Italian Journal of Educational Technology, 33(2), 17-32, 2025
ISSN 2532-4632 (print) – ISSN 2532-7720 (online)
DOI: 10.17471/2499-4324/1428
https://ijet.itd.cnr.it

Italian Journal of Educational Technology

ISTITUTO TECNOLOGIE DIDATTICHE

The implementation of mobile learning in Primary Schools in Indonesia

L'implementazione del mobile learning nelle scuole primarie in Indonesia

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HOW TO CITE Amalia, A. R., Wedi, A., & Setyosari, P. (2025). The implementation of mobile learning in Primary Schools in Indonesia. *Italian Journal of Educational Technology*, *33*(2), 17-32. https://doi.org/10.17471/2499-4324/1428

Received: December 27, 2024; *Accepted:* May 06, 2025; *First Published:* June 1, 2025

ABSTRACT This research explores the implementation of mobile learning in primary schools in Indonesia through a systematic literature review (SLR). Following the systematic review methodology outlined by Newman and Gough (2020), this research conducted an analysis of selected articles. These articles were retrieved from Google Scholar to ensure a broad and relevant selection of sources. Most articles were published in 2021 and 2022. Mobile learning has become a significant trend in education, with its applications including videos, teaching materials, e-modules, augmented reality apps and applications for gadgets (applications that can be accessed through devices such as smartphones or tablets). Based on the results of this study, mobile learning has been successfully implemented in various subjects, demonstrating its potential to improve educational outcomes. However, significant challenges remain, including limited infrastructure, lack of teacher skills and inequitable access to digital devices. Challenges were also identified, such as teacher preparedness and accessibility for students.

KEYWORDS Mobile Learning; Primary Schools; Indonesia; Literature Review.

SOMMARIO Questa ricerca esplora il tema dell'apprendimento basato sull'uso di dispositivi mobili nelle scuole primarie in Indonesia attraverso una revisione sistematica della letteratura. Seguendo la metodologia di revisione sistematica delineata da Newman e Gough (2020), questa ricerca ha condotto un'analisi degli articoli selezionati. Gli articoli sono stati reperiti tramite Google Scholar per garantire una selezione ampia e pertinente delle fonti. La maggior parte degli articoli è stata pubblicata nel 2021 e nel 2022. L'uso dell'apprendimento basato su dispositivi mobili è diventato una tendenza significativa nel campo dell'istruzione: le tipologie di uso variano dalla fruizione di video, materiali didattici, moduli e-learning, app di realtà aumentata e applicazioni per gadget (applicazioni accessibili tramite dispositivi come smartphone o tablet). Sulla base dei risultati analizzati, il mobile learning è stato implementato con successo in diverse materie, dimostrando il suo potenziale nel migliorare i risultati educativi. Tuttavia, permangono sfide significative, tra cui le infrastrutture limitate, la mancanza di competenze degli insegnanti e le disparità di accesso ai dispositivi digitali. Sono state individuate anche le principali barriere alla diffusione del mobile learning, come la preparazione degli insegnanti e l'accessibilità per gli studenti.

PAROLE CHIAVE Apprendimento Basato su Dispositivi Mobili; Scuole Primarie; Indonesia; Revisione Sistematica della Letteratura.

1. Introduction

The ways of accessing and sharing knowledge have changed significantly with the rapid advancements in information and communication technology in recent years. The need for individuals to have access to information on the go, the need to personalise education, and the ever-increasing use of technology all contribute to the increasing popularity of distance learning, e-learning, and mobile learning (Martha et al., 2018). This demonstrates the critical role of technology in creating new opportunities for more flexible and accessible learning for people from all walks of life. Wireless communication technologies and mobile devices play a major role in the spread of these concepts. Moreover, the continuous development of mobile applications further enhances the potential of mobile learning by providing learners with seamless access to educational resources, making learning more interactive, efficient, and accessible than ever before.

Wireless communication technologies and mobile devices play a major role in the spread of these concepts. With the development of applications, mobile technology has evolved beyond a simple communication tool to offer easy access to unlimited knowledge in the field of education anytime and anywhere (Rosiva et al., 2022). Mobile learning is the outcome of a positive impact of technological advancement that changes the values of education, where learning starts to move out of traditional contexts (Maritasari et al., 2022). This facilitates the use of technology in education and makes it easier for students to interact and access any information. Due to its advantages in the field of education, mobile technology is becoming increasingly important for teachers and students as it is being used more and more (Zengin et al., 2018). Based on this idea, mobile learning is a new approach to learning in the modern education system that has gained recognition in the literature.

Against this backdrop, while some countries, such as Italy, have introduced policies restricting the use of mobile devices in classrooms (Rahali et al., 2024), in Indonesia, the government has initiated various policies aimed at integrating technology into education. The Ministry of Education and Culture has emphasized the importance of digital literacy and the use of technology to support learning processes. For instance, the "Merdeka Belajar" (Freedom to Learn) initiative encourages innovative teaching methods, including the use of mobile devices to facilitate learning inside traditional classroom settings (Rasmitadila et al., 2020). This initiative reflects a broader recognition of the need to adapt educational practices to the demands of the 21st century. In line with this, mobile learning has emerged as a crucial way to enhance accessibility and flexibility in education, allowing students to engage with learning materials beyond the confines of a physical classroom.

