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Research Article

Extent of Digital Game Utilisation in Teaching Physics Concepts in Secondary Schools of Murang'a County, Kenya

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Abstract
This study investigated the extent of digital games utilisation in teaching physics concepts within secondary schools of Murang'a County, Kenya. Against a backdrop of rapid technological advancement and persistent disparities in ICT infrastructure, the research aimed to evaluate how frequently physics teachers employed digital games, identify the types of games utilised, determine the physics topics addressed, assess the duration of game-based activities, and explore the methods by which these games are integrated with traditional pedagogy. Employing a descriptive survey design within a mixed-methods framework, the study collected quantitative data through structured questionnaires and gathered qualitative insights via semi-structured interviews with 11 purposively sampled teachers. Statistical analysis revealed that a majority of teachers rarely incorporate digital games in their instruction, with over half reporting no use at all, while the limited adopters predominantly use physics simulations and quiz-based games to reinforce topics such as mechanics and electricity and magnetism. Qualitative findings further indicated that barriers to wider adoption-such as inadequate teacher preparedness, time constraints, and concerns over ICT support-significantly hinder the integration of digital games despite their demonstrated potential in enhancing conceptual understanding and student engagement. The study concludes by advocating for targeted professional development, curriculum revisions, and improved ICT infrastructure to bridge the gap between the theoretical promise of digital game-based learning and its practical implementation.
Keywords: Digital Game-Based Learning (DGBL), Physics Education, ICT Integration, Simulation-Based Learning, Curriculum Innovation, Educational Technology.

1. Introduction

In an era marked by rapid technological evolution, digital game-based learning (DGBL) has emerged as a transformative force in education. The fusion of interactive digital platforms with curriculum delivery is not only redefining how students engage with content but also opening new avenues for understanding complex scientific concepts. In the context of physics education, DGBL offers immersive simulations and interactive experiences that aid in demystifying abstract phenomena, thereby fostering deeper conceptual comprehension and enhancing student motivation (Gee, 2003; Hamari *et al.,* 2014).

This study is situated within the secondary schools of Murang'a County, Kenya-a region where educational innovation is both necessary and nascent. Kenya's national commitment to integrating information and communication technology (ICT) into its educational framework (Ministry of Education-Kenya, 2016) presents both opportunities and challenges. While modern digital tools have penetrated urban centers, disparities persist in rural and resource-constrained settings. Recent investigations have underscored that infrastructure limitations, coupled with varying levels of teacher preparedness, often impede the consistent deployment of digital strategies in classroom settings (Ke, 2015). This uneven landscape raises critical questions about the real extent and efficacy of DGBL in enhancing physics instruction within the region.

Moreover, as secondary school curricula evolve to meet the demands of a knowledge-based economy, the role of digital games in facilitating learning is garnering increasing attention. Scholarly research suggests that DGBL, when integrated purposefully within the physics curriculum, can transform traditional pedagogical approaches by promoting active learning and critical thinking. However, the effective translation of digital engagement into measurable academic outcomes remains a governing challenge, particularly in contexts where traditional teaching methodologies are deeply entrenched (Squire, 2011).

Against this backdrop, the present study investigates the extent to which digital games are utilised in teaching physics concepts in secondary schools of Murang'a County, Kenya. It seeks to unravel not only the prevalence of these innovative tools but also the challenges and opportunities that characterize their implementation. By drawing on empirical evidence from both global and local contexts, this research aims to inform policy and practice, paving the way for more integrated and effective educational strategies that harness the potential of digital games in fostering scientific inquiry.

1.1. Objective

The study's objective was to examine the extent to which digital games are utilised in teaching physics concepts in secondary schools.

1.2. Guiding Research Questions

The current study was guided by the following questions:

1) How frequently do physics teachers utilise digital games in their instruction?
2) What types of digital games are used in teaching physics concepts?
3) Which specific physics topics are taught using digital games?
4) For what duration are digital games typically utilised in physics lessons?
5) How are digital games integrated with traditional teaching methods in physics instruction?

