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Mobile Learning in Mathematics: Benefits, Challenges, Strategies, and Proponents' and Opponents' Views

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Abstract

Integrating mobile learning technologies in mathematics education in light of the pandemic, natural disasters, and recent technological developments is a significant shift in practice. This research applied the systematic review approach to assess the impact of mobile learning aids on students' learning attitudes, motivation, and performance in mathematics. Based on a synthesis of peer-reviewed articles published from 2010 to 2024, this paper focuses on five themes: (a) student and educator experience and engagement, (b) modification in instructional practices, (c) learning and achievements, (d) opportunities, challenges, and strategies, and (e) mobile learning perceptions. The review reveals that mobile learning enhances students' essential and higher-order thinking skills by establishing interactivity and learning through inquiry. However, other factors, such as the unequal distribution of resources and technology, still pose a challenge. To address these issues, it is suggested that future policies should focus on improving infrastructure, digital competency, and professional learning for instructors. Further, it is essential for institutions to engage faculty members in collaborative platforms to enhance their practice and have secure measures for data protection. This systematic review emphasizes the need for the researcher to conduct these evaluations over time to gauge the long-term impact of mobile learning and to look at the effects of this form of learning on different groups of students. It also concludes that future studies need to pay attention to ethical concerns and ways to provide equal opportunities in integrating technology into mathematics education for all students.

Keywords: mobile learning, mathematics, critical thinking, engagement, digital knowledge, professional development

Introduction

This modern science-focused world requires people to be equipped with fundamental knowledge and skills. In the 21st century, instructors are responsible for teaching mathematics in a way that allows students to acquire practical and effective problem-solving skills (Szabo et al., 2020). As one of the most essential pillars of contemporary society, mathematics is inevitable in routine decision-making and in a modern globalized society; without sufficient knowledge of mathematics, progress can sometimes be challenging (Rizki & Priatna, 2019).

Math literacy is an essential requirement in the 21st century, yet it continues to pose challenges in elementary education (Tang et al., 2023). Although students understand its significance, many do not like the subject. Both instructors and students find mathematics boring, and one of the main reasons why they dislike it is the complexity of understanding complicated formulas. Therefore, math instructors should find the causes of math anxiety and use efficient classroom strategies to enable students to overcome these challenges (Gravemeijer et al., 2017).

In the past few years, the integration of mobile learning has received increased attention in mathematics education (Novita & Herman, 2021). *Mobile learning* can be defined as learning on mobile devices, including smartphones and tablets. It allows access to educational resources and participation in learning activities from any place at any time. It facilitates flexible, personal, and interactive learning not confined to a classroom learning environment (Krouska et al., 2024). Mobile learning technologies offer new approaches to enhancing students' activities and interest in mathematics (Ninghardjanti & Dirgatama, 2021). Nashrullah et al. (2023) undertook a review to establish the effects of incorporating mobile learning in enhancing Realistic Mathematics Education. They revealed that mobile learning can improve students' performance and thinking abilities (Nashrullah et al., 2023).

Mobile technologies in the mathematics teaching–learning process have, therefore, brought about a significant shift in instructional practices and demand the assessment of their qualitative impact on mathematics learning. Instructors have introduced mobile technologies using interactive math applications, digital whiteboards, and game-based learning platforms, which help to personalize the education process, give feedback to the students, and involve them in the process more actively. Alabdulaziz (2021) revealed that the COVID-19 pandemic stimulated the process of realizing digital technologies in math education. His research shows that over 98% of the participants considered the pandemic a driver of digital learning, and they reported using online platforms more often after the pandemic. Mobile devices, touchscreens, pen tablets, and digital libraries were identified among the main tools used to teach mathematics during COVID-19 (Alabdulaziz, 2021).