ElçiÇek and Bahçeci (2017) define mobile learning as learning through mobile technology, which gives students access to information anytime and anywhere based on their specific needs (Wagner, 2008). Using portable devices such as laptops, tablets, and mobile phones for educational purposes is also known as mobile learning (Niazi, 2007). The term mobile learning also recalls the need for students to control their own learning process according to their own needs and learning styles, not just to access information through mobile devices regardless of time or location.

The centre of attention in this mobile-based online learning environment is the student. The use of mobile learning allows students to have a more personalized learning experience (Cholifah & Nafsi, 2021). Through the internet, one can access teachers, curriculum, and schools. Mobile learning allows access to e-learning content regardless of location thanks to the sophistication of mobile information technology. It can assist traditional learning methods as well as distance learning (Rorita et al., 2018). There are many benefits to integrating mobile learning environments into education. One of the main

benefits that mobile devices offer in terms of learning processes and outcomes is that they are portable, cheaper, and provide opportunities for both social and individualised learning (Chinnery, 2006). Therefore, mobile learning promises to support one's long-term learning process. In addition, mobile learning allows to tailor the learning process to the needs of different students (Corbeil & Corbeil, 2011). Thus, it affects the sociocultural and cognitive aspects of learning (Pachler, 2009). The development of mobile learning is expected to increase students' attention to learning materials, thus creating a more interesting and enjoyable learning experience (Pratama et al., 2018). According to Sari and Pardimin (2024), mobile learning can improve students' critical thinking abilities, making it an effective learning method to support higher cognitive skills.

While there are many advantages in the learning process and outcomes of the widespread use of mobile devices in education, there are also a number of barriers to its use. In general, these issues can be categorised under two main headings. The former is technology-related issues with hardware and software, including issues with internet access and infrastructure, issues with screens and keyboards, and issues with mobile device batteries (Kacetl & Klímová, 2019). The latter regards privacy and security concerns and the high cost of mobile devices (El-Hussein & Cronje, 2010). These issues are expected to diminish as technology advances. Therefore, choosing the best learning strategy for students is a must for educators. To implement learning strategies effectively, educators should consider students' conditions, learning materials, and available learning resources when selecting learning strategies. Consequently, educators should be able to utilise the available learning resources to facilitate students' academic success by implementing learning strategies effectively and efficiently. For example, in primary education, mobile apps can support learning through play in order to make learning easier and more motivating.

The aim of this study is to summarize the results of previous research on mobile learning by focusing specifically on its implementation in primary schools in Indonesia. This study intends to explore the current trends, challenges, and outcomes of research in the field of mobile learning to improve education in primary schools in Indonesia.

2. Methodology

This research employs the Systematic Literature Review (SLR) method. According to Dhamayanti (2022), the systematic literature review is a research design that is used to conduct a synthesis and analysis of evidence provided by earlier studies. The SLR method replenishes the expected contribution of several studies by stating and comparing their outcomes in order to summarize of the information and data collected on a certain study topic. This study uses the SLR methodology as explained by Newman and Gough (2020). According to these authors, in order to conduct a vigorous and balanced assessment of the literature, the stages shown in Figure 1 must be followed.

2.1. Research question

This systematic literature review (SLR) will address the following research questions:

- Question 1 (RQ1): What is the landscape of mobile learning studies in primary education in Indonesia, in terms of distribution in time, types of mobile learning technologies used and subjects taught?
- Question 2 (RQ2): What challenges are faced by teacher and students in the implementation of mobile learning in primary schools in Indonesia? What solutions can be adopted to overcome such challenges?