2. Literature Review

2.1. Utilization of Digital Games in Physics Instruction

Digital games in physics education offer interactive and immersive experiences that significantly enhance student engagement and understanding of abstract concepts. Research by Wang *et al.,* (2022) demonstrates that DGBL can lead to improved academic outcomes and more positive attitudes toward physics. In practice, digital games enable students to visualize phenomena that are difficult to grasp through traditional instruction alone. For instance, simulations such as those in 'Supercharged!' and 'SURGE Next' have proven effective in conveying complex topics like electromagnetism and Newtonian mechanics, as documented by Anderson and Barnett (2013) and Sengupta *et al.,* (2015). Recent studies further reveal that such interactive tools not only promote conceptual clarity but also foster critical thinking and problem-solving skills. Complementary research by Hamari *et al.,* (2016) and Vlachopoulos and Makri (2017) support the notion that integrating well-designed digital games into physics curricula enhances cognitive flexibility and long-term retention by providing adaptive challenges and immediate feedback.

The theoretical underpinnings of digital game-based learning are largely grounded in cognitive and constructivist theories, which emphasize active learning and knowledge construction through direct experience. Li and Tsai (2013) argue that successful educational games seamlessly integrate learning objectives into their gameplay mechanics, enabling students to build robust conceptual frameworks through experiential inquiry. This approach is further enriched by embedding metacognitive strategies within the gaming experience, as highlighted by Anagnostou and Pappa (2011) and Martin *et al.,* (2019), which encourage students to reflect critically on their learning processes. Moreover, adaptive learning features incorporated in modern digital games-identified in studies by Hwang *et al.,* (2012)-tailor educational content to individual student needs, thereby optimizing engagement and mastery. Additionally, seminal work by Gee (2003) underscores the transformative potential of game-based environments in merging entertainment with rigorous academic content, ultimately fostering a more dynamic and interactive learning ecosystem in physics education.

2.2. Frequency and Types of Digital Games Utilized in Physics Instruction

The frequency and types of digital games utilized in physics instruction vary significantly across educational contexts, reflecting differences in teacher preparedness, resource availability, and curriculum alignment. Simulation-based games remain one of the most common approaches because they allow students to control and manipulate variables while observing immediate visual consequences**.** This dynamic interactivity has been linked to better conceptual understanding of complex phenomena, such as electromagnetic fields or projectile motion (Anderson and Barnett, 2013; Hamari *et al.,* 2016).

For example, the game 'Supercharged! has received attention for its effectiveness in introducing students to the principles underlying electromagnetism by providing a virtual laboratory environment where key properties can be adjusted in real time. Moreover, empirical studies indicate that digital simulations facilitate not only conceptual learning but also the development of critical thinking skills, especially when these tools provide adaptive feedback and scaffold student learning (Vlachopoulos and Makri, 2017).

Quiz-based games such as Kahoot! and Quizizz are also widely implemented in physics classrooms. These platforms support formative assessment by providing immediate, interactive feedback that can reveal both individual and group trends of understanding (Rowe *et al.,* 2017; Zainuddin *et al.,* 2020). Such games create a competitive yet collaborative atmosphere that enhances student motivation and knowledge reinforcement. Nonetheless, the adoption of more immersive game types-like role-playing games that simulate scientific inquiry or virtual field trips-remains limited. This reluctance is often attributed to teachers' concerns regarding the alignment of these more complex games with specific curriculum objectives, as well as a general uncertainty about how well they translate abstract scientific principles into a classroom context. Recent reviews suggest that increased professional development and access to curated game repositories could expand the range of game types used in physics education (Squire, 2011).

2.3. Physics Topics and Duration of Digital Game Integration

The integration of digital games in physics education is frequently tailored to specific topic areas, with mechanics and electricity emerging as the most commonly addressed subjects. Studies have shown that games such as 'Newton's Race' are particularly effective in conveying the fundamentals of force and motion by aligning in-game mechanics with Newtonian principles (Van Der Linden *et al.,* 2024).

Similarly, research by Anderson and Barnett (2013) illustrates that focused games addressing electromagnetism can significantly enhance students' mental models of electrical fields and magnetic forces. These targeted applications stem from the premise that interactive digital environments are especially well suited to topics that students often struggle to visualize through traditional teaching methods.