Mobile mathematics education closely resonates with distance education theory, which focuses on learning free from time constraints and providing flexible access to educational content and resources. This theory, introduced by Börje Holmberg in the 1960s, teaches that mobile devices are powerful instruments for providing mathematics instruction and resources beyond the classroom (Moore, 1991; Velmurugan et al., 2025). With mobile learning, students can learn various interactive math applications and access online libraries and virtual lessons anytime and anywhere, making learning easier and more customized. Distance education theory also emphasizes the necessity of interaction and communication between a learner and an instructor, which can also be provided with the help of mobile learning. Mobile technologies allow networked communication through social media and discussion

forums, as well as real-time feedback systems, which give students access to other students and tutors and can provide far more depth to the learning process (Vankúš, 2021).

It is important to understand the impact of mobile learning on mathematics for several reasons. These specifically include the effects of technological learning inclusion on enhancing the students' motivation, engagement, and learning outcomes. Tang et al. (2023) conducted a systematic review on 52 articles. Their findings offer four key aspects regarding the inclusion of mobile learning into mathematics education: (a) the significance of the learning design for the research purpose, (b) the application of the technology into the mathematical curriculum, (c) the global nature of mobile learning research, and (d) the widespread use of mobile devices in secondary education settings (Tang et al., 2023).

The review discussed the influence of mobile technology on education, focusing on mathematics. It highlighted how mobile learning has transformed traditional teaching methods, enhancing learning outcomes. The COVID-19 pandemic and natural disasters have underlined the need for flexible and accessible education solutions. Mobile learning became crucial during lockdowns, allowing students to access learning materials from home. The review emphasized the importance of mobile technologies in making education accessible to all students, especially those in underserved areas (Tang et al., 2023).

The research gap of this review (Tang et al., 2023) lies in the limited exploration of the implementation of mobile learning in mathematics. The review was performed to determine the impact of mobile learning from 2010 to 2024. The current review aims to establish how mobile learning can help transform mathematics education. It seeks to demonstrate how the use of mobile technologies could be incorporated in such a way as to foster a more facilitative and engaging learning process. In addition, the review provides insights into the challenges faced when adopting a mobile learning solution and the measures that can be taken to make education more robust and available.

Research Objectives

The objectives of this research were to determine the following:

- How does mobile learning integration in mathematics impact students' experience and engagement?
- How does integrating mobile learning in mathematics modify the educator's instructional practices?
- How does learning mathematics through mobile methods affect students' learning outcomes and achievements?
- What are the opportunities and challenges of using mobile learning in mathematics, and which strategies can be applied to mitigate challenges?
- In what way does the perception of mobile learning in mathematics education differ between proponents and opponents in its implementation

Methodology

This paper reports on a systematic review that involved searching relevant studies, selecting those meeting specific criteria, and synthesizing the findings. This section discusses the search strategy, the inclusion and exclusion criteria, and the data extraction and analysis methods.

Search Strategy

A search strategy is a set of keywords that are used in such a way as to provide the relevant records in the target database. Formulating a search strategy is the first process in systematically searching the literature in the area of interest (Finfgeld-Connett & Johnson, 2013). To make the literature search more extensive, ERIC, Scopus, Web of Science, and Google Scholar databases were used to find the relevant academic papers. Furthermore, Boolean operators were used to help further narrow down the search results to include only the needed research studies while excluding unnecessary entries. Table 1 displays the search terms used to find the relevant keywords.

Table 1

Search Strategies

Serial. No	Search strategy
1.	("Mobile Learning" OR "M-learning" OR "Mobile Education" OR "Mobile Technologies") AND ("Mathematics" OR "Math Education" OR "Math Instruction")
2.	("Student Engagement" OR "Learning Outcomes" OR "Academic Performance" OR "Motivation") AND ("Mobile Learning" OR "Mobile Tools") AND ("Mathematics")
3.	("Teacher Practices" OR "Instructional Strategies" OR "Teaching Methods") AND ("Mobile Learning" OR "Digital Tools") AND ("Mathematics")
4.	("Challenges" OR "Barriers" OR "Limitations") AND ("Mobile Learning") AND ("Math" OR "Education")
5.	("Perceptions" OR "Attitudes" OR "Views") AND ("Students" OR "Instructors") AND ("Mobile Learning") AND ("Math")
6.	("Gamification" OR "Augmented Reality" OR "Interactive Apps" OR "Educational Technology") AND ("Mathematics Education") AND ("Mobile Use" OR "Mobile Platforms")
7.	("Critical Thinking" OR "Problem-Solving" OR "Cognitive Skills") AND ("Mobile Learning") AND ("Math Education")

