Advances in Nonlinear Variational Inequalities
ISSN: 1092-910X
Vol 28 No. 2s (2025)

Mathematics Learning Evaluation Use Mobile Application: A Systematic Review

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Article History:

Received: *23-09-2024*

Revised: *12-11-2024*

Accepted: *20-11-2024*

Abstract:

This study aims to provide a comprehensive overview of the use of mobile applications for the evaluation of mathematical learning in various educational contexts. It will also answer important questions about effective evaluation methods, effectiveness, benefits, and issues related to the use of mobile applications for mathematical learning evaluation. The study was designed as a systematic literature review. The results show that the use of mobile applications in mathematics learning evaluation has great potential to improve student engagement, improve their academic performance, and provide an interactive learning experience. Pre- and post-testing, use of usage data, opinion polls, and a combination of interviews and questionnaires are the most common methods of evaluation. The educational context and in-depth understanding of student needs greatly influence the performance of mobile applications in the evaluation of mathematical learning. Despite having significant benefits, the implementation of mobile applications also faces challenges, such as ethical issues, good application design, and the selection of applications that fit the curriculum. These findings suggest that to improve the quality and effectiveness of the use of mobile applications by students, it is necessary to develop ethical guidelines, better application design, and thorough evaluation of the compatibility of applications with curricula.

Keywords: Mathematics; Learning Evaluation; Mobile Application; A Systematic Review

1. Introduction

Learning mathematics using mobile applications has grown along with advances in information and communication technology. This phenomenon shows a paradigm shift in learning, where technology plays an important role in helping students interact with the subject matter (Burbules et al., 2020; Haleem et al., 2022). Technology is essential for enabling students to engage with the material through independent learning, empowerment, and real-time communication (Butnaru et al., 2021; Yates et al., 2021). However, to comprehensively understand how mobile applications have transformed the process of evaluating mathematical learning, a deep understanding of its function and effectiveness in an educational context is required. As a result, systematic and thorough research is essential to find out to what extent mobile applications can enrich the process of mathematical learning evaluation.

Evaluation is an important part of mathematics learning because it ensures that students acquire a deep understanding of math and can apply these ideas in a variety of contexts. Effective evaluation enables educators to identify learning aspects that need to be improved and adapt learning methods to meet student's needs (Castro & Tumibay, 2021; Munna & Kalam, 2021). The existence of mobile applications, along with technological advances, opens up new opportunities to create evaluation instruments that are more flexible and tailored to student's unique needs (Alanzi, 2021; Zain & Bowles, 2021). The creation of a tool to streamline the process of assessing and choosing critical thinking applications highlights the general tendency of using mobile technologies to develop specific assessment tools (Bernacki et al., 2020; Joao, 2020). Therefore, systematic and thorough research is needed to understand how mobile applications can enrich the process of mathematical learning evaluation.

Previous studies have found many benefits of using mobile applications in learning mathematics. Some studies show that mobile applications can help students learn independently, improve their involvement, and provide faster and more accurate feedback (Booton et al., 2023; Klimova & Polakova, 2020). However, we still don't understand to what extent mobile applications can help mathematical evaluation. To fill this knowledge gap and provide clearer guidance for practitioners of mathematical education in using cellular applications, a thorough and systematically organized review of the literature is required.

Mobile applications in mathematical learning have been used in many research (Amasha et al., 2021; Booton et al., 2023; Yosiana et al., 2021), but not many specifically discuss how to use them for learning evaluation. A deeper understanding of the various evaluation techniques used in mobile applications and how they affect students' mathematical understanding is required. There is an urgent need for systematic research that thoroughly studies the use of cellular applications in the evaluation of mathematical learning as previous research tends to be separate and has not provided a comprehensive overview that integrates these findings.

This systematic review aims to overcome this knowledge gap by synthesizing existing literature on the subject. By conducting a thorough review of existing research, we can gain a deeper understanding of how effective the use of mobile devices is in the evaluation of mathematical learning. Moreover, this systematic review aims to provide an in-depth overview of major trends and findings in the literature. The study aims to answer the following questions by combining existing literature:

1. How have mobile applications been used in the evaluation of mathematical learning in various educational contexts?
2. What are some of the most common evaluation methods used in learning mathematics using a mobile application?
3. How is the effectiveness of mobile applications in the evaluation of mathematical learning?
4. What are the main benefits and challenges of implementing mobile applications for mathematics learning evaluation?

This research aims to gain a deeper understanding of the function and effectiveness of mobile applications in the evaluation of mathematical learning. The other goal is to find the potential advantages and obstacles associated with the application of these applications in a variety of educational contexts.