In addition to selecting appropriate topics, the duration of game-based learning sessions plays a crucial role in enhancing educational outcomes. Research indicates that sustained engagement—where digital games are incorporated over extended periods—yields more robust learning compared to brief, isolated interactions (Clark *et al.,* 2015). Extended sessions can support deeper immersion and allow students to engage in iterative learning cycles, where hypothesis testing, feedback, and reflection lead to meaningful learning gains. However, practical classroom constraints such as strict lesson timings and heavy curriculum demands often limit game-based activities to shorter durations, typically less than 15 minutes. This abbreviated exposure may hinder the full cognitive benefits of immersive game environments, suggesting that educators must balance activity length with curricular requirements to optimize learning (Ke, 2015).

2.4. Digital Game Integration with Traditional Teaching Methods

Integrating digital games with traditional teaching methods has emerged as an effective strategy to enrich physics instruction. This hybrid approach leverages the dynamic and engaging aspects of digital games alongside the structured, systematic delivery of conventional pedagogy. For instance, educators increasingly use games as introductory activities to pique interest at the beginning of a lesson or as follow-up exercises to reinforce content after formal instruction (Bado, 2019). Studies have shown that when digital games are used in tandem with lectures and hands-on experiments, students exhibit higher levels of engagement and improved retention of core physics concepts (Gee, 2003).

Successful integration is contingent upon thoughtful planning and alignment with learning objectives. Teachers must ensure that the mechanics of the digital game complement, rather than distract from, the underlying physics content. This usually involves curating games that are directly relevant to the curriculum and designing accompanying tasks that encourage critical analysis and application. Professional development initiatives are critical in this regard, as they can empower teachers with the pedagogical strategies and technological skills necessary for effective implementation. Recent integrative models highlight that when educators receive specific training on game-based learning and have access to adequate technological resources, the synergy between digital games and traditional instruction can lead to improved conceptual understanding and a more engaging learning environment (Ke, 2015; Squire, 2011).

3. Methodology

3.1. Context and Research Strategy

This study examines the extent to which digital games are utilised in teaching physics concepts in secondary schools of Murang'a County, Kenya. Specifically, it investigates the frequency of digital game utilisation, the types of digital games used, the specific physics topics taught using digital games, the duration of digital game use in physics lessons, and the integration of digital games with traditional teaching methods.

A descriptive survey design within a mixed-methods approach was adopted that combined quantitative data collection through questionnaires with qualitative insights from teacher interviews. The structured questionnaire provided measurable data regarding digital game usage patterns, while semi-structured interviews allowed for a deeper exploration of teachers' experiences regarding DGBL.

3.2. Participants

The study targeted 69 physics teachers from 42 secondary schools in Murang'a County that were equipped with well-functioning computer laboratories. These schools were purposefully selected to ensure that respondents had access to relevant technological resources required for digital game-based learning. From this target population, 11 physics teachers were purposively sampled to participate in the study.

Participants were provided with detailed information regarding the study's purpose, and their consent was obtained before data collection. The questionnaire was administered to all selected teachers, and interviews were conducted at their convenience to facilitate open and reflective discussions on their experiences with digital games in physics education.

3.3. Data Collection

Data collection was accomplished using two primary instruments: a structured questionnaire and semi-structured interviews. The questionnaire was designed to capture quantitative data on key aspects of digital game utilization in physics instruction. It quantified information such as the frequency of digital game use in the classroom, the types of digital games employed, the specific physics topics addressed through these games, the duration of their use during lessons, and the extent to which digital games were integrated with traditional teaching methods. In order to gather measurable responses, the questionnaire incorporated Likert-scale items that assessed both the prevalence of digital game-based learning and its perceived effectiveness.

Complementing the quantitative data, semi-structured interviews were conducted to garner qualitative insights into teachers' perspectives, experiences, and challenges related to digital game utilization in physics education. These interviews delved into the practical aspects of integrating digital games into the curriculum, identified potential barriers to their adoption, and provided a platform for teachers to share recommendations for effective implementation. Together, the questionnaire and interviews provided an understanding of the current practices associated with digital game utilisation in teaching physics, thereby supporting the overall objective of the study.

3.4. Data Analysis

Data analysis employed both quantitative and qualitative techniques to ensure detailed understanding of digital game utilisation in physics instruction. For the quantitative analysis, descriptive statistics were used to analyze the questionnaire responses. Frequencies, and percentages were computed to identify patterns in digital game utilisation regarding frequency, type, duration, and integration with traditional teaching methods.