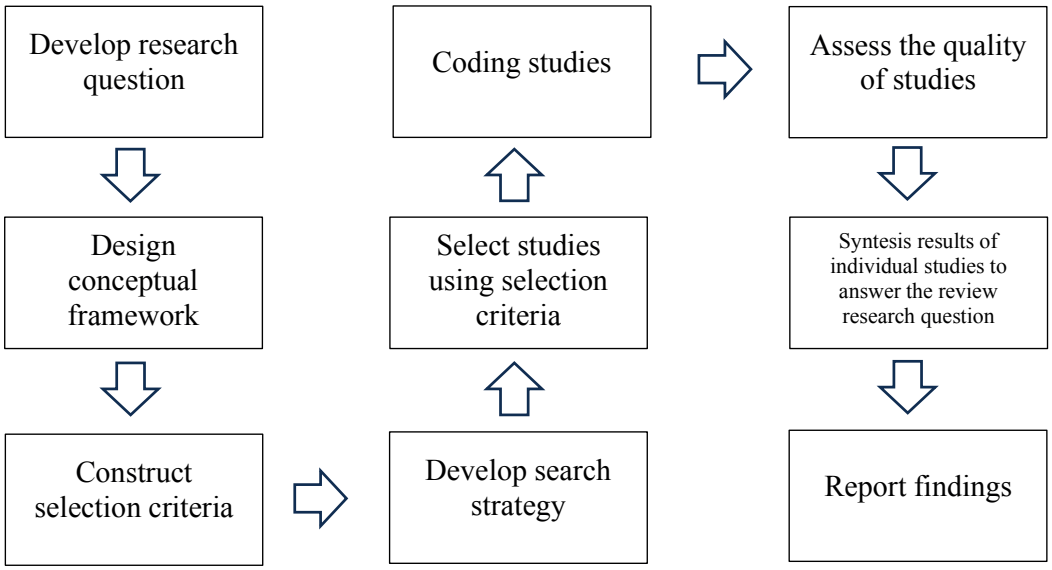

Figure 1. The systematic review process (Newman & Gough, 2020).

2.2. Search strategy

In this Design Conceptual Framework, the researcher chose to use Google Scholar as a search engine. The reason researchers made this choice is because Google Scholar is a search engine for retrieving not only academic documents, but also grey literature and documents in languages other than English (including Indonesian) (Haddaway et al., 2015). Additionally, its use is free. Based on Figure 2, this research consists of several stages, starting with the stage of determining the search engine, creating a search string, carrying out search experiments, refining the search string, and compiling a final list of primary studies that match the search string.

The search string used was "mobile learning", "M-learning", and "sekolah dasar / primary school". The string was adapted to fit the specific requirements of the search engine. These articles were screened based on the inclusion criteria (see Table 1), focusing on studies published between 2024-2019 and specifically addressing mobile learning in primary schools in Indonesia.

Table 1. Search Results on Google Scholar Search Engine.

Keyword String	Total
("mobile learning" OR "M-learning") AND ("sekolah dasar" OR "primary school")	101

The study selection process was carried out systematically to ensure relevance and consistency with the review's objectives. After conducting a search on Google Scholar with the specified keywords, the articles were then selected according to the inclusion criteria, namely focusing on studies published between 2024-2019 and specifically addressing mobile learning in primary schools in Indonesia. This way, 16 articles were obtained. In fact, while mobile learning in general has been investigated in recent

