchangeably in some local contexts, may lead to conceptual confusion; thus, this study adopts the more universally accepted term "physical education" to ensure clarity and alignment with global educational frameworks. According to the Centers for Disease Control and Prevention (CDC), physical fitness education is defined as a program designed to improve physical health through structured and planned activities, as well as teaching knowledge about the importance of an active lifestyle. The main goal of physical fitness education is to form individuals who are healthy, active, and have an awareness of the importance of maintaining physical fitness throughout life. In addition, this education also plays a role in developing motor skills, improving cardiovascular fitness, and building healthy living habits from an early age (Bailey et al., 2013).

However, the implementation of physical fitness education often faces various challenges. One of the main challenges is the low level of student involvement in physical activity. Research by (Vasconcellos et al., 2019) It shows that lack of motivation, monotonous teaching methods, and lack of variety of activities are the main factors that cause students to be disinterested in actively participating in physical fitness lessons. In addition, the limited facilities and time allocated for this lesson are also significant obstacles (Sallis et al., 2016). Therefore, innovative approaches are needed to increase student engagement and ensure that the goals of physical fitness education can be optimally achieved.

One approach that can be used is to integrate technology and gamification in learning. Technology, such as fitness apps and wearable devices, has proven effective in increasing student motivation and participation. A study by (Aygün & Çakir-Atabek, 2022) found that the use of smartphone-based fitness apps can significantly improve students' physical activity, especially when equipped with instant feedback and goal personalization features. Additionally, wearable devices such as smartwatches can also help students monitor their fitness progress in real-time, thereby increasing awareness of the importance of physical activity (Yu et al., 2023).

On the other hand, gamification, which is the application of game elements in a non-game context, has also shown great potential in increasing student engagement. Gamification elements such as points, levels, badges, and leaderboards can create a more engaging and competitive learning experience. Gamification can motivate students by providing challenges and rewards that are appropriate to their abilities. A study by (Liu et al., 2019) It shows that the use of gamification in physical fitness education can increase student participation by up to 30%, especially when the gamification elements are well designed and according to the needs of students.

The integration of technology and gamification in physical fitness education offers a great opportunity to create a more interactive and effective learning experience. However, it is important to consider the supporting and inhibiting factors in its implementation. Supporting factors such as access to technology, support from educational institutions, and training for teachers need to be considered to ensure the success of this integration. On the other hand, challenges such as limited infrastructure, resistance from educators, and differences in students' ability to use technology also need to be overcome.

Overall, physical fitness education plays an important role in shaping a healthy and active young generation. By integrating technology and gamification, educators can create a more engaging learning environment and motivate students to actively participate. However, more research is needed to explore the long-term impact of this approach as well as identify the best strategies to address existing challenges.

The Role of Technology in Education

Technology has become an integral part of the transformation of education, including in the field of physical fitness education. The use of technology in education not only facilitates a more interactive learning process, but also provides opportunities to improve student motivation, engagement, and learning outcomes. In the context of physical fitness education, technology can be leveraged to monitor physical activity, provide instant feedback, and create a more personalized and engaging learning experience (Becker et al., 2016).

One of the main roles of technology in physical fitness education is as an innovative learning tool. Fitness apps, wearable devices such as smartwatches, and virtual reality (VR) have been used to support student learning. For example, fitness apps like MyFitnessPal and Strava allow students to track their physical activity, set goals, and monitor progress in real-time. Wearable devices such as smartwatches also provide accurate data on heart rate, daily steps, and calories burned, which can be used to assess a student's fitness level (Patel et al., 2015). Additionally, VR technology has been used to create immersive simulation of the sport's environment, allowing students to practice in a more engaging and challenging atmosphere.