For the qualitative analysis, thematic analysis, following Braun and Clarke's (2006) framework, was conducted on the interview transcripts. This approach involved coding data to identify recurring themes related to teachers' engagement with digital games, their perceived benefits, and the challenges encountered in implementing DGBL. The themes were categorized into key factors influencing digital game adoption, including pedagogical, technological, and structural considerations.

4. Results

4.1. Extent of Digital Games Utilisation in Teaching Physics

This section presents the findings, interpretations, and discussions related to the extent of digital games utilisation in teaching physics. The analysis incorporates both quantitative and qualitative data collected through the questionnaires and the interviews conducted.

4.1.1. Findings on Frequency of Digital Games Utilisation

To assess the extent of digital games utilisation in teaching physics, teachers were asked about the frequency with which they incorporate these tools into their lessons. Data was collected through questionnaires and supplemented with data from the interviews. Table 1 presents the quantitative data on the frequency of digital games utilisation in physics teaching.

Table 1. Frequency of digital games utilization in physics teaching.

Frequency of use	Number of teachers	Percentage
Never	6	54.5%
Rarely (1-2 times per term)	3	27.3%
Sometimes (3-5 times per term)	1	9.1%
Often (6-10 times per term)	1	9.1%
Very often (more than 10 times per term)	0	0%
Total	11	100%

The data in Table 1 reveals that the majority of physics teachers (54.5%) never use instructional digital games in their teaching. Only 27.3% of teachers reported using these games rarely (1-2 times per term), while a small percentage (9.1%) use them sometimes (3-5 times per term) or often (6-10 times per term). None of the teachers reported using instructional digital games very often (more than 10 times per term). The qualitative data from interviews provided deeper insights into the frequency of digital games utilisation. Respondent 01 explained that they have not incorporated digital games into their physics lessons due to a lack of familiarity with appropriate educational games, limited time in the curriculum, and concerns over potential technical issues given the minimal IT support. While they recognize that digital games might engage students, they are hesitant to adopt a method they are not confident will offer significant educational benefits.

Respondent 02 shared that they primarily use Khan Academy about once every two weeks to complement textbook content in topics such as mechanics and electricity. The interactive simulations and gamified features like point systems and progress tracking help students visualize complex concepts and practice at their own pace, leading to improved engagement and understanding.

Respondent 03, who rarely uses digital games, mentioned that they incorporate them once or twice a term as a review activity before exams. Platforms like Kahoot! or Quizizz are used to create a fun and low-pressure environment to assess students' understanding. Although these games increase student enthusiasm, the educator remains unsure about their long-term impact on learning outcomes because of the difficulty in finding more immersive games aligned with the curriculum.

4.1.2. Findings on Types of Digital Games Utilised

To gain a more understanding of the extent of digital games utilisation in physics teaching, the study examined the types of games that teachers employed when they do use these tools. Table 2 presents the quantitative data on the types of instructional digital games used in physics teaching.

Table 2. Types of digital games utilised in physics teaching.

Type of game	Number of teachers	Percentage
Physics simulations	4	36.4%
Quiz-based games	3	27.3%
Virtual labs	2	18.2%
Puzzle games	1	9.1%
Role-playing games	0	0%
None used	6	54.5%
Note: The total percentage exceeds 100% as some teachers reported using multiple types of games.		

The data in Table 2 reveals that among the teachers who use instructional digital games, physics simulations are the most popular (36.4%), followed by quiz-based games (27.3%) and virtual labs (18.2%). Only one teacher (9.1%) reported using puzzle games, and none of the teachers used role-playing games. Consistent with the findings in section 4.3, six teachers (54.5%) reported not using any type of instructional digital games. The qualitative data from interviews provided deeper insights into the types of instructional digital games used by teachers.

Respondent 04, who utilises physics simulations, noted that they occasionally use PhET simulations to demonstrate concepts such as motion and forces. These interactive tools let students manipulate variables and witness real-time outcomes, which helps clarify abstract topics like projectile motion. However, some students occasionally need additional guidance to focus on the underlying physics principles rather than merely interacting with the simulation.