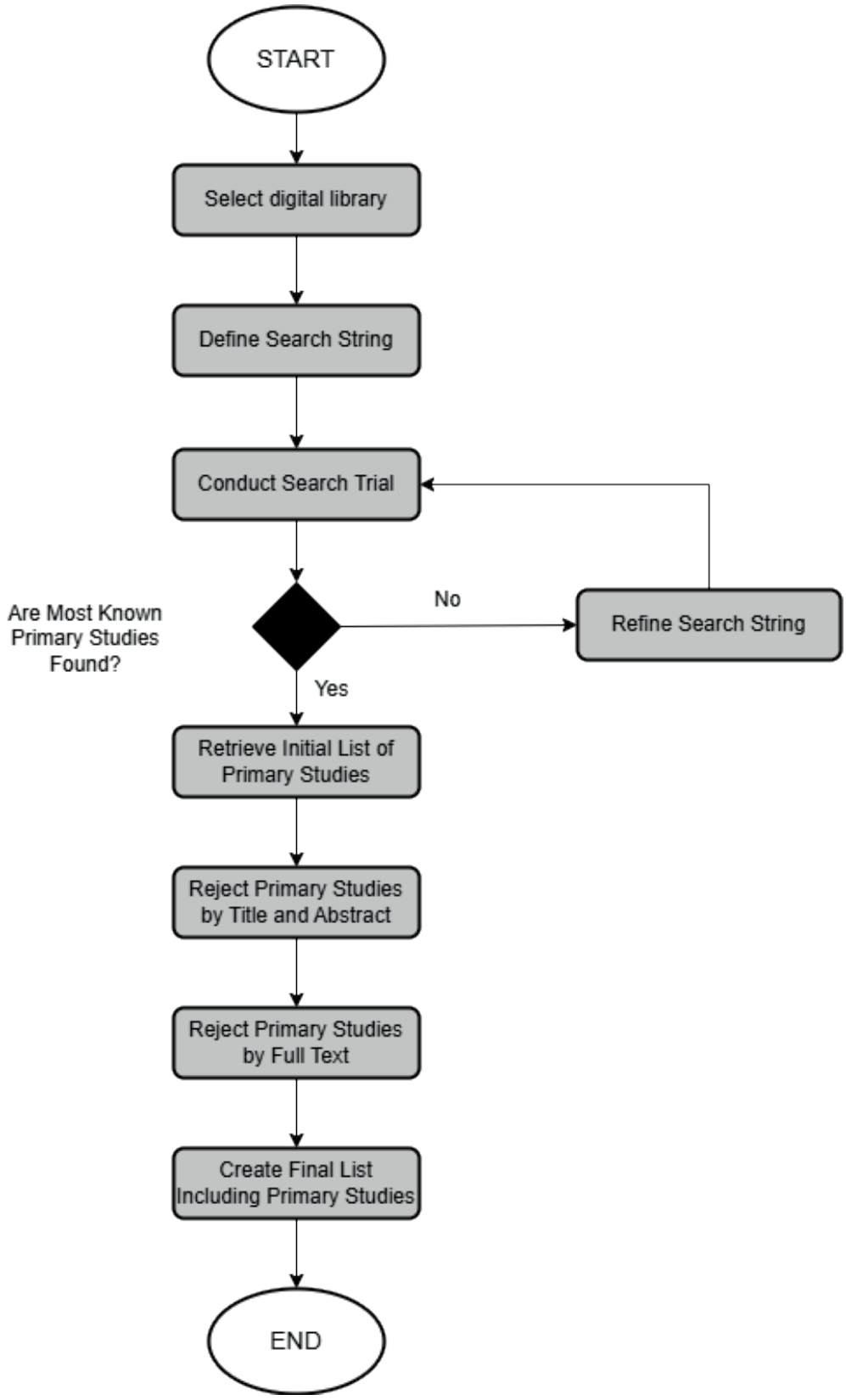

Figure 2. Flowchart of Search Stages.

reviews (Zafrullah & Ramadhani, 2024), Indonesia is a relatively underexplored area in the broader field of educational technology. To study this specific country in depth, this review needs to consider publications not typically included in Scopus or Web of Science, thus providing a more comprehensive understanding of mobile learning in the Indonesian primary education context.

As highlighted by Husain (2019), Google Scholar offers significant advantages for academic research by providing access to a wide range of scholarly articles across various disciplines, including, but not limited to, those covered by traditional databases like Scopus and Scholar. The journals covered include diverse topics, from technology in education to social sciences, ensuring a broad perspective. While databases like Scopus and Web of Science are often preferred for high-impact studies, Google Scholar is a more accessible and inclusive platform, especially for those without institutional access. Husain (2019) also points out that Google Scholar allows researchers to access articles from less conventional or regional sources, which is often relevant for studies such as this that focus on a specific geographical and educational context.

In line with the approach of Tulljanah and Amini (2021), who emphasise the importance of reviewing and selecting studies from accessible and relevant sources for educational research, this study highlights the usefulness of Google Scholar. This search engine provides access to a variety of sources that contribute to the development of educational practices, especially in regions where access to traditional academic databases is limited. This is particularly relevant in the context of mobile learning in Indonesia, where local studies might not always be indexed in high-impact databases. The use of Google Scholar allows researchers to identify research trends in Indonesia more effectively, due to access to a variety of sources that are not always available in Scopus or WoS (Amri et al., 2024).

Therefore, this review supports the use of Google Scholar as an appropriate tool for collecting relevant references on mobile learning in primary schools, particularly as it provides a wider range of articles that may not be available in other academic databases This approach ensures that a more comprehensive set of studies is included in the review, helping to capture trends and insights that might otherwise be overlooked.

However, reliance on Google Scholar as the sole source introduces certain limitations, as it lacks the rigorous indexing standards of databases like Scopus or Web of Science. This may lead to the inclusion of publications with varying quality and impact, potentially limiting the robustness of the review. Nevertheless, Google Scholar remains a more accessible and inclusive platform, especially for those without institutional access.

2.3. Coding phase

The study coding phase is a systematic process used to manage a collection of data into smaller units of analysis by creating categories and concepts derived from the data itself. The coding is carried out by identifying the elements of variables that represent key aspects of the research articles, referred to as quality and relevance variables (Izzaturahmah, 2024). These quality and relevance variables are further explained in Table 2, which outlines how the coding process was applied to assess the implementation of mobile learning in primary schools in Indonesia, as well as its relevance to the local context and the quality of implementation as recorded in the studies analysed.

To identify the key elements, the next step was to read the full text of each article, paying attention to any fragments of text that reflected the elements of the quality and relevance variables. After determining the elements of the quality and relevance variables, a new element was created that is relevant

to this study, where the focus is on articles discussing mobile learning in primary schools in Indonesia.

Table 2. Elements of Quality and Relevance in Research.

Element	Information Captured
Research aim	The aim of each study
Research method	Research method (survey design, statistical analysis methods, etc.)
Research sample	Sample size and demographic data of participants
Research findings	Conclusions, recommendations, and implications presented by the researchers

2.4. Appraising the quality of studies

In a systematic literature review, the data found were evaluated based on quality assessment criteria to gather evidence related to the research question and measure the quality of primary studies. This assessment was conducted using the checklist criteria from Izzaturahmah (2024) which can be seen in Table 3. For the selected articles related to the implementation of mobile learning in primary schools in Indonesia, the quality assessment included three main elements: appropriateness of the research design, quality of method implementation, and relevance to the Indonesian educational context. The research design should reflect the challenges and conditions in Indonesia, while the quality of implementation needs to consider the validity of the data and the application of appropriate mobile learning strategies. This assessment aims to provide a comprehensive picture of the effectiveness and challenges of mobile learning implementation in Indonesian primary schools.

Table 3. Checklist criteria based on Izzaturahmah (Izzaturahmah, 2024).

