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Literature review: the efficacy of mobile learning media in enhancing critical thinking skills among elementary school students

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ABSTRACT

The ongoing Industrial Revolution 4.0 is accompanied by the swift advancement of science and technology, necessitating high-quality Human Resources (HR). To do this, educational resources must be changed, particularly the media used for instruction. The educational sector currently requires practical and effective learning media, particularly through the utilization of mobile learning. This study aims to assess the efficacy of mobile learning media in enhancing critical thinking abilities among elementary school pupils. To examine the effectiveness of android-based learning media for improving critical thinking skills. The study used the Systematic Literature Review (SLR) methodology for its literature review component. The Systematic Literature Review method involves examining publications that align with the subject matter. This research is expected to improve future research on Android-based learning media. This study's findings indicate that mobile learning enhances critical thinking skills in elementary education. Research demonstrates that mobile learning media serves as an effective tool, particularly for fostering students' critical thinking abilities.

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Introduction

Contemporary life in the context of globalization is replete with numerous obstacles. All individuals encounter diverse challenges and engage in global competition across all sectors of contemporary life. Individuals must possess the capability, expertise, and experience to address the challenges that emerge. All necessary resources to address diverse existing issues are inextricably linked to the realm of education. The swift advancement of technology and knowledge in contemporary life is unavoidable. Individuals, from adolescence to adulthood, must experience the effects of technological and informational advancements, encompassing both beneficial and detrimental consequences. Technological and informational advancements can impact numerous domains, particularly the subject of Education (Arifani et al., 2021).

The ongoing Industrial Revolution 4.0 is accompanied by the swift advancement of science and technology, necessitating high-quality Human Resources (HR). The presence of skilled people resources will enable adaptation to contemporary advancements and scientific developments, ensuring that they do not lag behind other nations. In this context, education is crucial for equipping human resources with the competencies and abilities necessary to adapt to societal advancements (Hussain, 2018). The execution of education is conducted

by learning activities. The industrial revolution 4.0 demands that we are able to select information appropriately and accurately so that critical thinking skills are very necessary in learning.

This must align with the capacity of human resources to confront the advancements in technology, as such progress entails both positive and negative repercussions associated with the increasing volume of global information, which often necessitates critical thinking to avoid being misled by falsehoods and unreliable news. Critical thinking skills should be cultivated from an early age, beginning in primary education.

Regrettably, the latest report on literacy levels for each member nation, including Indonesia, was published by PISA (Program for International Student Assessment) in 2023. Research indicates that, among 81 member nations, Indonesian students' literacy level is ranked 68th (OECD, 2023). In 2023, Indonesia's reading literacy score in PISA reached 359 points. This value is 12 points lower than in 2018 where Indonesia scored 371. In fact, Indonesia's reading literacy score in 2023 is also lower when compared to 2000, which was 371. Indonesia is apprehensive about its literacy rating, as it affects its citizens' competitiveness in the global arena (Nair et al., 2012; Fitriansyah et al., 2020). The competitiveness of a nation in scientific literacy is contingent upon its literacy rate (Amaringga et al., 2021). Science literacy refers to the capacity to address problems through an individual's comprehension of scientific principles (Feinstein, 2011; Zulfiani et al., 2020). Given the rapid progression of global technology, scientific literacy is imperative to attain.

According to the PISA publication, Indonesia is positioned 68th, significantly trailing behind neighboring nations like Malaysia, Singapore, and Thailand. This tragedy necessitates focused effort to enhance the quality of science education in Indonesia. Enhancing students' critical thinking abilities in the field of science is a significant initiative in education. The ranking is significant for Indonesia as a nation's literacy level influences societal competitiveness in the context of global competition. The capacity for literacy can influence a nation's competitiveness in scientific literacy (Amaringga et al., 2021). Scientific literacy is the ability to apply one's understanding of science to address problems (Feinstein, 2011; Zulfiani et al., 2020). In accordance with the swift advancement of technology worldwide, scientific literacy is essential to acquire.

Indonesia's education problems related to technology include infrastructure limitations such as Many schools, especially in rural areas, do not yet have access to hardware such as computers, tablets, or other multimedia devices, limited stable and fast internet networks, maintenance and updating of technology infrastructure requires sufficient funds and resources. Then related to teacher readiness including lack of teacher knowledge about IT media, limited access to improve teacher skills, no obligation from schools for teachers to teach using IT. The existence of a digital divide among students, lack of digital literacy, especially on the part of education providers, low willingness to pay from schools and parents.