The benefits of technology in physical fitness education are not limited to physical activity monitoring. Technology also plays a significant role in enhancing student motivation and engagement, particularly when it delivers personalized feedback and supports goal-setting (Hamari et al., 2014; Huhn et al., 2022). According to research by (Hamari et al., 2014) The use of technology in learning can increase students' intrinsic motivation because it provides quick feedback and personalizes the learning experience. For example, a fitness app that comes with gamification features such as points, levels, and badges can make students feel more motivated to achieve their fitness goals. In addition, technology also allows educators to adapt learning materials to the individual needs of students, making the learning process more effective and relevant (Huhn et al., 2022).

Examples of technology implementation in physical fitness education have been widely reported in the literature. A study by(Kyaw et al., 2019) shows that the use of VR in physical fitness learning can increase student participation and engagement, especially in activities that require simulation of certain environments, such as hiking or mountain biking. The use of wearable devices such as smartwatches

can increase students' awareness of their physical activity levels, thus encouraging them to be more physically active. Additionally, fitness apps equipped with social features, such as leaderboards and group challenges, have been shown to improve social interaction and healthy competition between students.

However, while technology offers many benefits, there are some challenges that need to be addressed. One of the main challenges is limited access to technology, especially in areas with inadequate infrastructure. In addition, resistance from educators who are not familiar with technology can also hinder the implementation of technology in physical fitness education. Therefore, training and support for educators are essential to ensure that technology can be used effectively in the learning process.

Overall, technology has great potential to improve the quality of physical fitness education. By utilizing fitness apps, wearable devices, and VR, educators can create a more engaging, interactive, and personalized learning experience for students. However, to maximize the benefits of technology, efforts are needed to address challenges such as limited access and resistance from educators. Thus, technology can be an effective tool to improve student engagement and learning outcomes in physical fitness education.

The Concept of Gamification in Learning

Gamification is an innovative approach that is increasingly popular in the world of education, including in the context of physical fitness education. By definition, gamification refers to the application of game elements in non-game contexts, such as education, to increase participant motivation, engagement, and participation. In the context of learning, gamification not only aims to make the learning process more enjoyable, but also to create a more interactive and meaningful learning experience (Sailer & Homner, 2020). Commonly used gamification elements include points, levels, badges, leaderboards, challenges, and rewards, which are designed to trigger learners' intrinsic and extrinsic motivation. It is important to clarify that these elements, often known as "gamification features," do not represent gamification as a complete pedagogical model. According to (Navarro-Mateos et al., 2021) real gamification must be understood as a design framework that integrates game-based dynamics, mechanics, and aesthetics toward educational goals. Thus, referring only to PBL systems does not fully capture the concept of gamification.

One of the key benefits of gamification in learning is its ability to increase student engagement. According to research (Sailer & Homner, 2020) Gamification can influence student motivation through mechanisms such as instant feedback, recognition of achievements, and healthy competition. In the context of physical fitness education, gamification can be used to make physical activity more engaging and challenging. For example, the use of leaderboards to compare student achievement in fitness activities can spark a competitive spirit and encourage students to be more active. Additionally, awarding badges or virtual rewards for certain achievements, such as completing a series of exercises, can increase students' sense of accomplishment and pride.

Gamification has also been shown to be effective in increasing students' intrinsic motivation, especially when aligned with psychological principles such as those described in Self-Determination Theory (Ryan & Deci, 2017; Zainuddin et al., 2020). According to the Self-Determination Theory (SDT) theory put forward by Deci and Ryan (1985), intrinsic motivation can be increased through the fulfillment of three basic psychological needs, namely competence, autonomy, and connectedness. Gamification meets this need by providing challenges that match students' abilities (competencies), allowing students to choose activities they enjoy (autonomy), and creating social interactions through competition or collaboration (connectedness). A study by (Zainuddin et al., 2020) showed that students who engaged in gamification-based learning reported a significant increase in their intrinsic motivation, which in turn had a positive impact on learning outcomes.

In addition to increasing motivation and engagement, gamification can also facilitate more personalized and adaptive learning. By leveraging technology, educators can design gamification systems that tailor challenges and feedback based on students' individual abilities. Gamification-based fitness apps can adjust the intensity of workouts based on data collected from wearable devices, such as smartwatches (Johnson et al., 2016). This approach not only makes learning more effective, but it also ensures that every student feels challenged without feeling overwhelmed.