No	Item	Answer
1.	Is the article cited?	Yes/No
2.	Is the research aim clearly stated?	Yes/No/Partially
3.	Are the research participants or observation units sufficiently described?	Yes/No/Partially
4.	Is data collection carried out thoroughly? For example, is there a discussion of the procedures used for data collection, and how the research setting could affect the data gathered?	Yes/No/Partially
5.	Are potential confounding factors sufficiently controlled in the analysis?	Yes/No/Partially
6.	Is the approach to analysis and the formulation of the analysis presented clearly? For example, is there a description of the raw data forms, reasons for choosing methods/tools/packages?	Yes/No/Partially
7.	Are the findings trustworthy? For example, is the study described methodologically so that we can trust its findings, and do the findings/conclusions resonate with other knowledge and experiences?	Yes/No/Partially

3. Findings

3.1. RQ1 – The landscape of the selected studies

Table 4 shows the 16 studies selected for analysis in this SLR.

Based on the results of the analysis carried out, publications in the field started in 2019 with only 1 article. Figure 3 shows the distribution in time of the other studies. The years 2021 and 2022 saw a significant increase in the number of papers on mobile learning in primary schools in Indonesia. This increase may be attributed to the impact of the COVID-19 pandemic. During the pandemic, the adop-

Table 4. Articles included in the SLR.

No	Author	Research Design Model	Type of Study	Sample	Research Instruments	Mobile Learning Product Results	The Subjects of Mobile Learning Used
1	(D. A. P. Sari & Kiptiyah, 2024)	Borg and Gall Model	Research and Development	30 students in Year 5	Interviews -Media and material Validation Expert Questionnaire -Student Trial Questionnaire	Application for gadgets (articulate storyline-based mobile learning media)	Social studies
2	(Imaduddin & Damayanti, 2024a)	Borg and Gall Model	Research and Development	Year 5 students	-Interviews -Media and material Validation Expert Questionnaire -Student Trial Questionnaire	Application for gadgets (SIMOBILE)	Science
3	(R. V. Sari & Pardimin, 2024)	ADDIE model	Research and Development	10 students in Year 6	-Interviews -Validation sheet for two expert judgements, in this case the principal and teachers who have at least a master's degree – Student response questionnaire.	Application for gadgets (interactive multimedia based on mobile learning)	Mathematics
4	(Anggraini et al., 2023)	Borg and Gall Model	Research and Development	Primary School at West Java, Indonesia	Questionnaires for material feasibility experts, language experts and media experts	Augmented Reality (AR)	Mathematics
5	(Rofi'i & Susilo, 2023)	Borg and Gall Model	Research and Development	Year 5 students	-Interviews, - Questionnaire -Assessments of the Mobile Learning process	Teaching Materials	English language
6	(Suhardi et al., 2022)	ADDIE model	Research and Development	37 students in Year 4	-Interviews -Media and material Validation Expert Questionnaire -Teacher Eligibility Assessment Questionnaire -Student Trial Questionnaire	Application for gadgets (Scientific-based mobile learning application for thematic learning)	Thematic learning
7	(Hardiansyah et al., 2022)	Dick and Carey model	Research and Development	6 Year students	-Interviews – Questionnaires - Tests for students	Application for gadgets (Mobile learning-based learning media)	Science

(Continued).

DOI: 10.17471/2499-4324/1428

Table 4. (Continued).

No	Author	Research Design Model	Type of Study	Sample	Research Instruments	Mobile Learning Product Results	The Subjects of Mobile Learning Used
8	(Zaenal et al., 2022)	ADDIE model	Research and Development	6 Year students	- Interview - Questionnaires for subject matter experts and media experts NuMet assessment sheet instrument - Pretest and post test questions for students	Application for gadgets (Mobile Learning Numeracy "NuMet")	Mathematics
9	(Sakiyah et al., 2021)	DDD-E (Decide, Design, Develeop, and Evaluate) model by Ivers & Barron	Research and Development	35 students in Year 4	-Interviews -Media and material Validation Expert Questionnaire - Pretest and post test questions for students	Application for gadgets (Mobile learning with a Scientific Approach)	Social studies
10	(Ammatulloh et al., 2021)	ADDIE model	Research and Development	Primary school	-Interviews -Media and material Validation Expert Questionnaire -Student Trial Questionnaire	Application for gadgets (Civics Caring Apps)	Pancasila Education
11	(Auliyah & Sari, 2021)	ADDIE model	Research and Development	32 students in Year 3	-Interviews -Media and material Validation Expert Questionnaire -Teacher Eligibility Assessment Questionnaire -Student Trial Questionnaire	Application for gadgets (Appy Pie Android mobile learning application based on creative thinking skills)	Science
12	(Maryono & Budiono, 2021)	Hannafin and Peck model	Research and Development	9 students from each of Year 1, Year 2 and Year 3	- Interviews - Questionnaires for material feasibility experts, language experts and media experts - Teacher Eligibility Assessment Questionnaire - Student Trial Questionnaire	Teaching Materials	Bahasa Indonesia
13	(Utami, 2021)	ADDIE model	Research and Development	18 students in Year 5	- Interviews - Media and material Expert Questionnaire - Student Trial Questionnaire	E-modul	Bahasa Indonesia

(Continued).