2. Methods

The study is designed as a systematic review (Materla et al., 2019; Xiao & Watson, 2019), which aims to comprehensively gather, synthesize, and evaluate evidence from various studies relevant to the research topic, namely the use of cellular applications in the evaluation of mathematical learning.

The research method chosen is a literature review (Popenoe et al., 2021). Through the literature review, researchers will investigate and analyze published literature on the usage of mobile applications in mathematics learning evaluation. This will enable researchers to identify trends, major findings, and gaps in knowledge existing in the relevant literature.

The inclusion criteria for this study are articles dealing with the use of mobile applications in the evaluation of mathematical learning. The articles to be included must provide relevant information and can provide significant insights related to the effectiveness of cellular applications within the context of the mathematics learning evaluation. The exclusion criteria for this study were articles that did not discuss the use of mobile applications in evaluating mathematics learning, book chapters, non-open access, and not empirical articles. Articles that did not meet these inclusion criteria were excluded from the analysis. Data collection will be done by searching articles that meet the inclusion criteria in Scopus and Google Scholar databases. Searches will be carried out systematically using appropriate search strategies to ensure the inclusion of the most relevant articles. The keywords used are mathematics AND learning AND evaluation AND mobile AND application. The search is done on the article title section and the abstract section of the article.

Data analysis will involve careful analysis of articles that meet the inclusion criteria. Relevant data will be extracted and synthesized to answer research questions that have been set. In addition, the analysis will include the identification and mapping of key findings as well as the overall evaluation of existing evidence. Using this method, the study is expected to provide a comprehensive understanding of the use of cellular applications in the evaluation of mathematical learning, as well as make significant contributions to existing literature. The complete process of this systematic review research can be seen in Figure 1.

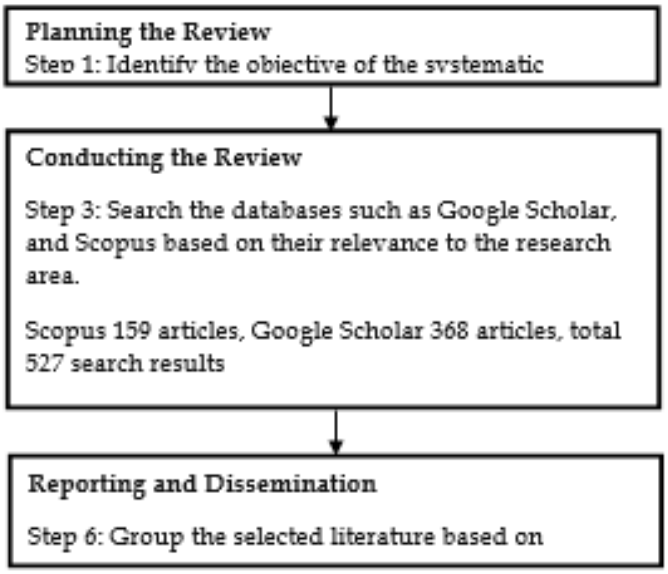

Figure. 1. Systematic review methodology.

3. Result

1. How have mobile applications been used in the evaluation of mathematical learning in various educational contexts?

Mobile applications have been used in various educational contexts to evaluate mathematical learning. A person develops and tests mobile applications for mathematics learning, and Botzer finds that these applications enhance engagement and collaboration (Botzer & Yerushalmy, 2007; Person

et al., 2018). Bedoya-Beltran incorporates mobile applications into the evaluation process in the university environment (Bedoya-Beltran et al., 2020), while Venter provides guidelines for selecting and evaluating mathematics learning applications (Venter & Swart, 2018). Shyshenko and Bitter respectively discussed the use of mobile applications in the professional training of future mathematics teachers and the analysis of the learning outcomes of such applications (Bitter & Corral, 2015; Shyshenko et al., 2021). Finally, Supandi explores the influence of mobile applications on students' ability to think critically in learning mathematics (Supandi et al., 2019). These studies collectively show the potential of mobile applications in improving mathematical learning and evaluation.

2. What are some of the most common evaluation methods used in learning mathematics using a mobile application?

Various evaluation methods have been used to assess the effectiveness of mobile applications in mathematical learning. Supandi and Venter use pre-and post-testing. Venter also combines student evaluation (Supandi et al., 2019; Venter & Swart, 2018). Kalloo and Isabwe used usage data to supplement questionnaire responses (Isabwe et al., 2014; Kalloo & Mohan, 2011, 2012), while Mandalina and Namukasa focused on expert and student validation opinion polls (Mandalina et al., 2019; Namukasa et al., 2016). Yosiana used a combination of questionnaires and interviews to measure the effectiveness of cellular learning in mathematics (Yosiana et al., 2021). These studies collectively highlight the importance of a multi-layered approach to evaluating the impact of cellular applications on mathematical learning.