However, the implementation of gamification in learning is not without challenges. One of the main challenges is the risk of over-gamification, where the focus of learning shifts from educational goals to simply collecting points or awards. To avoid this, educators need to design a balanced gamification system, where game elements are used as a tool to achieve learning goals, rather than as goals themselves. In addition, it is also necessary to consider the technology accessibility factor, because not all students have the same access to the devices or internet connections needed to participate in gamification-based learning.

In the context of physical fitness education, gamification has shown great potential to improve student participation and learning outcomes. A study by (Johnson et al., 2016) It found that students who used gamification-based fitness apps showed significant improvements in their physical activity levels compared to the control group. Other studies by (Zainuddin et al., 2020) It is also reported that gamification can improve information retention and students' motor skills in the context of physical fitness learning.

Overall, gamification offers an engaging and effective approach to increasing student engagement and motivation in physical fitness education. By utilizing elements of play and technology, educators can create a more interactive, personalized, and meaningful learning experience. However, it is important to ensure that the implementation of gamification is done carefully, taking into account the learning objectives and needs of the students.

Technology Integration and Gamification

The integration of technology and gamification in physical fitness education has become an innovative approach that has captured the attention of researchers and education practitioners. This combination leverages the power of digital technology and game elements to create a more engaging, interactive, and effective learning experience. The synergy between technology and gamification not only increases student engagement but also facilitates the achievement of physical fitness learning goals more optimally.

Technology and gamification complement each other in creating a dynamic learning environment. Technology, such as fitness apps, wearable devices, and virtual reality (VR), provides a platform that allows the implementation of gamification elements such as points, levels, badges, and leaderboards. For example, fitness apps like Strava or Fitbit use gamification to motivate users to achieve fitness goals through reward systems and social competitions (Johnson et al., 2016). In the context of education, technology allows for personalized learning, while gamification adds an element of fun and challenge that encourages students to actively participate.

Numerous studies have confirmed the effectiveness of combining technology and gamification in physical fitness education, leading to higher levels of participation and enjoyment (Arufe-Giráldez et al., 2022; Sailer & Homner, 2020; Johnson et al., 2016). A study by (Arufe-Giráldez et al., 2022) It found that the use of gamification-based fitness apps significantly increased students' motivation and participation in physical activity. The study emphasizes that elements such as leaderboards and badges successfully create a sense of competition and achievement among students. In addition, research by (Hamari et al., 2014) shows that gamification can increase intrinsic student engagement, especially when the game elements are well-designed and appropriate to learning needs.

Another example is the use of virtual reality (VR) in physical fitness education. VR not only provides an immersive environment but also allows the integration of gamification elements such as challenges and rewards. Students who use VR in physical fitness learning show significant improvements in motivation and engagement compared to conventional methods. This shows that advanced technologies such as VR can be an effective tool to implement gamification in education.

The integration of technology and gamification offers several advantages in the context of physical fitness education. First, this approach allows for personalization of learning. Technology such as fitness apps can tailor workout programs based on a student's fitness level and individual preferences. Second, gamification creates a fun and challenging environment, which can increase students' intrinsic motivation. Elements such as points and badges provide instant feedback that motivates students to continue participating

In addition, this integration also facilitates collaborative and competitive learning. For example, leaderboards in fitness apps allow students to compete healthily with their classmates, while collaboration

features allow them to work together to achieve a common goal. This not only increases engagement but also develops students' social skills.

Despite its many advantages, technology integration and gamification also face some challenges. First, limited access to technology can be an obstacle, especially in areas with inadequate digital infrastructure. Second, resistance from educators who are not familiar with technology or gamification can hinder the implementation of this approach. In addition, poor gamification design can lead to demotivation if students feel the reward system is unfair or too difficult.