Critical thinking is the ability to analyze an object, content, or problem, so enhancing the quality of thought by the adept management of its intrinsic structure and the application of intellectual standards (Elder & Paul, 2010). The primary attributes of higher-order thinking are critical thinking and creative thinking (Conklin & Manfro, 2012) (Sutrio et al., 2018). Creative thinking is developed through habits that students can cultivate by discovering and employing unconventional yet logical ideas in their learning processes (Hengki et al., 2019).

The process of analysis, evaluation, and creation serves as an indicator in higher-order thinking skills (HOTS). Higher Order Thinking Skills The acquisition of higher-order thinking skills arises from students' experiences in engaging with learning, enabling them to construct and internalize knowledge, hence fostering awareness in the learning process. This mode of learning enables students to cultivate reasoning skills. This indicates that the learning process primarily involves the capacity to apply concepts and develop advanced skill indicators for assessing higher-order thinking skills (HOT), which encompass: (1) analysis, involving the examination of incoming information and its decomposition into smaller components to identify patterns and relationships, recognizing and differentiating causal factors, and formulating questions; (2) evaluation, which entails assessing solutions, ideas, and methodologies against established criteria to determine their effectiveness or benefits, formulating hypotheses, critiquing and testing, and accepting or rejecting statements based on predetermined standards; (3) creation, which includes generalizing ideas or perspectives, devising problem-solving strategies, and reorganizing elements into novel structures. (Arrofa et al., 2020).

In order for the resources produced to truly be able to handle technological advancements, critical thinking abilities must be taught from the very beginning of education. The utilization of educational media in the teaching and learning process serves as an alternative to mitigate student boredom during instruction. Nofriyandi et al. (2021:22) assert that learning media is a crucial component for the efficacy of the teaching and learning system, facilitating content delivery for educators (Meilan et al., 2021).

The educational sector currently requires practical and effective learning media, one of which is the implementation of mobile learning. According to the perspective of Rahman, D. N. A., Saputra, D. S., and

Kurino (2019), mobile learning is notably practical and straightforward, as it is not constrained by time or location (Anni Faridah et al., 2021).

Prior studies addressing diverse aspects of mobile learning. Commencing with the notion of mobile learning, specifically Widiastika (2021) and Aripin (2018). Additionally, concerning the modality of mobile learning, Ping and Genzhong Research (2011) successfully developed a Moodle-based e-learning framework accessible via both the web and smartphones. Grasso and Roselli (2005) created a web-based application for Personal Data Assistant devices and established numerous design criteria for smartphone applications. A study by Yumarlin (2012) demonstrates the efficacy of mobile learning, indicating that multimedia products in the form of compact discs effectively engage students in the learning process. Nasution's (2016) research demonstrates that mobile learning-based solutions are highly beneficial in enhancing students' motivation and academic advancement (Firdausi et al., 2021).

The usage of mobile learning-based learning media boosts students' enthusiasm in learning and makes it simpler for them to comprehend the content that teachers deliver, according to studies (Suyatmo, 2023; Widyaningrum, 2022; Fadhilah, 2023). However, the study's findings (Prahani, 2020) show that pupils who use web-based media to acquire concepts comprehend them better than those who receive traditional instruction.

The study results (Irawati et al., 2022; Agustina, 2022; Yoseb, 2023) indicated a disparity in critical thinking skills between students engaged in mobile learning media and those utilizing conventional media. Utilizing engaging educational media to enhance students' analytical and deductive thinking abilities is a viable approach to ameliorate the problem. This is merely one of the actions that can be undertaken. Problem-based learning linked with mobile learning can address these demands (Herdianto et al., 2021; Ismail et al., 2018; Santoso & Soedjoko, 2019).

Mobile learning is designed to supplement education in elementary schools. Android-based mobile learning offers pupils the ability to revisit material that is inadequately comprehended. This can offer an alternative experience in the educational process. Regrettably, few academics have developed mobile learning media, since many perceive it to be overly complex to compile. However, if mobile learning media is effectively developed and implemented, it can yield satisfactory educational outcomes. Moreover, mobile learning represents a medium with numerous developmental variations. This serves as a foundation for academics aiming to investigate the advantages of mobile learning, and in the future, the advancement of Android-based mobile learning media must be pursued in both primary schools and higher education institutions.

The investigator employed the Systematic Literature Review (SLR) methodology in this investigation. This strategy involves gathering articles pertinent to mobile learning media and subsequently reviewing those that align with the research topic. The research topic pertains to the efficacy of mobile learning media in the domains of science, mathematics, social studies, and language acquisition. An analysis was conducted to facilitate a thorough discourse on mobile learning media and its application in elementary education. The researcher anticipates that the outcomes of this debate will stimulate further research by both prospective and current primary school teachers.