The assessment of learning mathematics through mobile applications involves various approaches. Multi-criteria decision-making (MCDM) techniques are used to choose appropriate educational mathematics mobile applications (EMMAs) based on specific criteria (Can et al., 2022). The TOPSIS algorithm is used to rank EMMAs based on their effectiveness and suitability for teaching mathematics (Başaran & El Homsi, 2022). Another assessment technique examines the pedagogical, mathematical, and cognitive elements of mobile educational applications (Bedoya-Beltran et al., 2020). Educational criteria, such as scaffolding, feedback, learning theory, and content integration, are used to determine the quality of math applications (Milinković, 2022). The CIPP model is used to assess the implementation and effectiveness of mobile learning in mathematics in online education (Laato et al., 2020). Discourse analysis is used to understand the advantages and extent of mobile learning in mathematics (Mamolo, 2022). These evaluation approaches help educators, developers, and learners maximize the use of technology for educational objectives.

3. How is the effectiveness of mobile applications in the evaluation of mathematical learning?

The effectiveness of cellular applications in learning mathematics has been explored in various studies. Yosiana found that mobile learning can be effective in improving students' understanding of mathematical content (Yosiana et al., 2021). Similarly, Bedoya-Beltran and Botzer had positive outcomes, while Botzer highlighted the role of mobility, flexibility, and availability in enhancing engagement and collaboration (Bedoya-Beltran et al., 2020; Botzer & Yerushalmy, 2007). Venter and Bitter focus on the selection and evaluation of mathematical learning applications, with Venter emphasizing the role of online platforms in guiding the selection process (Bitter & Corral, 2015; Venter & Swart, 2018). Supandi and Person discuss the development and analysis of mobile applications, the first focusing on critical thinking skills and the last on integrating features to support decision-making and judgment (Person et al., 2018; Supandi et al., 2019). Jihad provides further evidence of the effectiveness of mobile learning in improving students' understanding of mathematics (Jihad et al., 2018).

The effectiveness of mobile applications in evaluating mathematical learning has been extensively studied. Various research projects have highlighted the positive impact of mobile applications on mathematics education. Research has shown that mobile applications can enhance mathematics learning by providing a platform for students to practice problem-solving, access solutions, and improve their understanding of mathematical concepts (Lozano et al., 2023; Mustafa, 2022; Tang et al., 2022). Furthermore, the use of mobile learning applications has been shown to have a positive impact on student learning outcomes, especially for those in the middle and low-skill categories (Dori, 2023). In addition, research has emphasized the importance of choosing high-quality mobile applications for mathematics education, with methodologies such as Fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) used to identify the most suitable applications based on the ISO/IEC 25010 quality standard software (Başaran & El Homsi, 2022).

4. What are the main benefits and challenges of implementing mobile applications for mathematics learning evaluation?

The application of mobile applications for mathematical learning evaluation provides many benefits. This includes improved academic performance and learning outcomes (Alcócer et al., 2018; Supandi et al., 2019), improved engagement and collaboration (Botzer & Yerushalmy, 2007), and the ability to explore mathematics freely and in real-life situations. (Patmawati et al., 2019). Mobile applications also provide a platform for practical assessment and feedback (Canché-euán et al., 2014), and can be used to create educational applications for analysis and decision-making. (Person et al., 2018). They can reduce stress levels associated with evaluation activities and motivate students (Bedoya-Beltran et al., 2020), as well as facilitate knowledge transmission and self-employment (Blazhko et al., 2021).

The implementation of mobile applications for the evaluation of mathematical learning faces several challenges. This includes ethical issues and perceived disturbances in the classroom (Abidin et al., 2017), the need for effective designs to enhance critical thinking (Supandi et al., 2016), and the selection of appropriate applications that align with the curriculum and encourage interactivity (Handal et al., 2013; Namukasa et al., 2016; Sayed, 2015). Despite these challenges, cellular learning can enhance cognitive and emotional processes, encourage collaboration, and provide new learning experiences (Skillen, 2015). The combination of mobile applications also produces valuable data for analysis, which can be used to enhance the learning process of teaching (Person et al., 2018).