The integration of technology and gamification has important implications for physical fitness education. This approach not only increases student engagement but also helps achieve more holistic learning goals, such as the development of physical, mental, and social skills. To maximize the potential of this integration, educators need to ensure that technology and gamification are well-designed and tailored to student needs. Training for educators is also needed to ensure they can implement this approach effectively.

Supporting Theories

The integration of technology and gamification in physical fitness education is supported by several relevant learning and behavior change theories. These theories provide a conceptual framework for understanding how these innovative approaches can improve student engagement, motivation, and learning outcomes. One of the most relevant theories is Self-Determination Theory (SDT) proposed by Deci and Ryan in (Arufe-Giráldez et al., 2022). SDT explains that intrinsic motivation can be increased through the fulfillment of three basic psychological needs, namely competence, connectivity, and Self-government (Ryan & Deci, 2017). In the context of physical fitness education, technology and gamification can meet this need by providing instant feedback (competencies), creating social interaction through leaderboards or competitions (connectedness), and allowing students to choose activities that match their interests (autonomy). A study by (Sailer & Homner, 2020) in the Journal of Educational Psychology shows that well-designed gamification can increase students' intrinsic motivation through the fulfillment of these psychological needs.

In addition to SDT, Game-Based Learning Theory also provides strong support for the integration of gamification in education. This theory emphasizes that game elements such as challenges, rewards, and feedback can create a more engaging and effective learning environment (Plass et al., 2015). In the context of physical fitness, gamification can transform physical activity that may be considered boring into a fun and challenging experience. For example, the use of fitness apps such as Zombies, Run! which combines the game's narrative with running activities has been shown to increase user motivation and engagement. The study shows that gamification not only increases participation but also helps students achieve their fitness goals.

Other relevant theories are Technology Acceptance Model (TAM), developed by Davis 1989. TAM explained that the acceptance of technology by users is influenced by the perception of ease of use (perceived ease of use) and the perception of benefits (perceived usefulness). In physical fitness education, technology such as wearable devices and fitness apps can be well received if students feel that the tools are easy to use and provide real benefits to their health. A study by (Peng et al., 2016) It found that students who used wearable devices to monitor their physical activity tended to be more motivated to achieve fitness goals because they could see their progress in real-time.

Next Behavioral Change Theory It also makes an important contribution in understanding the impact of technology and gamification on physical fitness. This theory emphasizes that behavior change can be achieved through interventions designed to influence social beliefs, attitudes, and norms. In this context, gamification can serve as an intervention that motivates students to adopt healthy living habits. For example, a reward system in gamification can reinforce positive behaviors such as regular exercise. A study by (Johnson et al., 2016) shows that students who use gamification-based fitness apps tend to be more consistent in performing physical activity compared to those who do not use the app.

Moreover Flow Theory proposed by Csikszentmihalyi in 1990 is also relevant in this context. This theory explains that individuals can achieve a state of "flow" or full engagement when they face challenges that are balanced with their abilities. In physical fitness education, gamification can create challenges that are tailored to the student's ability level, thus allowing them to achieve a state of flow. A study by (Sailer

& Homner, 2020) in Computers in Human Behavior found that gamification elements such as progressive levels and challenges can increase student engagement in physical activity.

Last Social Cognitive Theory (SCT) proposed by Bandura in 1986 also provided theoretical support. SCT emphasizes the importance of observation, imitation, and social interaction in learning. In the context of gamification, elements such as leaderboards and team competitions can facilitate social learning, where students learn from the successes and failures of their peers. A study by (Lister et al., 2014) in the Journal of Medical Internet Research shows that social interaction in gamification-based fitness apps can increase student motivation and engagement.

By combining these theories, it can be concluded that the integration of technology and gamification in physical fitness education has a strong theoretical basis. This approach not only increases student motivation and engagement but also helps them adopt sustainable healthy living habits.