Method

The study employs the Systematic Literature evaluation (SLR) methodology for its literature evaluation process. The Systematic Literature Review technique consists of five stages: formulating the research question, identifying and locating relevant articles, categorizing and assessing the collected articles, synthesizing the articles, and interpreting the findings (Khan et al., 2003). This aligns with the perspective that a Systematic Literature Review entails evaluating publications relevant to the research issue and thereafter doing a comprehensive analysis of the examined articles (Vienna et al., 2021). The researcher is investigating the utilization of mobile learning to enhance critical thinking skills in primary education. The database utilized is derived from sources like Google Scholar, Crossref, Scopus, and Springer.

Subsequent to the completion of a search, a categorization is conducted based on the following criteria: The literature aligns with the study topic and comprises journal papers published between 2015 and 2024. Article reviews are determined not only by the year of publication but also by specific topics, particularly focusing on "the use of mobile learning to enhance learning outcomes and critical thinking skills" to ensure a more concentrated discussion. The article central to this study performs analyses to address questions pertinent to the research topic under examination.

Systematic literature review (SLR) identifys, selects, and critically assesses research to answer clearly formulated questions (Dewey, A. & Drahota, A. 2016). A systematic review should follow a clearly defined protocol or plan, where the criteria are clearly stated before the review is conducted.

The selection of articles in this study is based on the topic of the effectiveness of mobile learning media in improving critical thinking skills. The article was taken over a period of 9 years to see its development starting from year to year. Articles that are not in accordance with the topic are not used and articles with a low h-index are also not used, this is done to maintain the validity of the article.

After the articles to be analyzed are collected, the author conducts a meta-analysis where the data analysis technique combines the results of several studies to draw more reliable conclusions. This technique uses statistical techniques to summarize the findings of previous research.

Results and Discussions

The study's findings are predicated on research issues, namely with the application of mobile learning in primary school education, specifically in the areas of science, math, and language. The researcher gathered papers from 2015 to 2024. This is done in order for the article to be unique and allow for a detailed interpretation of the findings from the study that the article explains. The Harzing publish or perish app is used to help in article searches. Table 1 shows the number of papers that were examined for this study.

Table 1 <KSearch Results Based on Keywords>

Keywords	Number of Searches	Number of Reviews
Elementary school, critical thinking	100	19
Mobile learning, critical thinking	176	13
Mobile learning, primary school	72	11
Total	348	43

The aspects that might be evaluated concerning the article are as follows:

Android applications as an educational medium

The incorporation of media in the educational process serves as an alternative to mitigate student boredom during learning activities. Learning media is the primary determinant of the efficacy of the teaching and learning system, facilitating the delivery of material by educators (Meilan et al., 2021).

The educational sector currently requires practical and effective learning media, one of which is the implementation of mobile learning. According to the perspective of Rahman, D. N. A., Saputra, D. S., and Kurino (2019), mobile learning is notably practical and straightforward, as it is not constrained by time or location (Anni Faridah et al., 2021).

Numerous publications I examined present numerous instances of Android applications designed as educational tools to enhance critical thinking skills. Presented below are examples of Android-based educational applications.