Respondent 03, when referring to their use of quiz-based games, stated that they sometimes use online quiz games like Kahoot! to review physics concepts after traditional instruction. Custom quizzes aligned with the curriculum provide immediate feedback and help identify areas of misunderstanding, although these games are viewed as more suitable for review rather than initial teaching.

Respondent 05 described their use of virtual lab simulations for experiments that are too dangerous, expensive, or time-consuming to perform in a physical lab. For instance, during lessons on radioactive decay, a virtual lab allows students to observe and measure decay rates while ensuring safety. The main challenge lies in ensuring that students approach virtual labs with the same rigor as they would a hands-on experiment.

4.1.3. Findings on Physics Topics Taught Using Digital Games

To further understand the extent of digital games utilisation in physics teaching, the study examined the specific physics topics for which these games are employed. Table 3 presents the quantitative data on the physics topics taught using instructional digital games.

Table 3. Physics topics taught using digital games.

Physics topic	Number of teachers	Percentage
Mechanics (including motion and forces)	5	45.5%
Electricity and magnetism	3	27.3%
Waves and optics	2	18.2%
Thermodynamics	1	9.1%
Modern physics	0	0%
None	5	45.5%
Note: The total percentage exceeds 100% as some teachers reported using games for multiple topics.		

The data in Table 3 shows that among the teachers who use instructional digital games, mechanics is the most common topic (45.5%), followed by electricity and magnetism (27.3%), and waves and optics (18.2%). Only one teacher (9.1%) reported using games for teaching thermodynamics, and none used games for modern physics topics. Consistent with previous findings, five teachers (45.5%) reported not using instructional digital games for any physics topics. The qualitative data from interviews provided deeper insights into the physics topics taught using instructional digital games.

Respondent 06 explained that digital simulations are particularly useful for teaching concepts of motion and forces. These tools allow students to visualize acceleration, momentum, and other dynamic concepts, thereby linking mathematical equations to real-world applications. Although these simulations often trigger breakthrough moments for struggling students, they are balanced with traditional problem-solving exercises to foster independent learning.

Respondent 07 shared that they use virtual circuit builders to teach electricity, which allows students to safely experiment with circuit design and measure variables like current and voltage. For magnetism, simulations that visualize magnetic fields are employed. While these digital tools help demystify complex concepts, some students require extra guidance to connect the simulations to practical, real-world scenarios.

Respondent 08 described their approach for teaching waves and optics using interactive simulations. These tools enable students to adjust variables such as frequency, amplitude, and medium properties, which aids in understanding phenomena like interference, diffraction, and refraction. In optics, ray tracing simulations clarify the behavior of lenses and mirrors. To prevent overreliance on digital tools, these activities are supplemented with traditional pencil-and-paper exercises.

4.1.4. Findings on Duration of Digital Games Utilised in Physics Lessons

To gain further understanding of the extent of digital games utilisation in physics teaching, the study examined the duration for which these games are employed during lessons. Table 4 presents the quantitative data on the duration of digital games utilisation in physics lessons.

Table 4. Duration of digital games utilisation in physics lessons.

Duration	Number of teachers	Percentage
Not used	7	63.6%
Less than 15 minutes	3	27.3%
15-30 minutes	1	9.1%
31-45 minutes	0	0%
More than 45 minutes	0	0%
Total	11	100%

The data in Table 4 reveals that among the teachers who use instructional digital games, the majority (27.3%) use them for less than 15 minutes per lesson and a small percentage (9.1%) used them for 15-30 minutes. No teachers reported using games for more than 30 minutes in a lesson. Consistent with previous findings, 63.6% of teachers reported not using instructional digital games at all. The qualitative data from interviews provided deeper insights into the duration of digital games utilisation in physics lessons.

Respondent 04 mentioned that they typically use digital games for about 10-15 minutes at the beginning of a lesson, such as using a simulation for projectile motion to capture students' interest and provide a visual introduction before a more detailed explanation follows.

Respondent 08 remarked that they sometimes dedicate around 30 minutes during a double lesson to a virtual lab simulation focused on topics like electromagnetic induction. This longer session allows for comprehensive exploration, guided discussions, and in-depth experimentation, though it requires careful balancing with the rest of the curriculum.