4. Discussion

The findings from the literature survey suggest that mobile applications have been used in a variety of educational contexts to evaluate mathematical learning. A study conducted by Person (2018) and Botzer (2007) noted the development and testing of mobile applications specific to mathematics learning. Botzer(2007) revealed that the use of such applications significantly improved student engagement and encouraged collaboration in the learning process. (Botzer & Yerushalmy, 2007; Person et al., 2018). These results highlight the great potential of integrating cellular technology into mathematics education. With a mobile application designed specifically for learning mathematics, educators can create a more interactive and participatory learning environment, which can enhance student motivation and engagement. Several studies have shown the effectiveness of mobile applications designed specifically for learning. Cruz found that mobile applications can improve learning outcomes, this study focused on high school students (De La Cruz et al., 2023). Research shows that these applications have a positive impact on classroom performance by encouraging creativity, active learning, and critical thinking (Lee et al., 2023; Rocque, 2022).

Research by Bedoya-Beltran (2020) and Venter (2018) also showed the use of mobile applications in the evaluation of mathematical learning. The findings are consistent with Botzer's and Person's

findings, suggesting that mobile applications have a variety of benefits in the context of evaluation of mathematical learning at different levels of education. Studies by Shyshenko (2021), Bitter (2015), and Supandi (2019) highlight additional aspects of the use of mobile applications in the context of mathematical education. (Supandi et al., 2019). These findings make a unique contribution to our understanding of the use of mobile applications in the evaluation of mathematical learning.

The findings from the literature survey suggest that various evaluation methods have been used to assess the effectiveness of cellular applications in mathematical learning. Studies conducted by Supandi (2018) and Venter (2018) used pre-and post-tests and student evaluations to measure the impact of using mobile applications in mathematics learning (Supandi et al., 2019; Venter & Swart, 2018). In addition, Kalloo (2012, 2011) and Isabwe (2014) used usage data to complement questionnaire responses, while Mandalina (2019) and Namukasa (2016) focused more on expert and student validation polls. (Kalloo & Mohan, 2011, 2012; Isabwe et al., 2014; Mandalina et al., 2019; Namukasa et al., 2016). Yosiana (2021) even used a combination of questionnaires and interviews to measure the effectiveness of cellular learning in mathematics. (Yosiana et al., 2021).

The findings show the importance of a multi-faceted approach in evaluating the impact of mobile applications on mathematics learning. By using various evaluation methods, educators can gain a more comprehensive understanding of the effectiveness of mobile applications and gain valuable insights to improve their use in the context of learning mathematics. Research by CAN et al. (2022) used multi-criterion decision-making techniques to select mathematical applications based on specific criteria, while Başaran & El Homsi (2022) used the TOPSIS algorithm to rank applications based on effectiveness and suitability for teaching mathematics. These findings add valuable contributions to our understanding of the evaluation of cellular applications in mathematical learning. For complete details regarding the method used in Figure 2.

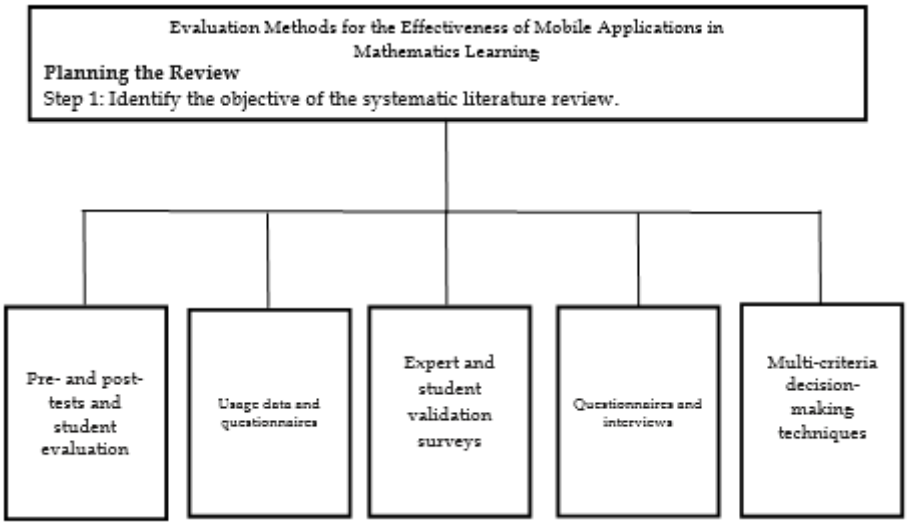

Figure 2. Evaluation Methods

The effectiveness of mobile applications in evaluating mathematical learning is significant in a variety of educational environments, affecting student learning outcomes, motivation, and cognitive development (Hou et al., 2023; Lozano et al., 2023), increases its potential to promote mathematics learning through exciting and interactive experiences. Mobile learning applications in Hong Kong have a positive impact on student learning outcomes and motivation, as well as improving their performance. Mobile learning apps, based on the ISO/IEC 25010 standard and multi-criterion decision-making methods, have been shown to improve student performance in mathematics subjects. The integration of mobile applications in classrooms has been linked to creativity, learning,

and development, encouraging student participation in positive thinking processes and improved understanding (Kyobe et al., 2022; Liu et al., 2022).

