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SYSTEMATIC LITERATURE REVIEW: APPLICATION-BASED LEARNING MEDIA TO MEASURE MATHEMATICAL CRITICAL THINKING ABILITY

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Article Information	ABSTRACT
	In this modern era, the world's population is now faced with the need to balance technological advances with knowledge, this is reflected in the development and improvement of technical abilities and skills of today's humans through the development of technology that continues to grow. One form of its implementation in the world of education is the use of application-based learning media. The use of application-based learning media is used to improve students' abilities, one of which is the ability to think critically mathematically. This study aims to determine the use of application-based learning media to measure mathematical critical thinking skills. The method used in this study is SLR *(Systematic Literature Review)* where researchers collect articles related to the use of learning applications to measure critical thinking skills with a publication period of 2020-2023. Based on this study, it was found; 1) applications as learning media have definitions, objectives, important roles in the field of education, and 2) there is a significant influence in the use of applications on students' critical thinking skills.

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1. INTRODUCTION

Education is a process of forming knowledge, characteristics, nature and attitudes, and thinking patterns of a student. Education is all efforts and all efforts to make society able to develop human potential to have spiritual religious strength, self-control, personality, intelligence, noble character, and skills needed as members of society and citizens (Bunari et al., 2024; Widodo et al., 2019). Thus, we can say that with education, a person's abilities can be formed. One of the abilities in students that needs to be instilled and developed is the ability to think critically mathematically.

Currently, critical thinking skills are very important in everyday life, because they develop other thinking skills, such as the ability to make decisions and solve problems (An et al., 2024). Critical thinking skills are thinking skills that involve cognitive processes and invite students to think reflectively about problems. Meanwhile, according to Ennis Critical thinking is a process in expressing goals that are equipped with clear reasons about a belief and activities that have been carried out (Indraswati et al., 2020; Maudsley, 2000; Pu, 2021).

Critical thinking skills in students can be trained, honed, and improved with various things in the learning process. One of the facilities in learning to improve critical thinking skills is in the use of learning media. Students' critical thinking skills can be developed by using the right learning media as stated by (Soliemanifar et al., 2015) that a teacher's expertise in choosing the right learning media is one of the factors that determines the success of developing students' critical thinking skills (Yomaki et al., 2023). One of the learning media that can be chosen in mathematics learning is in the form of learning applications as a form of development in the world of education in responding to the development of the times.

The digital age has brought tremendous advancements in education, revolutionizing traditional teaching methods and enhancing the learning experience (Ida Bagus Kade Gunayasa et al., 2023; Wahyudi & Haryati, 2023). With the widespread availability of digital tools and resources, students now have access to a wealth of information at their fingertips. Online platforms and educational apps offer interactive and personalized learning opportunities, catering to diverse learning styles and needs (Dezuanni & Woods, 2014). Additionally, digital technology enables educators to create dynamic and engaging lessons, incorporating multimedia elements such as videos, simulations, and virtual reality. Learning media facilitates communication and collaboration between students and teachers, creating a more interactive and inclusive learning environment. Furthermore, distance learning has become increasingly possible, allowing students to access education remotely, transcending geographical boundaries. As technology continues to advance, its impact on education is expected to increase, empowering learners and educators to thrive in the digital age.

An application is a software program designed to perform a specific task on a computer, *smartphone,* tablet, or other device. A learning application is a software program that contains learning materials that can be accessed via devices such as mobile phones or PCs, etc. Learning applications can also make the learning atmosphere more enjoyable and effective, so that it can improve students' critical mathematical thinking skills. Based on the background that has been described, the purpose of the study is to determine the use of application-based learning media to measure critical mathematical thinking skills.

2.   RESEARCH METHODS

The method used in this article is *Systematic Literature Review.* This research process involves several steps, including formulating research questions and conducting a literature search. The purpose of *a Systematic Literature Review* is to identify the best techniques, specific procedures, technologies, methods, or tools by collecting information from various comparative studies (Maulyda et al., 2024).

