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Technology in education through mobile learning application (MLA) and its impact on learning outcomes: Literature review

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ABSTRACT

Integration of information and communication technology (ICT) in teacher education is a means to support the teaching and learning process. Good teaching by utilizing technology certainly requires changes, especially in the realm of pedagogy, but teachers apparently do not have enough ability to optimize ICT in the learning process. In fact, ICT has the potential to provide various benefits for teachers and students, including joint learning areas, cooperative and collaborative learning opportunities. Therefore, this research aims to identify the use of mobile learning application (MLA) and its impact as a form of ICT integration in learning. The method used is literature study, by taking data from various relevant scientific articles and books. Data analysis uses descriptive analysis from the results of the synthesis of several literature reviews obtained. The research results show that a number of 10 main articles and 15 relevant supporting articles as well as several book sources show that mobile-based learning with smartphone devices is becoming a trend at various levels of education, both academic and vocational.

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1. INTRODUCTION

The use of information and communication technology (ICT) in the context of teacher education is a tool that can be used to support the teaching and learning process. This process requires collaboration between various parties, including teacher educators, teachers, prospective teachers, and leaders. This effort is a step to find the best method for utilizing technology to improve meaningful learning for students in the current digital era. Therefore, students must be given opportunities to learn by incorporating efficient and effective ICT integration elements and processes in the classroom [1]. ICT integration into the classroom may be highly challenging, particularly when it comes to the planning stage before teachers begin engaging students in learning activities [2]. While there are many aspects that contribute to the successful integration of ICT in teaching and learning, such as teacher educators' professional growth, strong leadership backing, and institutional commitment are crucial [2], [3]. Good teaching by utilizing technology certainly requires changes, especially in the pedagogical and content domains [4]. Therefore, educators are then urged to think for themselves, and go beyond technological literacy to promote educational practices that innovatively use the interaction between technology, pedagogy, and content (TPACK).

Current teacher education programs need to be improved by adopting technology-enhanced learning and effective management practices. ICT has the potential to provide various benefits to teachers and students, such as being a shared learning resource, a place for joint learning, and supporting collaborative and

cooperative learning. In addition, ICT also provides a foundation for independent learning [5]. Through communication channels and networks, ICT has allowed us to communicate one to one, one to many, and many to many [6].

Technology can play a major role during presentations, such as by including live Internet broadcasts, podcasts of authors reciting their poetry, or concept maps students create on an interactive whiteboard. However, class presentations can also involve non-digital support, such as reading a book or giving a lecture [7], [8]. Therefore, currently many teaching media have emerged that can be created and used by teachers in the teaching and learning process, how to make them can also be found easily through internet network access. One of the learning media is a learning application that can be accessed via smartphone, where the application is said to be able to help students think critically and logically.

One form of developing learning media is that it can be created using media technologies based on Android or smartphones [9], [10] or, more commonly, mobile learning. Mobile learning is a move from e-learning techniques to self-paced learning, allowing information to be aesthetically appealingly created and accessible to students outside of the classroom [11], [12]. Mobile learning can improve the quality of learning effectively and efficiently [13], [14] and help students in the learning process [15]. Moreover, statistical data shows that almost individuals around the world have used smartphones and continue to experience an increasing trend of their use, it is noted that 5.3 billion smartphone users in July 2021 or almost 67% of the world's population already have smartphones with the latest version of the operating system [16]. In Indonesia, it is ranked 4th in the category of countries with the most smartphone users with a total of 192.15 million users, below China (910.14 million), India (647.53 million) and the United States (249.29 million). Million) as the following illustration. The high number of smartphone users showed in Figure 1 that this technology is not new, and has often been used by various individuals in almost all aspects of life, including the education sector.

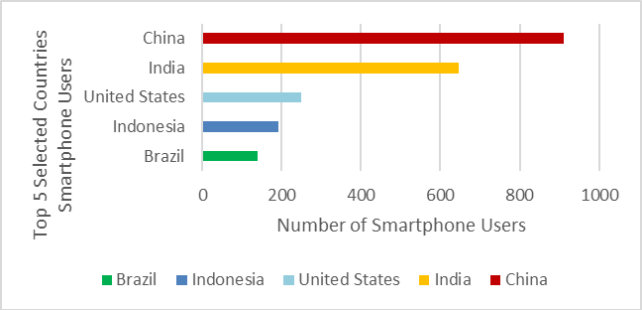

Figure 1. Smartphone user in the world [17]

Many successful studies have shown that Android-based mobile learning media can help students learn because it is practical and flexible to use [18], [19] and can be used for individual or group learning [20] as well as influencing the desire and motivation of students in learning [21], [22]. There's no denying that the utilization of mobile devices in education and the widespread adoption of mobile courses have yielded numerous advantages in terms of the learning processes and results, yet they have also given rise to certain challenges [18], [19]. When the literature on mobile learning is reviewed, it is seen that mobile devices cause most of the problems in mobile learning [23]. Utilizing mobile devices in the educational setting simplifies the task of educators in facilitating personalized learning. Consequently, the educational experience that students acquire through mobile devices will be tailored to their specific objectives or needs, as well as their diverse learning preferences [24]. Mobile devices that enable learning in real-life contexts while searching for related information to validate information or to enhance experiences.