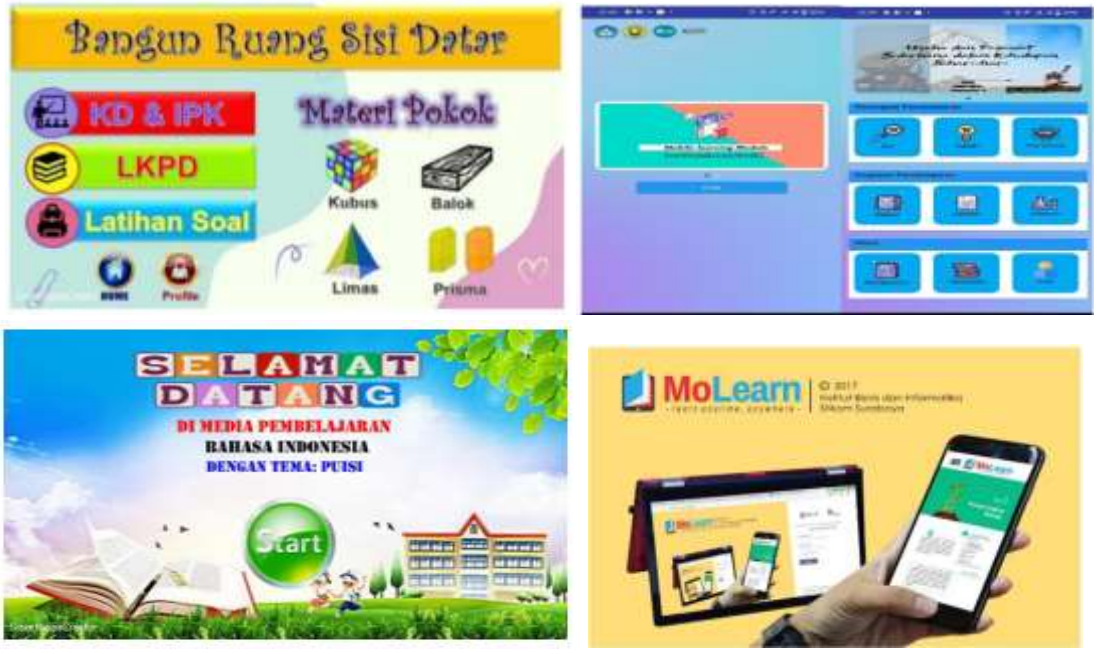

Figure 1 <Android-Based Apps 1>

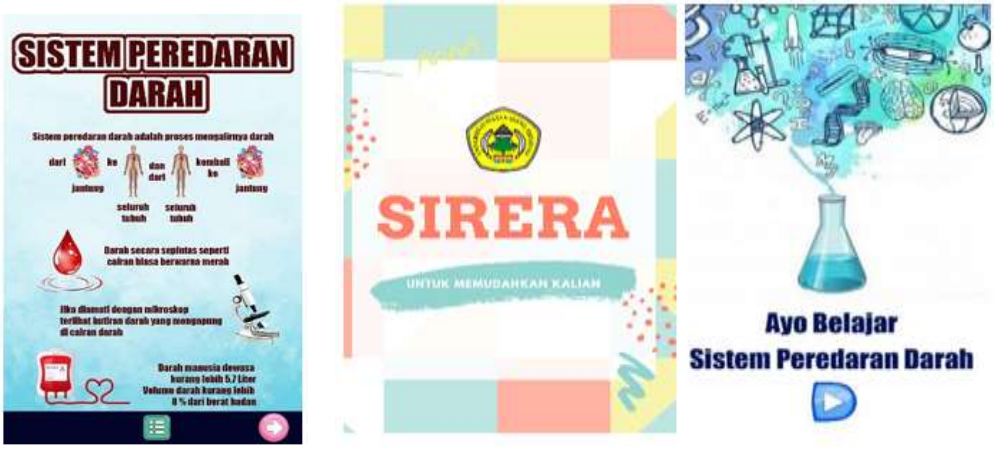

Figure 1 <Android-Based Apps 2>

Platforms available for the development of educational media

The swift advancement of technology corresponds with the growing accessibility of knowledge, enabling academics to create diverse mobile learning media.

Table 2 <A Platform that Can be used to Develop Learning Media to Improve Critical Thinking Skills>

Learning Media Platform	Result	Reference
Web 2 apk builder	The findings indicated that the Android-based learning media designed to enhance students' critical thinking skills in mathematics induction materials was viable and garnered a favorable response from students, signifying their enthusiasm and interest in utilizing the Android-based learning media, which can assist students in comprehending the learning materials.	Khusnul Khotimah (2024)
Mobile Moodle	The moodle-based e-learning model and the guided discovery learning strategy exert differing influences on the enhancement of critical thinking skills.	Imron Gozali (2021)
Mobile learning Environment	The students' feedback regarding the utilization of RPG Maker MV-based mobile learning applications in ecosystem education is quite favorable.	Abdur Rashid (2020)
Ispring Suit	The implementation of mobile learning via Ispring Suite media in third-grade mathematics education positively influences students' critical thinking abilities, hence enhancing their academic performance.	Anik Twiningsih (2022)
Macromedia Flash Animate CC	This mobile learning digital simulation can enhance student engagement and boost academic performance.	Riki Fajri Rahmat (2019)
Smart Apps Creator (SAC) 3	The results indicate that mobile learning media is effective for enhancing students' mathematical critical thinking skills.	Rini Mairani (2021)
Mobile Augmented reality (AR)	Current research indicates that Augmented Reality can enhance students' cognitive skills in scientific education.	Yonatan (2021)
App Inventor	Mobile learning-oriented education Media can serve as an alternate educational tool to enhance pupils' critical thinking abilities.	Aisyiyah (2019)
Appy Pie	The data gathering results indicate that the Appy Pie Android mobile learning application, designed to enhance creative thinking skills, is appropriate for use as a learning medium for third-grade elementary school pupils.	Nur Auliyah (2021)

Mobile learning is evolving across multiple domains, including formal schooling, professional environments, and informal learning contexts. The objective is to integrate informal learning design with the technological landscape. Android-based mobile learning offers pupils the ability to review material that is not well comprehended. This can offer an alternative experience in the educational process. The subsequent conclusions derive from many national and international research publications concerning platforms utilized in educational media to enhance critical thinking abilities.