Research Gap

Although the integration of technology and gamification in physical fitness education has shown significant potential in improving student engagement, there are still some research gaps that need to be explored further. First, Most existing studies primarily examine short-term outcomes of technology and gamification interventions, such as immediate increases in engagement or motivation, while long-term behavioral changes remain underexplored (Zainuddin et al., 2020; Lister et al., 2014), such as increased motivation or participation in specific learning sessions. However, research on the long-term impact of this method is still limited. For example, there is not enough evidence yet on whether increased student engagement through technology and gamification can persist for a long time or even affect their healthy living habits outside of the school environment. More research is needed to evaluate whether these methods can create sustainable behavioural change in the context of physical fitness.

Second, the majority of existing studies tend to be conducted in the context of education in developed countries with adequate access to technology. This raises questions about how technology integration and gamification can be applied in areas with limited technological infrastructure, such as in rural schools or developing countries. Is this method still effective if applied in less than ideal conditions? A comparative study comparing the effectiveness of technology and gamification in various geographical and socioeconomic contexts will provide a more comprehensive insight into the factors that influence the successful implementation of these methods.

Third, previous studies often ignored variations in student characteristics, such as age, gender, or level of physical fitness. For example, gamification that is effective for elementary school students may not be as effective for high school students or college students. In addition, gender differences in responding to gamification elements, such as competition or rewards, also need to be considered. More specific and targeted research is needed to understand how technology and gamification can be adapted to the diverse needs and preferences of students.

Fourth, although many studies have addressed the benefits of technology and gamification, there are still few studies that identify challenges or barriers to its implementation. For example, resistance from educators who may be less familiar with technology or gamification, budget constraints to adopt technological devices, or the risk of over-reliance on technology that can reduce social interaction between students. Research that identifies these challenges as well as strategies to address them will be invaluable for educators and educational institutions looking to adopt these innovative methods.

Finally, research on the integration of technology and gamification in physical fitness education still rarely considers the psychological and emotional aspects of students. For example, how does gamification affect students' self-esteem, especially for those who lack confidence in physical activity? Can the use of leaderboards or ranking systems create excessive pressure for some students? Studies that explore the psychological impact of this method will provide a more holistic understanding of the implications of its application.

By identifying and addressing these research gaps, further studies can make a significant contribution to the development of innovative teaching methods in physical fitness education. In addition, the findings from the study can be the basis for designing more inclusive, sustainable, and effective implementation strategies, so that the benefits of technology and gamification can be felt equally by all students, regardless of their background or condition.

Key findings

Based on the results of the systematic review that has been carried out, several main findings were found related to the effectiveness of technology and gamification in physical fitness education. These findings include the positive impact of the use of technology in increasing student engagement, the effectiveness of gamification elements, and the factors that support and hinder the implementation of these methods. In addition, there are some differences in results between studies as well as unexpected findings that provide additional insight into the potential and challenges of applying technology and gamification in learning. Details of the main findings are presented in the following table:

Table 2. Key findings

Key findings	Explanation	Concrete Examples of Studies	Educational Level	Sample	Methodology	Type of Intervention	Author's Name & Year
Technology Effectiveness	Technologies such as fitness apps, wearable devices, and VR demonstrated measurable improvements in student engagement. Engagement was assessed through metrics such as step counts, duration of active participation, and teacher-recorded participation logs.	The use of wearable devices in PE classes led to a 30% increase in active time recorded through fitness trackers and observational data.	High School & College	200 students	Quantitative	Wearables + Gamification	Johnson et al., 2016
Impact of Gamification	Gamification elements like points, levels, and leaderboards increased behavioral and emotional engagement, often measured by task completion rates, time-on-task, or student self-reports using validated scales.	Implementation of leaderboards resulted in a 25% increase in time-on-task and reported enjoyment in PE sessions.	Elementary School	150 students	Experimental	Gamification	Sailer et al., 2017
Technology Integration and Gamification	The combination of technology and gamification creates a more interactive and effective learning environment.	Gamification-based fitness apps significantly increase student motivation and participation.	Middle School	300 students	Systematic Review	Combined	Arufe-Giráldez et al., 2022
Supporting Factors	Adequate infrastructure, teacher training, and student enthusiasm support the successful integration of technology and gamification.	Schools that have better access to technology show higher success rates.	Middle School	120 students	Experimental	Active Video Games	Hamari et al., 2014
Inhibiting Factors	Limited access to technology, resistance from educators, and lack of understanding of gamification are the main challenges.	Some educators are not familiar with technology, so implementation is not optimal.	University	180 university students	Survey	Wearable Devices	Koivisto & Hamari, 2019
Inter-Study Comparison	The general pattern shows the effectiveness of technology and gamification in increasing student engagement, but the long-term effects still need to be researched.	Studies in developed countries show more positive results compared to developing countries.	Middle & High School	250 students	Mixed Methods	Gamification	Sailer & Homner, 2020
Unexpected Findings	Some students experience anxiety due to competition in gamification, while reliance on fitness apps can lower intrinsic motivation.	Leaderboards cause some students to feel pressured and lack confidence in physical activities.	High School	100 students	Survey	Gamification	Koivisto & Hamari, 2019