Referring to various analyzes regarding mobile learning, it is important for teachers to know the positive and negative aspects of mobile learning. If these positive and negative aspects are not paid attention to, several problems will arise when developing the content of learning materials. Therefore, this study aims to identify how the use of mobile learning and its contribution to improving learning outcomes and achievements by collecting related studies based on certain criteria. In other words, research findings on mobile learning are analyzed in a comprehensive and holistic manner through various literature reviews originating from internationally and nationally reputable scientific sources.

2. METHOD

This paper includes a systematic literature review [25], This systematic review aims to map and describe the features and functions of mobile learning applications and their applications in smartphone-assisted learning at various levels of education. The scope and topics of research articles that will be included in a systematic review are based on the main objective of the research, which is to identify the various impacts of using Android-based mobile learning applications on the learning process [26]. The search terms used in this review are "Mobile Learning", "Android", "Mobile Application", "Mobile Application in Learning". The following databases are used to perform searches: i) ERIC, ii) Elsevier, iii) Google Scholar, and iv) several books that are relevant to the use and utilization of android-based applications for implementing learning [27].

Relevant research or studies are included as data sources if published between 2018 - 2022. Android-based learning or mobile learning is a field that is developing quite rapidly, so studies or research that are too long may no longer be relevant to the development of the digital world in education as it is today. As a result, a number of 10 relevant research categories found a match with the selection criteria for this study, and 15 relevant research with secondary categories were used in order to support the studies studied.

3. RESULTS AND DISCUSSION

3.1. Literature review results

In this section, several findings related to the literature that have been found and analyzed according to the method adopted will be presented. Referring to Table 1 [14], [27]–[35] (see in Appendix), several findings from literature were presented clearly, which have been identified through various stages of article selection, taking into keywords and other various criteria. Overall, there were ten scientific articles which are the focus of theoretical studies regarding the use of mobile learning in learning. Apparently, the application of mobile learning has been proven to have a positive impact on student learning achievement, as revealed on those articles. Those literature findings come from different countries and adopt different research approaches. We will present information regarding the characteristics of the type of research used as well as the distribution of research based on countries that implement mobile learning from ten literature articles that we have reviewed.

The information we can get from Figure 2 and Figure 3 is regarding the type of research used to find out the impact of mobile learning on student learning achievement, and the distribution of research results from literature reviews based on countries that have adopted mobile learning. Even though it appears that many countries have adopted mobile learning for learning activities, we still prioritize the research location, namely Indonesia, as the dominant reference considering that in the future this research will also be carried out in Indonesia, so it will make it easier to see the usage characteristics and characteristics of Mobile Learning users in Indonesia.

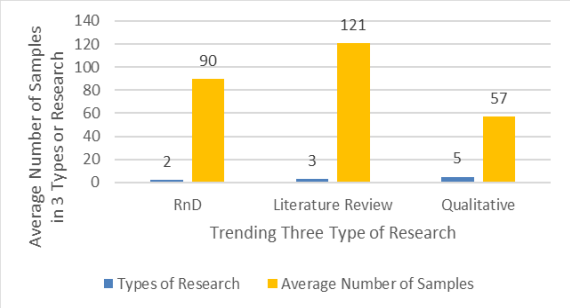

Figure 2. Type of research and sample average

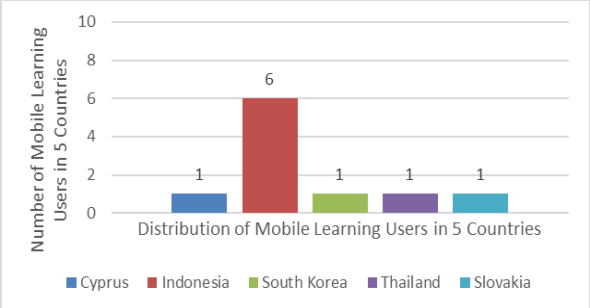

Figure 3. Country distribution of mobile learning users

It can be seen that the use of smartphones has been widely used in educational institutions from various countries, This is inextricably linked to technological advancements and the requirement for information delivery channels that can meet students' needs. Some research indicates that this smartphone- or Android-based learning technology can be used in learning at all levels, from primary school to university [19], [32], [33], [36]. Of course, the most important of all is the analysis of needs and adjustments between student characteristics and the characteristics of the information that should be conveyed to students, so that

interrelationships occur and the achievement of learning objectives is more optimal. Through this research, several topics on the use of smartphones to support learning activities will be discussed.