Review Selection Criteria

The term *selection criteria* relates to the general principles defining the range of research articles and studies to be included in the review (Gentles et al., 2016). Table 2 depicts the inclusion and exclusion criteria used in this review.

Table 2

Inclusion and Exclusion Criteria

Inclusion criteria	Exclusion criteria
Articles that investigated mobile learning interventions in mathematics education	Articles not concentrating on mathematics education through mobile learning
Articles written explicitly in the English language	Articles written in any language other than English
Articles published from 2010 to 2024	Articles that were published before 2010
Articles published in peer-reviewed journals or reputable conference proceedings	Articles needing more rigorous methodological frameworks

Data Analysis

The data from the selected studies were coded thematically with MAXQDA 24 (Verbi, 2025); inductive coding was employed to elicit patterns and themes. These themes were cross-mapped across studies, clustered, and synthesized to present an overall picture of the influence of mobile learning on math learning. This systematic review analyzed existing research on the impact of mobile learning in mathematics education, focusing on five key themes: student and educator engagement, instructional practices, learning outcomes, challenges and strategies, and perceptions. Findings were synthesized from multiple studies to highlight the benefits and limitations of mobile technologies, offering insights into how they shape teaching methods, student achievement, and equitable access to learning.

Findings and Results

The findings of this review provide a comprehensive understanding of mobile learning's role in mathematics education. They are organized into five main themes: (a) student and educator experience and engagement, (b) modification in instructional practices, (c) learning and achievements, (d) opportunities, challenges, and strategies, and (e) mobile learning perceptions. Table 3 shows the themes, subthemes, and number of papers involved in each theme, along with the references.

Table 3

Main Themes, Subthemes, and Supporting References

Theme	Subtheme	References	No. of references
Student and educator experience and engagement	Students' interest and engagement	Al Mulhem & Almaiah (2021); Kang (2024); Krouska et al. (2022); Li et al. (2024); Svela et al. (2019); Vankúš (2021); Wong et al. (2022)	7
	Students' and instructors' narratives and experiences	Al Omoush & Mehigan (2023); Chen & Zainal Abidin (2023); Dawodi et al. (2023); Edmonds & Smith (2017); Zhang et al. (2023); Ibrahim (2024)	6
Modification in instructional practices	Educator's mobile learning instructional strategies	Alabdulaziz (2021); Borba et al. (2016)	2
	Educator's adaptations and professional development needs	Kaliisa & Michelle (2019); Papadakis et al. (2021); Rohadi & Yavani (2023); Taleb et al. (2015); Tang et al. (2023)	5
Learning and achievements	Understanding of students' learning and their achievements	Song & Cai (2024); Suyatmo et al. (2023)	2
	Enhancing problem-solving and critical thinking skills	Huda et al. (2022); Ninghardjanti & Dirgatama (2021)	2
	Improving higher-order thinking skills and cognitive abilities	Astuti et al. (2023); Sucilestari & Arizona (2020)	2
Opportunities, challenges, and strategies	Technological, pedagogical, and contextual challenges	Dawodi et al. (2023); Ghoulam et al. (2024); Kaliisa & Michelle (2019)	3
	Strategies to solve barriers	Barana & Marchisio Conte (2023); Ghoulam et al. (2024); Upadhayaya (2023)	3
Mobile learning perceptions	Proponent views	Burke et al. (2022); Drigas & Pappas (2015); Marques & Pombo (2021); Taleb et al. (2015)	4
	Opponent views	Astuti et al. (2023); Chen et al. (2022); Deswita et al. (2024); Ghimire (2023)	4

The literature review findings highlight that mobile learning improves students' participation in lessons, changes instructors' approaches toward instruction, and positively affects learning. They also stress the implementation issues and challenges and showcase differing opinions regarding the efficiency of mobile learning. Furthermore, they reveal the strengths, weaknesses, opportunities, and threats of adopting technology into the system.