A literature review suggests that the application of mobile applications to evaluate mathematical learning provides a range of significant benefits. Studies conducted by Alcócer et al. (2018) and Supandi and al. (2019) show that the use of mobile applications can improve academic performance and learning outcomes (Alcócer and al., 2018; Supandi et al., 2019). In addition, Botzer & Yerushalmy (2007) found that mobile applications can also enhance student engagement and collaboration in the learning process. (Botzer & Yerushalmy, 2007). A study by Patmawati (2019) shows that mobile applications allow students to explore mathematics freely and in real-life contexts. (Patmawati et al., 2019). These benefits suggest that mobile applications can be an effective tool in improving student math learning experience. By providing a platform for practical assessment and feedback, as well as facilitating independent and collaborative learning, mobile applications can help create a more dynamic and responsive learning environment for students' individual needs. In addition to the benefits that have been mentioned, other studies also highlighted other benefits of the implementation of mobile applications in the evaluation of mathematical learning. Canché-euán et al. (2014) emphasized the importance of mobile applications as a platform for practical assessment and feedback, while Person et Al. (2018) highlighted the potential of mobile apps to create educational applications for analysis and decision-making. These findings make a unique contribution to our understanding of the benefits of mobile applications in the context of mathematical learning evaluation.

A study conducted by Abidin et al. (2017) showed that the implementation of mobile applications for the evaluation of mathematical learning faced several challenges, including ethical issues and disturbances perceived in the classroom. (Abidin et al., 2017). In addition, Supandi et al. (2016) highlighted the need for effective design to enhance student critical thinking (Supandi et al., 2016). Other challenges include selecting applications that match the curriculum and encouraging interactivity (Handal et al., 2013; Namukasa et al., 2016; Sayed, 2015). These challenges highlight the importance of taking into account design, ethics, and curriculum aspects in the development and implementation of mobile applications for mathematics learning. It takes greater effort to ensure that the application is used by the learning needs and can deal with any interference that may occur in the classroom. Despite the challenges, mobile learning still has great potential to enhance the learning process. Skillen (2015) notes that despite the challenges, mobile learning can enhance cognitive and affective processes, encourage collaboration, and provide new learning experiences (Skillen, 2015). Moreover, the integration of mobile applications can also produce valuable data that can be used to enhance teaching-learning processes. (Person et al., 2018).

5. Conclusion

The great potential of mobile applications in improving mathematics learning and evaluation. By supporting student involvement, enhancing collaboration, and facilitating a better understanding of concepts, mobile applications can be valuable tools to improve the quality of mathematics education in various educational contexts. By using various evaluation methods, we can better understand and measure the impact of mobile applications in mathematics learning. This multi-faceted approach provides a broader and holistic view of the effectiveness of mobile applications in improving students' understanding and mathematical skills. It will help educators, developers, and learners in maximizing the potential of technology to educational goals. The effectiveness of mobile applications in evaluating mathematics learning in various educational environments affects student learning outcomes, motivation, and cognitive development. These games not only desired results but also provided positive evaluation and feedback, enhancing their potential to promote mathematical learning through interactive experiences. The application of mobile applications in mathematical

learning evaluation provides a range of significant benefits, ranging from improved academic performance and student engagement to the ability to explore mathematics in real-life contexts. These benefits reaffirm the importance of integrating cellular technology to improve the quality of mathematics education. The challenges faced in the implementation of mobile applications for the evaluation of mathematical learning include Ethical issues and disruptions in the classroom, the need for effective application design to encourage critical thinking of students and the selection of applications that are appropriate to the curriculum.

Through an in-depth understanding of the challenges faced in the implementation of mobile applications for the evaluation of mathematical learning, we can formulate strategic steps to overcome such obstacles. Development of ethical guidelines, more effective application design, and careful evaluation of application compatibility with curricula can improve the quality and effectiveness of the use of cellular technology in mathematics learning.

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