Table 4. (Continued).

No	Author	Research Design Model	Type of Study	Sample	Research Instruments	Mobile Learning Product Results	The Subjects of Mobile Learning Used
14	(Firdaus & Hamdu, 2020)	Focus Group Discussion (FGD)	Research and Development	Year 5 students	- Discussions in specific grou	Video	Science, Technology, Engineering and Mathematics (STEM)
15	(Nurhidayat et al., 2020)	Lee, W.W., & Owens, D.L. model	Research and Development	17 students in Year 5	- Interviews - Media and material Expert Questionnaire - Student Trial Questionnaire	Application for gadgets (mobile learning application product that is used in Madura Language)	Non-academic Material
16	(Mabruri et al., 2019)	ADDIE model	Research and Development	64 students in Year 4	- Media Expert Questionnaire-Teacher Eligibility Assessment - Student Trial Questionnaire	Application for gadgets (Science Mobile Learning Media)	Science

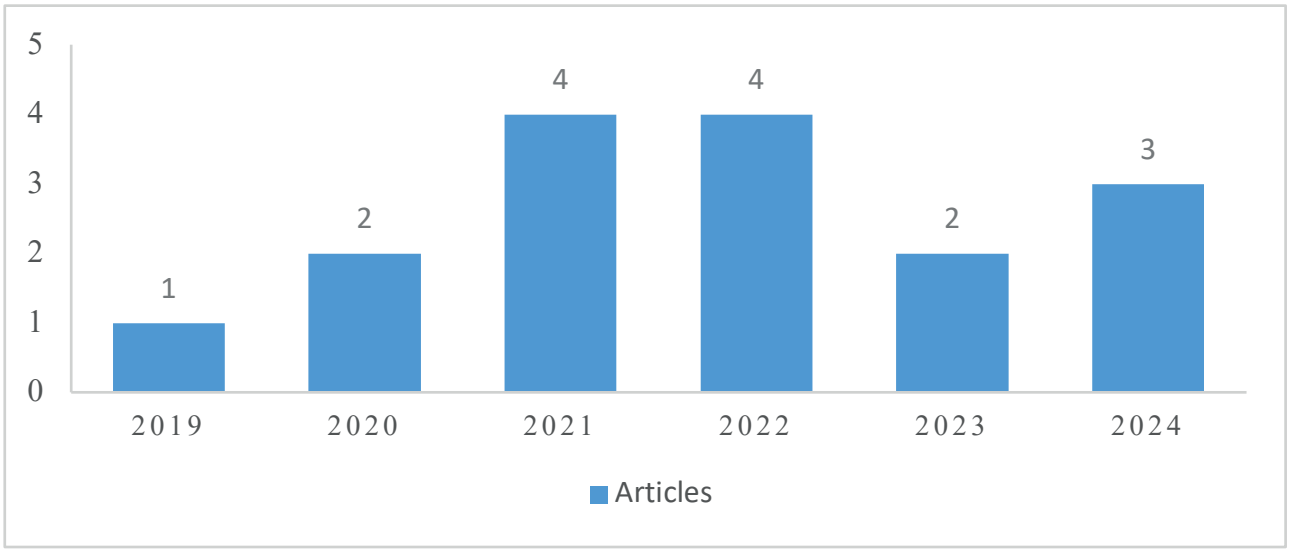

Figure 3. Articles on mobile learning in primary schools in Indonesia by year of publication.

tion of mobile learning surged as schools transitioned to remote learning, leading to a higher reliance on portable devices. However, in 2023 and 2024 the number of studies is lower than during the pandemic. Various factors may have influenced this development, including technical challenges, limited accessibility of devices, as well as lack of adequate training for educators (Mabruri et al., 2019). While the potential of mobile learning to increase flexibility and student engagement remains high, some educational institutions may still face obstacles in overcoming these barriers. Therefore, despite the positive trends in 2021 and 2022, further efforts are needed to ensure that mobile learning can be thoroughly integrated across schools, so that its potential can be truly realised in supporting the education of the future.

Based on the analysis of Figure 4, the devices were used in implementing mobile learning in primary schools in Indonesia to watch videos, access teaching materials, e-modules, applications for gadgets (Android-based applications that can be accessed through devices such as smartphones or tablets), and augmented reality (AR). The use of augmented reality-based mobile learning research is still scarcely investigated (see Figure 4). Even so, augmented reality-based mobile learning research is a subject that should be further investigated and strictly relate to mobile learning research. Through augmented reality, learning is brought to a new dimension as learners can easily visualise what is happening and easily understand complex concepts. The type of mobile technology more frequently used is "Applications for gadgets". These applications serve the purpose of improving students' learning outcomes in various ways. For example, Sari and Kiptiyah (2024) developed articulate storyline-based learning media that showed a significant increase in student learning outcomes in social studies subjects, with an average increase of 56%. Imaduddin and Damayanti (2024) (2024) developed a 'SIMOBILE' application for science lessons that targets increased motivation and learning outcomes. This application received material (89%) and media (88%) expert validation, and was very well received by students (95%). R.V. Sari and Pardimin (2024) used an interactive multimedia approach for Maths, which received an average validation of 92.67%, demonstrating the success of the implementation in supporting learning.