Theme 1: Student and Educator Experience and Engagement

Mobile learning's influence on students' academic achievement and learning experience has become a research focus in mathematics education. Including flexible technologies through mobile methods enhances students' overall learning experience and motivation as students use these technologies daily. Enhanced lessons are developed for mobile devices to implement interactive media and gaming elements in mathematics learning. By analyzing students' motivation, attitudes, and cognitive abilities, several authors have observed that the inclusion of mobile learning is associated with a positive learning experience and engagement (Al Mulhem & Almaiah, 2021; Krouska et al., 2022; Svela et al., 2019). This theme explored the impact of mobile learning on students and instructors, focusing on their experiences and levels of engagement.

Students' Interest and Engagement

Several past studies have recognized the role of mobile learning in enhancing students' learning interest and motivation in mathematics. Mobile technologies offer instructors the flexibility to create effective lesson plans that fulfil this generation of students' needs. They are proficient in using mobile devices and tablets (Krouska et al., 2022; Svela et al., 2019). The adoption of mobile games tied to learning has been shown to improve students' engagement and performance (Al Mulhem & Almaiah, 2021). According to Vankúš (2021), mobile learning captures students' attention and motivates them to learn more, primarily through gaming with appropriate learning approaches.

Research findings (Kang, 2024) have pointed out that game-based learning boosts students' motivation, engagement, attitudes, pleasure, and state of flow in mathematics education. Mobile learning implementation also increases student interaction with their instructors, as well as learning materials, develops and maintains positive attitudes, and increases self-generated motivation and learning outcome effectiveness (Li et al., 2024). Furthermore, research has established that the use of games in supporting education in the digital age effectively boosts students' learning engagement, enhancing their motivation to learn (Wong et al., 2022).

Students' and Instructors' Narratives and Experiences

The educational applications of augmented reality and gamification in mathematics have gained much popularity due to their efficiency in reinforcing students' motivation, engagement, and knowledge improvement (Al Omoush & Mehigan, 2023). In addition, educational robotics has also improved students' access to, attention to, and learning interest in mathematics through better and more playful interactive tools (Edmonds & Smith, 2017). Furthermore, location-based mobile learning activities have been found to present students with active, enjoyable, and realistic learning experiences, thus enabling them to engage with mobile content, different places, and other students (Zhang et al., 2023).

To enhance students' learning experience in mathematics education, the relationship between students' and instructors' motivation, engagement, and performance should be studied (Ibrahim, 2024). Students mentioned that using interactive tools gave them autonomy and the willingness to provide

mathematical material with peers and instructors as part of the learning process. Instructors also recounted that mobile learning has improved classroom interaction and helped them employ differentiated instruction (Chen et al., 2022).

Afghan students have exemplified mobile learning platforms as essential tools for bridging gaps in education, particularly where conventional learning resources have been limited or unavailable. Students noted that mobile technologies provided them with flexibility and accessibility in cases of other external challenges, such as environmental issues. Instructors observed that such tools enabled them to reach distant students in widespread locations, thereby being inclusive (Dawodi et al., 2023). Thus, instructors and students repeatedly emphasized how using such technologies increased motivation, achieved greater depth of learning, and resulted in a more engaging classroom atmosphere.

Theme 2: Modification in Instructional Practices

Implementing mobile learning technologies in mathematics learning has required new teaching strategies. Instructors are seeking new ways of embedding mobile learning devices into practice to improve students' learning outcomes. This means that teaching methodologies must be modified and materials must be created to inform instructors on how to employ mobile technologies in teaching math. This theme explores the professional learning and pedagogical approaches required of instructors to teach through mobile learning.