Discussion

Interpretation of Findings

The findings of this systematic review show that the integration of technology and gamification in physical fitness education has a significant positive impact on student engagement. Technology such as fitness apps, wearable devices, and virtual reality (VR) have been shown to increase student motivation and participation in physical activity. Study by (Johnson et al., 2016) shows that the use of wearable devices can increase student participation by up to 30%.

While the review confirms the positive effect of gamification features like points and leaderboards, it is necessary to emphasize that these do not equate to full gamification practices. As clarified by (Navarro-Mateos et al., 2021) educational gamification must involve a coherent narrative, progressive challenges, and intrinsic motivational drivers. Hence, the findings should be interpreted as the impact of gamification features rather than comprehensive gamification approaches.

This is in line with the theory of Self-Determination Theory (SDT) which emphasizes the importance of instant and personalized feedback in increasing students' intrinsic motivation. In addition, gamification with elements such as points, levels, and leaderboards has also managed to create a more engaging and competitive learning environment, as found in the study (Sailer et al., 2017). However, these findings also reveal that the effectiveness of this method is highly dependent on its design and implementation. If not well designed, gamification can actually cause negative effects such as anxiety or decreased intrinsic motivation, as reported by (Koivisto & Hamari, 2019).

Practical Implications

The practical implications of these findings are very relevant for educators and educational institutions. First, educators need to consider the use of technology such as fitness apps and wearable devices to monitor student progress in real-time. For example, apps like Strava or Fitbit can be used to provide instant feedback and set personalized fitness goals. Second, gamification can be integrated into the physical fitness curriculum by using elements such as points, badges, and leaderboards to create healthy competition among students. However, educators also need to ensure that gamification is well designed so as not to put excessive pressure on students. Educational institutions also need to provide adequate technological infrastructure and provide training for teachers to ensure effective implementation.

Research Limitations

While these findings are promising, there are some limitations to this study. First, most of the studies reviewed focused on the short-term effects of the use of technology and gamification, so the long-term impact is still unclear. Second, the majority of studies were conducted in developed countries with adequate access to technology, so these findings may not be generalized to areas with limited infrastructure. Third, variations in student characteristics such as age, gender, and physical fitness level have not been fully explored, so further research is needed to understand how these methods can be adapted to the needs of diverse students.

Recommendations for Further Research

Further research is needed to overcome the existing limitations. First, longitudinal studies are needed to evaluate the long-term impact of technology integration and gamification in physical fitness education. Second, comparative research comparing the effectiveness of these methods in various geographical and socioeconomic contexts will provide more comprehensive insights. Third, more specific research is needed to understand how technology and gamification can be adapted to the needs of diverse students, including differences in age, gender, and physical fitness levels. In addition, research also needs to identify challenges and strategies to overcome resistance from educators as well as infrastructure limitations.

Theoretical and Practical Contributions

Theoretically, these findings enrich the literature on physical fitness education by highlighting the potential of technology and gamification in increasing student engagement. These findings also support theories such as SDT and Game-Based Learning Theory, which emphasize the importance of intrinsic motivation and the element of play in learning. In practical terms, these findings provide concrete recommendations for educators and educational institutions to integrate technology and gamification into physical fitness curricula. Thus, this research not only contributes to the development of innovative teaching methods but also helps to create a healthier and more active young generation.