Respondent 09 admitted that they rarely use digital games, often limiting their usage to brief 5-10 minute sessions aimed at breaking up a lesson or offering quick demonstrations. Although these short interactions engage students momentarily, the educator is not convinced of their lasting educational value and tends to favor traditional methods for more substantial learning.

4.1.5. Findings on Integration of Digital Games with Traditional Teaching Methods

The final aspect of examining the extent of digital games utilisation in physics teaching involved understanding how these games are integrated with traditional teaching methods. Table 5 presents the quantitative data on the integration of instructional digital games with traditional teaching methods.

Table 5. Integration of digital games with traditional teaching methods.

Integration method	Number of teachers	Percentage
Not integrated (games not used)	6	54.5%
As introductory activities	2	18.2%
For concept reinforcement after traditional instruction	2	18.2%
As main instructional method with traditional support	1	9.1%
Fully integrated throughout the lesson	0	0%
Total	11	100%

The data in Table 5 shows that among the teachers who use instructional digital games, the most common integration methods are as introductory activities and for concept reinforcement after traditional instruction (18.2% each). A small percentage (9.1%) use games as the main instructional method with traditional support. No teachers reported fully integrating games throughout their lessons. Consistent with previous findings, 54.5% of teachers reported not using instructional digital games at all. The qualitative data from interviews provided deeper insights into how teachers integrate instructional digital games with traditional teaching methods.

Respondent 10 indicated that they start lessons with a quick simulation game to spark student interest, such as launching objects to illustrate linear motion. This brief introductory activity helps provide a tangible reference for abstract concepts and generates questions for further exploration, while being limited to 5-10 minutes to allow ample time for in-depth teaching.

Respondent 03, speaking about their use of quiz games for concept reinforcement, explained that after a traditional lesson, they sometimes use a quiz game like Kahoot! to check understanding and solidify key ideas. The immediate feedback and competitive element help clarify misconceptions, though this strategy is primarily employed for review rather than introducing new material.

Respondent 11 described using simulation games as a central instructional method for complex topics such as wave behavior and electromagnetic fields, supported by conventional explanations and problem-solving exercises. This integrated approach enables visual learners to connect digital interactions with theoretical concepts while also preparing all students for formal assessments, though ensuring equitable benefits across diverse learning styles remains a challenge.

4.2. Interpretation of Findings

The analysis of the frequency of use reveals a low overall adoption of instructional digital games in physics teaching. With more than half of the teachers (54.5%) reporting never using these games, and only a small percentage using them regularly, it's evident that digital game-based learning is not yet a mainstream practice in physics education. This limited use could be attributed to various factors, including lack of knowledge about suitable games, time constraints, and uncertainty about the educational benefits of game-based learning. The qualitative data suggests that even teachers who are open to using games face barriers such as limited resources and concerns about aligning games with curriculum requirements. Regarding the types of games used, the preference for physics simulations (36.4%) and quiz-based games (27.3%) indicates that teachers prioritize games that closely align with traditional teaching methods and assessment practices. The popularity of simulations suggests that teachers value the ability to visualize complex physics concepts, while the use of quiz games reflects a focus on knowledge reinforcement and assessment. The limited use of more immersive game types, such as role-playing games, may indicate a lack of awareness of these options or concerns about their educational value and time efficiency.

The findings on physics topics taught using games reveal a focus on certain areas, particularly mechanics (45.5%) and electricity and magnetism (27.3%). This preference could be due to the availability of high-quality games for these topics or the perception that these areas particularly benefit from visual and interactive representations. The limited use of games for topics like modern physics might reflect a lack of suitable games for these advanced concepts or a belief that traditional teaching methods are more appropriate for complex, abstract topics. The duration of game use in lessons, predominantly less than 15 minutes (27.3%), suggests that teachers are integrating games as supplementary tools rather than core instructional methods. This approach may reflect time constraints, concerns about maintaining curriculum coverage, or uncertainty about how to effectively use games for extended periods. The lack of longer game sessions might limit the potential for deep, immersive learning experiences that some digital games can offer.