Educators' Mobile Learning Instructional Strategies

Mobile learning has impacted the delivery of mathematics education through modifications in instructional methods, prompting teachers to improve their practices and seek professional development. Instructors have embraced mobile technology in the classroom to expand mathematics learning in this era of technology. According to Borba et al. (2016), to prepare instructors to incorporate mobile technologies, digital libraries, and collaborative learning into mathematics, they must be trained through blended learning.

Instructors have shifted from traditional teaching approaches to adapt mobile devices in teaching mathematics, whereby new approaches are incorporated to capture students' attention and enhance their learning. Alabdulaziz (2021) organizes the use of mobile devices in mathematics education into categories, including applications for teaching and learning, practical uses for mobile devices, and the education of mathematics instructors, underlining the importance of instructors' acceptance of technologies in their teaching practices.

Educator's Adaptations and Professional Development Needs

Instructors have been encouraged to search for effective instructional strategies in teaching mathematics that can be implemented in collaboration with the functionalities of mobile devices, such as interactive simulations, augmented reality, and gamification. Following the adoption and incorporation of mobile technologies in learning institutions, Tang et al. (2023) noted that educational researchers have deemed this new form of learning "mobile learning." Mobile learning has brought vitality and reform to conventional models of learning (Tang et al., 2023). Furthermore, mobile learning has empowered instructors to deliver personalized instructions, integrate students' learning styles, and create engaging and innovative learning solutions. Taleb et al. (2015) emphasize that technology plays a vital role in reshaping teaching methods and increasing students' interest in learning. In particular,

mobile learning has been shown to be especially effective in motivating students to engage with mathematics.

According to Papadakis et al. (2021), instructors have explored mobile learning to implement Realistic Mathematics Education in classrooms in an engaging manner to improve student learning outcomes. Papadakis et al. (2021) noted that better teaching practices are key to adopting mobile technologies in mathematics to design learning activities that are contextually related to students' interests and real-life situations in mathematics.

Instructors have realized the importance of engaging in professional development to update their practices while implementing change regarding mobile learning technologies in mathematics education in the learning environment. Rohadi and Yavani (2023) recognized that teacher training and continued professional development make up one way that instructors may ensure the use of mobile learning technologies in online mathematics courses. They emphasized the importance of embracing contingency in instructional practices for digital students (Rohadi & Yavani, 2023).

Kaliisa and Michelle (2019) have identified different mobile learning policies and strategies, focusing on Education for All, specifically in higher learning institutions. To address inequalities, instructors must develop a clear understanding of the context and realities within their locality (Kaliisa & Michelle, 2019). Thus, it can be concluded that mobile learning technologies have influenced instructors by shifting their conventional teaching practice, requiring them to adopt different behaviors and engage in professional development to integrate technologies into the teaching–learning process. Instructors must provide positive and productive learning climates that support students and improve mathematical learning through mobile technologies in the classroom.

Theme 3: Learning and Achievements

Mobile learning technologies enhance math knowledge by developing students' mental abilities, critical thinking, and problem-solving. They ensure the students' active involvement with the content by providing interactive, engaging, and customized experiences. This theme deals with how such tools assist students in applying math concepts to real-life problems.

Understanding Students' Learning and Their Achievements

Mobile learning technologies have given instructors new tools that assist students in enhancing their thinking skills and developing a deeper understanding of mathematical concepts. Incorporating mobile learning with inquiry-based learning models improves students' learning achievements and develops their problem-solving skills (Suyatmo et al., 2023). According to Song and Cai (2024), mobile learning applications have improved students' critical thinking abilities in mathematics education. Instructors using mobile learning to create effective communication platforms help students develop their critical thinking and problem-solving skills by effectively applying, assessing, and analyzing math concepts in various practice situations (Song & Cai, 2024).