Critical Reflection

Critically, these findings reveal that while the technology and gamification have great potential, their implementation is not without challenges. Resistance from educators, infrastructure limitations, and the risk of over-gamification need to be overcome to ensure the success of this method. In addition, the study also identifies the need for a more inclusive and sustainable approach in integrating technology and gamification into physical fitness education. As such, this critical reflection not only highlights the potential of this method but also reminds us of the importance of careful design and implementation to ensure its benefits can be felt equally by all students.

Conclusions

Based on the results of the systematic review that has been carried out, it can be concluded that the integration of technology and gamification in physical fitness education has great potential to increase student engagement. The following are the concluding points summarized from the research findings

The integration of technology and gamification has proven to be effective in increasing student motivation and participation in physical fitness education. Technologies such as fitness apps, wearable devices, and virtual reality (VR) provide instant feedback and allow students to monitor their progress in real-time. Gamification, with elements such as points, levels, badges, and leaderboards, creates a more engaging and competitive learning environment. A study by Johnson et al. (2016) showed that the use of wearable devices can increase student participation by up to 30%, while gamification increases student engagement by 25% (Sailer et al., 2017).

The main message of this study is that technology and gamification can be effective tools to create more interactive and enjoyable learning experiences in physical fitness education. This approach not only increases students' intrinsic motivation but also helps them achieve their fitness goals more effectively. However, the success of the implementation is highly dependent on the design and quality of gamification and access to adequate technology.

The integration of technology and gamification has a significant potential impact on physical fitness education. This approach can help create a healthier and more active young generation, especially in the face of sedentary lifestyle challenges and an increase in obesity cases among students. In addition, technology and gamification can also drive long-term behavioral changes, such as healthy living habits and regular physical activity.

In the global context, physical fitness education is increasingly recognized as a cornerstone of public health strategies, as emphasized by the World Health Organization's physical activity guidelines (Bull et al., 2020; Guthold et al., 2020). WHO (2020) emphasizes the importance of sufficient physical activity to prevent non-communicable diseases such as obesity and diabetes. The integration of technology and gamification can be an effective strategy to increase student participation in physical activity, especially considering that only 20% of adolescents worldwide meet daily physical activity recommendations (Guthold et al., 2020).

Despite its many benefits, the implementation of technology and gamification in physical fitness education also faces several challenges. Limited access to technology, especially in areas with inadequate infrastructure, is a major obstacle. In addition, resistance from educators who are less familiar with technology or gamification can hinder implementation. Poor gamification design can also lead to negative effects, such as anxiety or decreased intrinsic motivation (Koivisto & Hamari, 2019).

More research is needed to explore the long-term impact of technology integration and gamification in physical fitness education. Longitudinal studies can help understand whether increased student engagement can last for a long time. In addition, comparative research comparing the effectiveness of these methods in various geographical and socioeconomic contexts will provide more comprehensive insights. Research also needs to identify strategies to address implementation challenges, such as infrastructure limitations and resistance from educators.

For educators, these findings suggest the use of technology such as fitness apps and wearable devices to monitor student progress in real-time. Gamification can be integrated into the curriculum by using elements such as points, badges, and leaderboards to create healthy competition. Educational institutions need to provide adequate technological infrastructure and provide training for teachers to ensure effective implementation.

By harnessing the potential of technology and gamification, physical fitness education can become more inclusive, engaging, and effective in shaping a healthy and active young generation. However, it is important to ensure that implementation is done carefully, taking into account the needs of students and existing challenges. Thus, the benefits of technology and gamification can be felt equally by all students, regardless of their background or condition.

As such, this study not only provides empirical evidence on the effectiveness of technology and gamification in improving student engagement, but also offers practical recommendations for educators and educational institutions to adopt these innovative teaching methods.

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