The integration methods employed by teachers provide insight into how games are positioned within the broader instructional strategy. The equal use of games as introductory activities and for concept reinforcement (18.2% each) suggests that teachers see value in games for both engaging students at the start of a lesson and consolidating learning. The limited use of games as a main instructional method (9.1%) indicates that most teachers still view traditional teaching approaches as primary, with games serving a supportive role. Overall, these findings paint a picture of cautious and limited adoption of digital games in physics teaching. While some teachers are exploring the potential of these tools, there appears to be a significant gap between the theoretical potential of game-based learning and its practical implementation in physics classrooms.

5. Discussion of Findings

The findings related to the extent of digital games utilisation in physics teaching reveal a complex landscape of adoption, challenges, and opportunities. The low frequency of use, with over half of the teachers never incorporating these games, aligns with Bourgonjon *et al.,* (2013), who found that despite positive attitudes towards digital game-based learning, actual implementation in classrooms remains limited. This gap between potential and practice underscores the need to address barriers to adoption, such as lack of training, time constraints, and resource limitations. Koh *et al.,* (2015) similarly noted that while teachers recognize the potential of digital technologies, their actual use in science classrooms is minimal.

The preference for physics simulations and quiz-based games indicates a tendency to utilize tools that align closely with traditional teaching methods. This observation is consistent with Li and Tsai (2013), who found that many educational games in science education focus primarily on knowledge gain and conceptual change rather than fostering deeper learning outcomes. While these game types can be beneficial, there may be missed opportunities to leverage more immersive experiences that could enhance engagement and problem-solving skills, as suggested by Gee (2003).

The focus on specific physics topics, particularly mechanics and electricity and magnetism, raises questions about the availability and perceived suitability of games across different areas of physics. This uneven distribution of game use aligns with Honey and Hilton's (2011) observation that educational game development often clusters around certain subjects. The limited use of games for advanced topics like modern physics may reflect challenges in designing games for complex concepts or a lack of awareness of existing resources. The predominantly short duration of game use (less than 15 minutes) suggests that games are often employed as supplementary tools rather than core instructional methods. While this pragmatic approach aids time management, it may limit the potential benefits of more extended game-based learning experiences. Squire (2011) argues that deeper learning through games often requires sustained engagement. The challenge lies in balancing the time needed for meaningful game-based learning with the pressures of curriculum coverage and traditional assessment preparation.

The integration methods employed by teachers, primarily using games as introductory activities or for concept reinforcement, reflect a cautious approach to incorporating new technologies into established teaching practices. This aligns with Ertmer and Ottenbreit-Leftwich (2010), who noted that teachers often adapt new technologies to fit existing pedagogical beliefs rather than fundamentally altering their teaching methods. The limited use of games as a main instructional method suggests a gap between the potential of game-based learning and its practical implementation in classrooms. Similar patterns have been observed in Africa. Mwanda *et al.,* (2017) found that while secondary school teachers in Kenya showed interest in using ICT, the actual integration of digital technologies in science classrooms was minimal. This aligns closely with our findings on the low frequency of digital games utilisation. Mtebe and Raisamo (2014) reported similar trends in Tanzania, where teachers acknowledged the benefits of digital games but faced barriers such as lack of training and resources. In Kenya, Ntorukiri *et al.,* (2021) highlighted that despite the availability of digital learning tools, teachers often resorted to traditional methods due to insufficient knowledge and confidence in using these technologies effectively.

The preference for certain types of games and physics topics reflects broader trends in African educational technology adoption. Msoka *et al.,* (2015) found that Tanzanian science teachers primarily employed simulations and virtual experiments. Similarly, Muuro *et al.,* (2014) noted that digital games in science education were often limited to simulations or quiz-style formats, mirroring our findings on the popularity of these game types. The short duration of game use observed in this study is consistent with findings from other African countries. Munyengabe *et al.,* (2017) revealed that despite government initiatives to promote ICT in education, the use of digital technologies in science teaching remained infrequent, attributed to factors such as lack of training and limited access to resources.