Enhancing Problem-Solving and Critical Thinking Skills

The effective adoption of mobile devices enhances critical thinking among students as it promotes problem-solving and self-learning skills. Instructors can help students develop analytical and evaluative skills by incorporating critical thinking tasks into mobile-based interactive learning media. Tasks involving technology also incorporate exploration and inquiry skills, which are necessary in

mathematics (Ninghardjanti & Dirgatama, 2021). Huda et al. (2022), in their research, mentioned that the use of mobile devices in mathematics helped students to develop inquiry-based skills. Including mobile devices promotes analytical thinking, communication, and interpersonal skills to help students overcome complicated problem-solving challenges in mathematics (Huda et al., 2022).

Improving Higher-Order Thinking Skills and Cognitive Abilities

The adoption of inquiry-based learning models supported by mobile technologies has effectively enhanced cognitive processes and critical thinking skills among students. The inquiry-based model developed on mobile devices is based on different problem-solving, critical thinking, and reflective tasks that provide interactive learning experiences. This model enhances students' understanding of a particular subject, such as math, and allows them to handle daily life problems (Sucilestari & Arizona, 2020). Astuti et al. (2023) indicated that including mobile learning helps develop rigorous mathematical thinking that supports higher-level students' mathematical-level concepts. Therefore, this theme proves that mobile learning enhances the critical thinking and problem-solving skills of students. Using mobile technologies helps instructors design engaging and rich learning environments that foster students' critical thinking skills and enable them to succeed in mathematics education.

Theme 4: Opportunities, Challenges, and Strategies

Mobile learning technologies have the potential to enhance mathematics education, but their use also comes with challenges, such as issues with device compatibility and network connection. In this context, instructors need to find ways to make fair distributive decisions and address issues of diversity and inequality. This theme highlights strategies to overcome the mobile learning integration challenges and improve effectiveness.

Technological, Pedagogical, and Contextual Challenges

Instructors and institutions face several pedagogical, technological, and contextual challenges while integrating mobile learning into mathematics education. The most common technological challenges that instructors face are related to the compatibility of devices, network access, and the presence of effective software. The successful implementation of mobile application software for mathematics education can be hindered by ineffective software, which disrupts seamless communication across various devices (Dawodi et al., 2023). Furthermore, in the context of mobile learning, data security and privacy issues require robust protocols and measures (Ghoulam et al., 2024).

According to Kaliisa and Michelle (2019), instructors who adopt a mobile technological approach to teaching may need help designing content that fully makes use of mobile devices to provide students with an interactive learning experience. Research suggests adequate planning for instructors to guarantee they use mobile devices efficiently to produce math material that engages students (Kaliisa & Michelle, 2019).

Strategies to Solve Barriers

There are many challenges related to mobile learning, including resource and culture differences, as well as institutional limitations. Technological inequalities in resources, inadequate use of mobile devices, and poor infrastructure negatively impact effective mobile learning in mathematics. To address these barriers, applying systemic approaches that guarantee mobile learning for all students is essential (Kaliisa & Michelle, 2019).

Instructors and institutions may effect several measures. According to Ghoulam et al. (2024), implementing technical support and training enables instructors to enhance their understanding of mobile technology for teaching. Moreover, data protection policies should ensure that student rights are not violated and regulatory laws are followed (Ghoulam et al., 2024). Upadhayaya (2023) noted that instructors should collaborate to effectively share knowledge regarding appropriate mobile learning practices. Furthermore, instructors should tailor their teaching to their students' needs and promote continuous improvement to provide compelling mathematical learning experiences (Upadhayaya, 2023).

For effective mobile learning to enhance socioeconomic equity, specific formative assessment tools, such as marking criteria, must be appropriately employed in education systems to ensure all students are treated equally (Barana & Marchisio Conte, 2023). Thus, overcoming challenges for mobile learning in mathematics requires a holistic approach with an aim to empower instructors to create engaging and inclusive learning environments.