3.2. Technology-based learning innovation through mobile learning

Smartphone-based mobile learning is now widely used in various parts of the world [18]. This is because, through smartphone devices students can access information repeatedly, and students have the freedom to learn at their own pace and in accordance with their particular learning preferences. The flexibility of mobile devices further broadens the range of study areas. Location-based data can be used to facilitate simulated learning sessions. Students can engage in self-directed learning activities through mobile learning, giving them the freedom to practice and hone their knowledge and abilities without being constrained by time or place [37], [15]. Therefore, it is not surprising that smartphone-based mobile learning is believed to be an innovative breakthrough in overcoming various problems in learning activities [15], [38]. With their high levels of portability and accessibility, Smartphones make it feasible to encourage students to learn independently and actively, as well as to collaborate and communicate with their teachers. The process of developing innovations in the smartphone-based mobile learning format requires attention to several elements, including elements of needs analysis, development and assessment by experts, practitioner assessments and elements of product effectiveness testing [20], [39]. Some of these elements must receive attention so that innovation can be guaranteed quality.

The conclusion from the assessment of experts, practitioners and students will be a consideration of whether or not the innovation being developed can be implemented [40], [32]. So that the word innovation here does not just present smartphone technology, but ensures that the mobile learning application is suitable for use as a medium to support learning both in terms of the media concept and in terms of the quality of the subject matter.

3.3. Smartphone technology as a tool to help achieve competence

The newest advancement in mobile technology that has attracted scholarly interest and public interest is the smartphone. Anywhere and at any time, people can learn and communicate. Then, some individuals employ smartphones for both non-educational and educational purposes. Mobile learning (m-learning), where students can get content at any time and anywhere via technology, is described as learning through mobile or smartphone technology [41], [42]. It is inevitable that the presence of mobile technology can help students learn efficiently. Today's students are very friendly towards the presence of technology and are fluent in using various digital devices [43], [44]. A useful way to approach the evaluation of mobile assisted language learning otherwise known as MALL is by addressing its usefulness, effectiveness and satisfaction along with learner attitudes towards the use of mobile devices during the learning process. Research results related to the use of smartphones in language learning are proven to significantly improve language skills, both in writing, reading and listening [19], [13], Besides that, the use of smartphones in language learning can also indirectly improve the attitude of students so that they are more independent in learning [45], [46].

Apart from being in the language field, the use of mobile learning can also be applied to other scientific disciplines, such as in chemistry learning. Research shows that if smartphone media can be applied to chemistry learning, it is proven that students tend to understand the material more easily because the material is interactive, dynamic and can be accessed at any time [34], [47], so that indirectly the use of smartphones can increase the mastery of competence in the cognitive aspects of students. These results are in line with other research which reveals the use of smartphones in vocational schools, as it is known that vocational learning requires various practical skills that students need to master, in addition to cognitive abilities [48], [49]. Students in vocational high schools were able to learn more effectively because to the use of cellphones in the classroom [36], [50], Besides that, other research has also succeeded in proving that the use of smartphones in which there are applications for learning turns out to be influential and contributes to the achievement of 21st-century students' abilities, such as critical thinking and creative thinking [51], [52]. This will undoubtedly make it simpler for students at vocational schools to compete in the globalization era. In addition, the learning that is being experienced by the millennial generation and generation Z is almost inseparable from technology [53], as well as the unlimited format for presenting material when using a smartphone, where subject matter can be produced into learning applications in a game format [54], [55], digital book [56]–[58], as well as interactive multimedia [59]–[61] all of which can be accessed through a technology called a smartphone. Therefore, the smartphone as an application in learning certainly has a very big opportunity to be applied.

Technology-assisted learning such as smartphones also opens opportunities for lifelong learners to be created [62]–[64], Through technology, students will be able to access unlimited material and position themselves as lifelong learners who are thirsty for subject matter [50]. This will certainly be in line with the

trend of education in the 21st century or education in the 4.0 era, where education will play a role in helping individuals to achieve competence and actualize themselves so they can compete in the industry [65], [66]. Therefore, a study of some of the literature related to the use of smartphones is very important, so that educators can gain an insight into how the roles and opportunities of the integration of ICT in the form of smartphones into the implementation of learning can actually have a positive impact on student achievement.

4. CONCLUSION

Based on the search results and findings from various scientific literature studies, it can be concluded that mobile-based learning with smartphone devices is becoming a trend at various levels of education, in addition to keeping up with the times, it turns out that learning using smartphones is proven in several findings to have succeeded in increasing students' abilities, both in terms of academics and skills. It's just that, from the research it was also found that there were concerns from some teachers about the development of ICT, where there were still some educators who had difficulty keeping up with the times such as trying to develop an Android-based learning platform. This of course required support from various stakeholders so that learning by using smartphones can be immediately implemented as a whole so as to create a dynamic and collaborative learning climate.