The integration methods employed by teachers in this study, primarily using games as introductory activities or for concept reinforcement, reflect a cautious approach observed in other African educational contexts. Njiiri *et al.,* (2024) found that while teachers recognized the potential of digital resources, their actual use was limited due to challenges such as lack of infrastructure and inadequate preparation. These findings highlight the urgent need for targeted support and professional development to enhance teachers' ability to effectively integrate digital games into physics education, particularly in the African context. Awuor and Okono (2022) emphasized that such support should focus not only on technical skills but also on pedagogical strategies for technology integration in specific subject areas like physics. The cautious adoption of digital games in physics teaching reflects broader challenges in educational technology integration. Cuban (2001) noted that the introduction of new technologies often follows a pattern of initial enthusiasm followed by limited adoption due to practical constraints and institutional inertia. Overcoming these challenges requires a multifaceted approach that addresses teacher preparation, resource availability, and institutional support, ensuring alignment with educational policies and assessment practices.

6. Conclusion

The findings of this study clearly underscore a cautious and limited adoption of DGBL in the teaching of physics concepts in secondary schools of Murang'a County, Kenya. The quantitative data revealed that a majority of physics teachers rarely incorporate digital games into their lessons, with more than half reporting no use at all. Qualitative insights further confirmed that the infrequent use is largely attributed to factors such as inadequate knowledge of appropriate digital tools, time constraints inherent in the curriculum, and significant concerns related to technical support and infrastructure.

Furthermore, the study's investigation into the types of digital games employed showed a prevailing preference for physics simulations and quiz-based games, which are perceived as aligning more closely with traditional teaching methods. This observation is consistent with previous research indicating that such game types are valued for their role in visualizing abstract concepts and reinforcing content through immediate feedback. Despite this, the limited adoption of more immersive game formats, such as role-playing or virtual field trips, indicates an unmet potential for transformative digital learning, which could otherwise foster deeper understanding and critical thinking.

In examining the physics topics addressed through digital games, the study found that mechanics and electricity and magnetism are the most frequently targeted areas. This focus appears to reflect both the availability of high-quality digital simulations for these topics and the perception that visual and interactive representations are particularly beneficial for elucidating these core concepts. However, the underutilisation of digital games for subjects like modern physics suggests that there remains a significant gap in resource development and teacher training for advanced topics.

The duration of digital game use, predominantly under 15 minutes, highlights an approach wherein games are treated as supplementary tools rather than as a central instructional methodology. Such brief integrations may serve as effective hooks or review sessions, yet they may also limit the scope for sustained engagement and deep, iterative learning processes that are critical for achieving lasting conceptual change. Moreover, the integration of digital games with traditional pedagogical methods-mainly as introductory or reinforcing activities-reflects a constrained innovation landscape. Most teachers continue to rely primarily on conventional instruction, a reality that underscores the need for further professional development and systemic support to fully realize the potential of DGBL.

7. Recommendations

This study offers several strategic recommendations to enhance the utilisation of digital games in the teaching of physics in secondary schools. First, it is imperative for educational stakeholders and policymakers to invest in structured professional development programs that focus on building teachers' technological pedagogical content knowledge (TPACK). Such initiatives should specifically target the effective use of digital games, providing teachers with hands-on training to navigate digital tools while aligning game mechanics with curriculum objectives. In conjunction with teacher training, there is a critical need to upgrade the existing ICT infrastructure in schools. With many educators citing limited technical support as a barrier, allocating resources for both hardware improvements and routine maintenance is essential to create a reliable digital environment that supports innovative instructional methods.

Furthermore, curriculum developers are encouraged to revise and expand the current physics curriculum to incorporate digital game integration as a core element rather than a supplementary activity. This could involve developing or adapting digital games that are aligned with specific physics topics, including advanced areas such as modern physics, where a notable gap currently exists. Collaborations between educational institutions, game developers, and subject matter experts could foster the creation of immersive and pedagogically sound games that facilitate deeper conceptual understanding and stimulate critical thinking. Such partnerships would not only enhance the quality of digital learning tools but also ensure that game-based instructional strategies are dynamically linked to learning outcomes.

In addition to professional development and curriculum enhancement, it is recommended that schools and local education authorities should establish dedicated budgets for continuous digital innovation in teaching. Implementing regular feedback mechanisms will ensure that teachers' experiences with digital game utilisation are systematically recorded and used to refine both instructional practices and resource allocation. With coordinated efforts among educators, administrators, and policymakers, these recommendations aim to bridge the gap between the theoretical potential of DGBL and its practical, sustainable implementation in physics instruction.

Declarations

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