Theme 5: Mobile Learning Perception

The use of mobile learning in mathematics education has elicited positive and negative responses. Its proponents claim that creativity and adaptability increase students' engagement and learning. The opponents, alternately, are concerned about factors that may hinder the effectiveness of such learning strategies, including distractions, reduction in face-to-face learning, and issues related to the digital divide. This theme covers both perspectives to help instructors create fair and efficient strategies for integrating mobile technologies into learning environments that are welcoming to students with a wide range of needs.

Proponent Views

Proponents of mobile learning in mathematics education have cited that its use improves learning achievement, motivation, and interaction. Taleb et al. (2015) confirmed that using mobile technologies enhances students' motivation to learn as it sparks their interest and enthusiasm (Taleb et al., 2015). In their research, Drigas and Pappas (2015) emphasized that mobile learning activities increase critical thinking in students, and therefore, more mobile learning activities should be implemented. Furthermore, according to Burke et al. (2022), integrating technology for educational purposes can enhance students' perceptions of learning outcomes, especially in mathematics, by providing them with technology-enhanced collaborative and realistic activities. By reviewing instructors' experiences with incorporating mobile augmented reality games, Marques and Pombo (2021) provided insight into the impact of mobile learning on students and teaching approaches.

Opponent Views

Opponents of mobile learning in mathematics education have voiced concerns and criticism, focusing on its negative side. Some critics argue that mobile learning can lead to diversions, decreased face-to-face communication, and decreased student attention toward learning (Astuti et al., 2023). Furthermore, as per Deswita et al. (2024), mobile learning can cause a digital divide, privacy issues, and overreliance on technology.

Chen et al. (2022) performed qualitative research investigating how improper mobile phone use affects students' anxiety and self-confidence in mathematics and proposed prospective challenges in and drawbacks of using it in mathematics learning. They noted that mobile learning causes math anxiety

and a lack of self-confidence in problem-solving, adversely affecting cognitive skills (Chen et al., 2022). Moreover, Ghimire's (2023) research has highlighted concerns about equity of access to mobile gadgets for all students and the effects of using mobiles for learning purposes on the psychosocial health of students.

Discussion

This systematic review has discussed the implications of mobile technologies on mathematics learning, basing its findings on students' and instructors' experiences. It has reviewed major themes that highlight increasing momentum toward using digital tools to stimulate student engagement, motivation, and performance in mathematics. Across the literature, mobile technologies are noted to act as key drivers in shaping adaptive, interactive, and student-focused learning environments.

Five themes were identified: (a) student and educator experiences and engagement, (b) modification in instructional practices, (c) learning and achievements, (d) opportunities, challenges, and strategies, and (e) mobile learning perceptions.

The findings related to the first theme affirm that mobile learning significantly improves students' and instructors' experience because it is more engaging, flexible, and motivating when it comes to mathematical learning (Al Mulhem & Almaiah, 2021; Krouska et al., 2022; Svela et al., 2019). Mobile-based game elements and interactive content attracted students and made them mentally active (Al Mulhem & Almaiah, 2021). Instructors discovered the usefulness of mobile technologies in developing adaptive lesson plans with the learner as the focal point (Vankúš, 2021). This implies that mobile learning not only increases academic performance but also creates a more comfortable and animated learning process (Kang, 2024).

The second theme reveals that mobile learning integration in mathematics changes teaching practices. It requires teachers to make efforts to acquire new approaches to teaching mathematics and to participate in professional development on an ongoing basis. These findings are consistent with previous research on the significance of teacher training and how mobile technologies should be contextualized to students' interests and learning needs to promote motivation and better achievements (Borba et al., 2016; Taleb et al., 2015). Furthermore, changes related to traditional pedagogy and the introduction of technology-enhanced and individualized education indicate one of the shifts in the educational sector that necessitate adaptive teaching behavior to develop engaging and supportive learning scenarios (Papadakis et al., 2021; Rohadi & Yavani, 2023). Successful implementation of mobile learning cannot be achieved solely through the acceptance of technology; it also requires experts in educator development.