The results of the analysis then led to several recommendations, one of which was to reduce teacher worries in developing a learning media product, teachers need to be given assistance and training so they can develop software. As well as designing a learning system with students as learning subjects with smartphones as assistive technology. Future researchers can examine how the opportunities for smartphone development in the education level are more specific and the urgency for achieving 21st century competencies.

APPENDIX

Table 1. Relevant research findings

No.	Writer	Research findings
1.	Sari *et al.* [28]	The development of Android-based smartphone learning media obtained validation results from validators in the appropriate category as learning media for junior high school students [28].
2.	Kim and Park [29]	The results of this study reveal that learning by using smartphones is quite effective in increasing several student competencies, including attitudes, skills, strengthening cognitive abilities [29].
3.	Sophonhiranrak [30]	Educators must consider learning styles, attitudes, or learner's readiness for acceptance of smartphone-based learning. Therefore, it is important to analyze the material, objectives, and delivery strategy of the material. Besides that, from some of this research it is also necessary to note that the scope and type of material must determine or be in accordance with the delivery strategy of student material [30].
4.	Kristriani and Usodo [31]	Leveraging gamification, particularly through Android-based smartphones, such as Quizizz, is widely regarded as highly beneficial. It provides valuable support to educators in the teaching and learning process and is seen as pertinent to the digital age's evolution in the 21st century. However, the reality is that numerous educators encounter significant challenges: lack of familiarity with gamification systems, difficulties in creating gamified content, limited access to training and resources, and a lack of understanding regarding the pros and cons of gamification itself. Therefore, further in-depth research in this area is still required [31].
5.	Firdawati *et al.* [32]	This development research states that smartphone-based learning media can be applied to any subject, for example in this research it has succeeded in developing mobile learning media from Newton's laws, namely science (chemistry) subjects, this media developed using the appy pie application is categorized as valid according to the results of the assessment by validator and get very good categories, as well as good responses from teachers and students who use them [32].
6.	Metruk [27]	With the new generation of students (such as Generation Z or Generation Alpha), language teachers must realize that technology-mediated teaching to facilitate the language learning process is considered to be able to help students master the material. Modern technology has undoubtedly been able to offer new ways to improve the learning process of EFL students. To utilize cellphones intelligently, efficiently, and appropriately to support and enhance students' language learning, however, requires adequate planning and preparation. This review paper has demonstrated that while integrating current technology into the teaching process, teachers will face a number of problems that they never thaught before [27].
7.	Puspitarini and Hanif [33]	In fact, schools that already encourage the use of technology in the learning process have begun using it as a learning medium. Laptops, LCD projectors, and internet connection are among the infrastructure and equipment at the institution. The use of smartphones by elementary school pupils offers a possibility that can be investigated for its applicability in the implementation of learning. Keeping this in mind, the use of technology in the form of learning media can be a substitute to get around the space and time constraints of the current learning process so that teachers don't have to spend too much time explaining information to pupils [33].
8.	Ningsih *et al.* [34]	The findings of this study reveal that teachers have a positive view of smartphone-based technology trends and practices in language learning. Teachers consider motivation to be the main driving force for integrating smartphones into learning activities. In-depth analyses of teacher interviews reveal a variety of motivations that are frequently cited by Indonesian educators. These include the well-known benefits of

Table 1. Relevant research findings (*continue*)

No.	Writer	Research findings
		incorporating smartphone technology and its significant influence on teaching output. When technology was included into the learning process, three challenges emerged, involving concerns with infrastructure, teachers' technological ability, and educational regulations within each educational setting [34].
9.	Ismail *et al.* [14]	In an effort to facilitate participatory and active learning, this research has succeeded in developing a mobile-based learning application that combines problem-based learning into a smartphone-based learning application design. After being developed, the product was then tested on students in order to measure the impact of the mobile application on improving students' critical thinking skills. From the results of the test analysis carried out, it was identified that there was an average difference between students' pre-test and post-test scores, which showed an increase in students' critical thinking abilities after utilizing mobile learning by integrating it with problem-based learning. In fact, it appears that there are seven processes involved in developing students' critical thinking during intervention through the products being developed. It is hoped that the results of this research will be able to provide practical contributions to science teachers to be able to integrate technology such as mobile applications for learning in the classroom [14].
10.	Ozdamli and Ercag [35]	The results of this research, which aims to evaluate the use of mobile applications in developing mobile learning applications, show that prospective teachers generally respond positively to the use of applications in learning contexts. This was due to the fact that at that time, students already had experience with technology, especially smartphones. The research results also indicate that the use of mobile applications in developing multimedia projects is successful in attracting students' attention and facilitating efficient communication during learning activities [35].

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