The table above indicates multiple platforms utilized by researchers for creating mobile learning media applicable to diverse elementary school subjects. Numerous examined research articles demonstrated favorable outcomes associated with the use of mobile learning-based education.

The Influence of Mobile Learning-based Learning Media with Critical Thinking Skills in Learning

The mobile *learning-based learning media* developed is valid and reliable so that it is feasible to use. Students' critical thinking skills after using mobile learning-based learning media have improved, and are included in the category of moderate improvement. The effectiveness of the learning media used is good and the implementation of learning is in the very good category. So that mobile learning-based learning media can be used as an alternative media in learning to help improve students' critical thinking skills (Aisyiyah et al., 2019)

The data analysis results indicate that Moodle-based mobile learning media received an average practicality score of 95.6% from vocational school teachers, categorizing it as "Very Practical," while students awarded it a score of 94.57%, also deemed "Very Practical." The effectiveness test yielded a post-test score of 85.56%, surpassing the KKM threshold of 70, indicating that Moodle-based mobile learning medium is successful for teaching Foodstuff Knowledge. Faridah et al. (2021)

The efficacy of mobile learning in enhancing students' critical thinking abilities indicates a substantial disparity between the experimental group and the control group. The experimental class employing PBL-based mobile learning outperforms the control class. The use of the Cohen effect size formula indicates that the efficiency of mobile learning in enhancing students' critical thinking skills falls under the strong group. This occurs because the strong category aligns with the elevated category of the Cohen effect size formula. Irawati et al. (2022)

Advantages and Disadvantages of Mobile Learning-based Learning Media as Learning Media

The implementation of mobile learning as an educational medium undoubtedly presents both advantages and problems. This information was derived from the remarks of media specialists, content experts, and users (educators and learners) via questionnaires and interviews. The benefits of this mobile learning medium include: (1) media products in the form of Android packages (APK) with a size under 5MB, (2) the systematic and user-friendly presentation of material, and (3) interactive media designed to engage students' interest in learning. Alongside its benefits, this mobile learning medium presents numerous drawbacks, including: (1) the necessity of an internet connection to access video content within the program, and (2) subpar image quality resulting from restricted memory for application development. (Dania et al., 2019)

Furthermore, this mobile learning medium possesses various advantages and downsides. This information was derived from the statements of media professionals, material specialists, and users (teachers and students) via questionnaires and interviews. The benefits of this mobile learning medium include: (1) media products in the form of Android packages (APK) with a size under 5MB, (2) the systematic and user-friendly presentation of material, and (3) interactive media designed to enhance student engagement in learning. Alongside its benefits, this mobile learning medium presents numerous drawbacks, including: (1) the necessity of an internet connection to access video content within the program, and (2) subpar image quality resulting from restricted memory for application development. (Dania et al., 2019)

Alongside the benefits of mobile learning as an educational medium, it also presents drawbacks. The content in mobile learning is currently restricted to audio wave materials exclusively. The implementation of this program utilizes WhatsApp, necessitating an internet connection (Yuberti et al. 2021). Nonetheless, the deficiencies inherent in the implementation of mobile learning-based media can be effectively addressed without diminishing the benefits associated with such educational tools.

Conclusions

The researcher identified 348 articles related to the use of mobile learning for enhancing learning outcomes and critical thinking skills. Subsequently, the focus narrowed to 43 articles that were examined in detail and depth. A review of 43 pertinent studies indicates that mobile learning as an educational media presents engaging opportunities for learning. The implementation of mobile learning media has proven successful in enhancing critical thinking skills. Mobile learning media can be utilized for diverse educational content in primary schools. Commencing with materials ranging from low to high grades. Numerous research findings indicate favorable outcomes associated with the implementation of mobile learning-based educational media, particularly in enhancing critical thinking skills among elementary school pupils. Consequently, it is essential to further explore mobile learning-based educational media in primary school instruction.

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