The third theme reveals that mobile learning technologies can help significantly improve the mathematical literacy skills of students by cultivating higher-order thinking skills and abilities associated with critical thinking, problem-solving, and inquiry-based learning models. Mobile tools make possible the development of individual experiences that are personal and interesting, as they help students to effectively apply math concepts to real-life situations. Research findings are consistent about the impact of mobile devices in math learning, which assumes an integrative approach and prompt availability of material that propagates analytic, critical, and contemplative thinking, of which the former is fundamental to intuitive learning and achievements in academics (Astuti et al., 2023; Song & Cai, 2024; Suyatmo et al., 2023). This highlights how mobile learning can enrich the learning environment with more effective learning empowerment of students and instructors.

The fourth theme reveals that mobile learning in mathematics education presents tremendous opportunities but faces technological, pedagogical, and contextual challenges such as issues in device compatibility, network connectivity, and data protection. These need to be addressed through systemic responses and strategies including technical assistance, specific instructor training, and balanced resource allocation for assured equal access (Dawodi et al., 2023; Ghoulam et al., 2024; Kaliisa & Michelle, 2019). Furthermore, teacher cooperation and ongoing adjustments in instructional techniques are required to battle the aforementioned problems and develop effective, interesting learning spaces (Barana & Marchisio Conte, 2023; Upadhayaya, 2023).

Lastly, the fifth theme reveals that there are differing perceptions of the concept of mobile learning in mathematics education. Proponents state that by encouraging creative activities and collaboration, mobile learning promotes students' learning by enhancing motivation, critical thinking, learning, and engagement (Drigas & Pappas, 2015; Taleb et al., 2015). On the other hand, opponents discuss the possibility of distractions, diminished face-to-face communication, and equity concerns regarding the digital divide, in addition to the suggestions that mobile use may develop math anxiety as well as decreased confidence in students (Astuti et al., 2023; Chen et al., 2022; Ghimire, 2023). An equilibrium between these views is essential for comprehensive and viable mobile learning strategies.

This review's findings align with the distance education theory because they underscore a flexible and learner-centered setting with the help of mobile technologies that surpass conventional classroom borders and foster connectivity and personalized learning (Velmurugan et al., 2025). The findings imply that the translation of mobile learning may require institutions to invest in sound infrastructure, instructors' ongoing professional development, and policies of inclusion in order to capitalize fully on some of the benefits of mobile learning and resolve some of the equity and access issues presented by distance education environments.

Recommendations

The following are recommendations for the execution of mobile learning in educational institutions:

- Authorities and educational leaders should ensure that every learner has access to mobile learning tools and a stable Internet connection; this will remove the technological and situational aspect of accessibility that hinders equity in mathematics learning opportunities (Dawodi et al., 2023; Kaliisa & Michelle, 2019).

- Governments should ensure that instructors receive continued training that integrates technical skills and pedagogical approaches toward the successful integration of mobile technology that fosters differentiation and engagement among students (Borba et al., 2016; Rohadi & Yavani, 2023; Taleb et al., 2015).

- Learning institutions must create professional learning communities for teachers to share best practices, issues, and innovations among each other and so they can continue adapting and improving when using mobile learning in learning institutions (Upadhayaya, 2023).

Limitation and Future Implications

The present review's limitation is that the findings are limited to the mathematics classroom only; the results may not be generalizable to other contexts or have the same relevance in the future. Nevertheless, important conclusions can be made regarding the application of mobile learning in

teaching and students' interactions. It also emphasizes the lack of literature and gives recommendations for trainers and policymakers implementing mobile learning for students.

Conclusion

Mobile learning technologies promise to improve student engagement, learning, and teaching activities in mathematics education, but they come with some concerns that must be addressed. Thus, a careful approach, constant assessment, and adherence to equality principles are critical for achieving the intended positive outcomes without experiencing significant negative consequences. In this way, mobile learning will benefit students and instructors by improving the efficiency of educational processes and, more importantly, providing a better chance for all students to receive the educational opportunities they need and deserve.

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