These bespoke apps allow flexible access to learning materials and enhance student interactivity through features such as interactive evaluation, games, and animations.

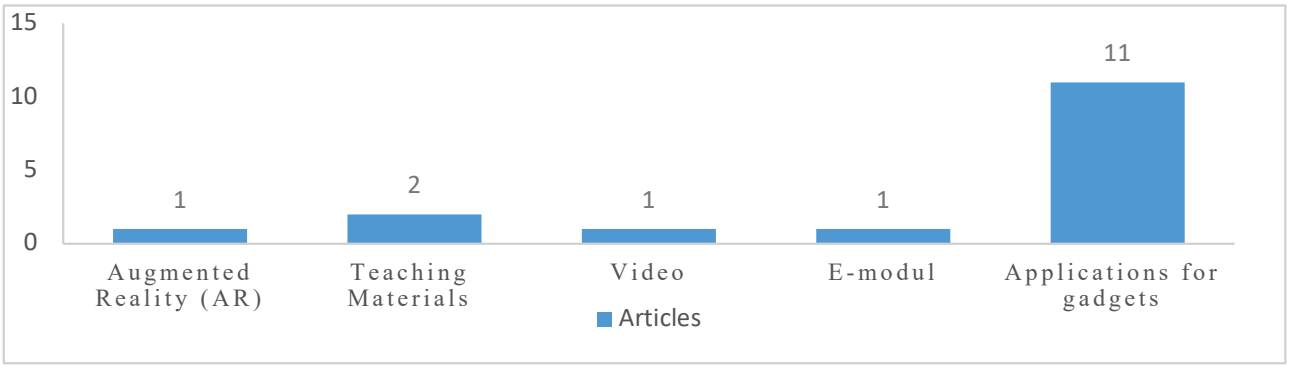

Figure 4. Articles on mobile learning in primary schools in Indonesia by types of mobile learning technology used.

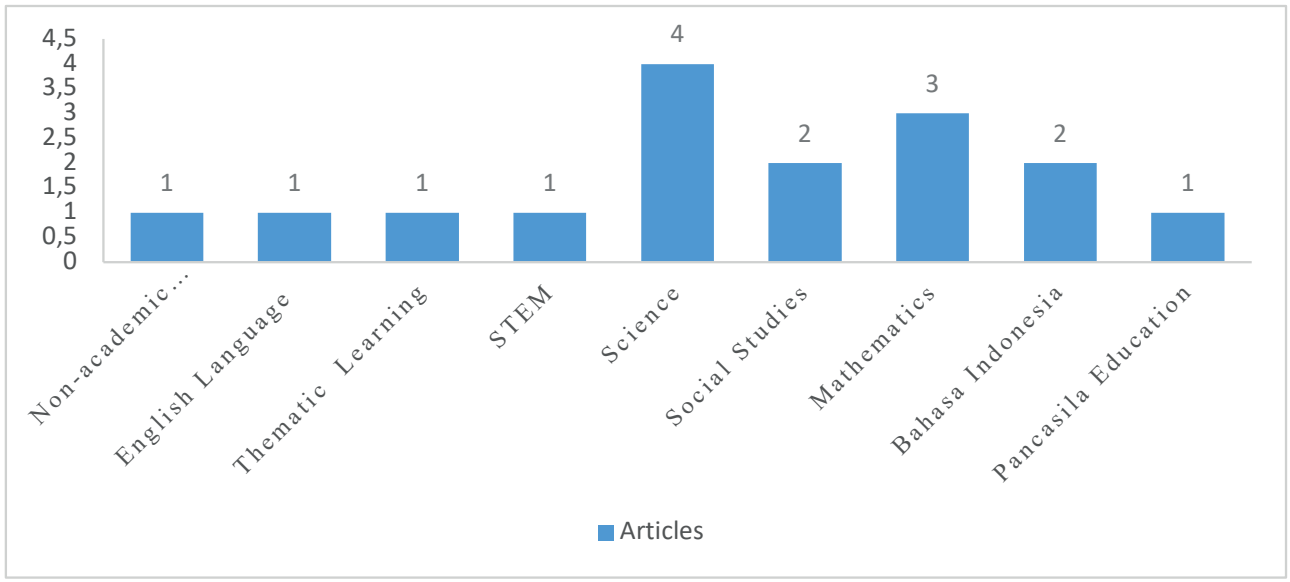

Figure 5. Articles on mobile learning in primary schools in Indonesia by subjects.

Subjects used in primary schools in Indonesia are diverse, such as Indonesian language and Pancasila education, a subject that focuses on Indonesia's national ideology, Pancasila. It aims to instill values of nationalism, ethics, and civic responsibility in students. However, based on Figure 5, mobile learning research mostly uses science subjects. Bahasa Indonesia is a subject used in Indonesia to develop students' language skills in reading, writing, speaking, and listening. It also covers grammar, literature, and text analysis, including various text types such as narrative, exposition, argumentation, and description.

3.2. RQ2 – Challenges in mobile learning implementation

This section addresses research question 2, and is organised according to the classification of study audiences, namely focusing on teachers and students first, and solutions afterwards.

3.2.1. Challenges faced by teacher

One of the key challenges in implementing mobile learning is teacher readiness and competence. Suhardi et al. (2022) highlight the limited capacity of teachers to integrate mobile learning technologies into their teaching practices, especially in rural areas where training opportunities are scarce. Similarly, Hardiansyah et al. (2022) found that many teachers lack the digital literacy skills to effectively use mobile learning tools. Furthermore, teacher-centred studies such as Maryono and Budiono (2021) highlight the need for professional development programmes to increase teachers' understanding of mobile learning. Without adequate training and support, the potential of mobile learning to promote critical thinking and independent learning remains untapped. The lack of user-friendly interfaces in mobile learning tools also adds to the difficulties faced by educators.

3.2.2. Challenges faced by students

Students face various challenges, mainly related to accessibility and engagement. Rofi'i and Susilo (2023) note that while mobile learning materials can significantly increase student motivation, technical barriers such as the requirement for Android-based devices and stable internet connectivity limit access for many students. This problem is exacerbated in regions with inadequate infrastructure, as noted by Zaenal et al. (2022). Motivational challenges also arise when mobile learning materials do not match students' interests and abilities, or are difficult to access. For example, Auliyah and Sari (2021) found that students were less engaged when the mobile application required continuous internet access for educational videos.

3.2.3. Possible solutions

Mobile learning has shown promising results in improving educational outcomes. However, studies such as Hardiansyah et al. (2022) and Suhardi et al. (2022) reveal gaps in teacher preparedness, accessibility for students, and systemic support at the community level. Addressing these gaps requires a multifaceted approach, including:

1) Targeted teacher training: Professional development programmes to increase digital literacy and familiarity with mobile learning platforms.
2) Infrastructure development: Improved access to devices and internet connectivity, especially in underserved areas.
3) Community engagement: Involving parents, stakeholders and policymakers in creating a supportive ecosystem for mobile learning.

By doing so, it is hoped that mobile learning can be integrated more effectively into basic education to support critical thinking, motivation, and collaborative learning.

4. Conclusions

Although this review focuses on a topic that has already been covered by several reviews, it sheds light on a geographic area which, to the best of our knowledge, is not covered by previous reviews. The results show that the number of studies was higher during the pandemic, but remained high after it, the scientific subjects were the most commonly addressed and the technological tools used were quite varied, although bespoke applications were the most frequently used. This systematic review highlights

the implementation of mobile learning in primary schools in Indonesia, demonstrating its effectiveness in improving learning outcomes, critical thinking skills and student motivation across a wide range of subjects, particularly science. However, significant challenges remain, including limited digital literacy among teachers, as noted by Suhardi et al. (2022), and infrastructure issues such as inequitable access to devices and internet connectivity, as noted by Zaenal et al (2022). Furthermore, while culturally relevant tools such as ARBARU (Anggraini et al., 2023) show promise, their scalability remains underexplored, and collaboration between schools and communities is often overlooked (Sakiyah et al., 2021). These findings highlight the importance of addressing systemic barriers through teacher training, infrastructure development, and the creation of culturally relevant and user-friendly mobile learning tools.

However, challenges such as limited teacher preparedness, infrastructure inequalities, and a lack of community involvement hinder mobile learning broader implementation in Indonesia. Addressing these barriers requires focused teacher training programs, equitable infrastructure development, and the creation of mobile learning tools that are both culturally relevant and accessible. By tackling these issues, mobile learning can serve as a transformative educational tool, ensuring equitable and effective learning experiences for all students while supporting the development of Indonesia's educational ecosystem in the digital era.

5. Study limitations and future research trends

This systematic literature review has several limitations. First, the analysis is based solely on articles retrieved from Google Scholar, which may not comprehensively represent all published research on mobile learning in Indonesia, potentially introducing coverage bias. Second, the review found that all included studies were categorised as qualitative research and development projects. While this highlights a focus on innovation and design within Indonesian mobile learning research, it reveals that experimental, quantitative or longitudinal studies evaluating the effectiveness of mobile learning in Indonesian settings remain scarce. As a result, the generalisability of these findings is limited because Research & Development studies typically emphasize prototyping and theoretical validation rather than empirical validation through rigorous methodologies. Future research should prioritise experimental designs, randomised controlled trials and large-scale quantitative studies to objectively assess the implementation of mobile learning and mitigate the confirmation bias inherent in developer-led Research & Development studies. In addition, more focus on inclusivity, enhancing collaboration and exploring innovative pedagogical approaches should ensure that the potential of mobile learning is fully realised.

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