In this article, a literature study search related to data collection and research results in the period 2019 to 2024. The literature study search was obtained from *the Google Scholar database.* The keywords in filtering articles in this study are application learning media, critical thinking skills and mathematics education. The articles collected were only articles published in the period 2020-2023. From the various articles collected, the researcher selected 15 articles with the keywords used. The researcher recorded the literature obtained in the form of a table to review the articles as research results. The researcher compared the research results from several articles and made research conclusions.

Table 1. Article specifications

Specification	Information
Intervention	Development using application learning media
Results	There is an increase in critical thinking skills
Context	Mathematics learning in junior high and high schools

3.   RESULTS AND DISCUSSION

The results of the analysis are shown in table 1 which relates to the keywords used. The researcher reviewed articles related to the application. in mathematics learning reviewed from students' mathematical thinking skills. The reviewed articles are included in the table below.

Table 2. Research results related to application - based learning media to measure students' critical mathematical thinking skills.

Author	Title	Results
Syamsi Damarjati and Asih Miatun	Development of Android-Based Educational *Games* as Learning Media Critical Thinking Skills Oriented	*game* "Linear Program Adventure" is proven valid for use as a learning medium. *The game* "Linear Program Adventure" is said to be practical to use as a learning medium based on the percentage of student response questionnaire results.
Inayah Meityastuti and Ariyadi Wijaya	Development of STEM-based PBL model LKPD using demos application to improve critical thinking skills	The learning tools developed meet valid and practical requirements.

Author	Title	Results
Acep Medi Utama	Development of Android -Based Teaching Materials Flip *PDF Application* On Social Arithmetic Material For Improve Ability Critical Thinking and Learning Independence of Grade VII Students at SMP Salman Al Farisi Bandung	The results of this development show that the quality of the teaching materials, seen from the feasibility aspect, is included in the very feasible category, and the materials produced are effective. improve critical thinking skills , and there is a correlation between critical thinking skills and learning independence
Ahmad Gufron, Pinta Deniyanti Sampoerno, and Lukman El Hakim	The influence of using comic applications containing local Betawi culture with a contextual teaching and learning (CTL) approach on students' critical mathematical thinking skills	The use of comic application media that combines local Betawi culture with the CTL approach has a big impact on critical thinking skills.
Rinda Kusmayanti	Utilization of Math City Map Application to Improve Students' Critical Thinking Skills and Learning Motivation	*Math City Map* application is an application that can be used to provide mathematics learning in a more enjoyable way. The use of *the Math City Map application* tends to improve critical thinking skills and student learning motivation in mathematics learning.
Desi Andryani Lubis, Ludi Arianto, Iqbal Ma'ruf Al Ashari, and Amidi	Cultural Mathematics Learning (Ethnomathematics) Assisted by *Math City Map Application* to Improve Students' Critical Thinking Skills	The use of applications carried out in groups and the existing problems in the form of questions that trigger the ability to connect one mathematical concept with another mathematical concept causes students' critical thinking skills to increase. So that the use of *the Math City Map application* tends to increase students' critical thinking skills in cultural mathematics learning.
Novia Wulansari, Aji Raditya, and Rika Sukmawati	Implementation of the use of Geogebra application media to improve students' critical thinking skills	Judging from the data from *the Posttest results* , which is 73.8281, students' critical thinking skills have increased from the results obtained, so that the use of the Geogebra application media that has been used can improve critical thinking skills with effective results.
Ratih Rosiana, Siti Patonah, and Ferina Agustini	Development of pepper application (fraction material media) to improve critical thinking skills of grade IV elementary school students	The MERICA application product that was developed can improve students' critical thinking skills, as proven by the results of the *pretest* and *posttest analysis.*
The Grace of Wisdom	The influence of geogebra application in improving students' critical thinking skills at SMPN Cibinong	The improvement of critical mathematical thinking skills of students who learn with GeoGebra media is better than students who learn with regular learning.
Nur Hasanah	Development of learning media based on mathematical operation guessing games that are oriented towards critical thinking skills.	Application-based learning media is said to be valid; the level of students' critical thinking ability test is said to be valid, the learning media is considered effective, and the results of the students' post-test show that 80% of students' critical thinking skills have been completed.
Lala Aulia P. Hutagalung and Dara Fitrah Dwi	Development of learning media using the Benime application based on problem based learning in the mathematics subject of fractions	From the validation results carried out on several experts, it was found that the Benime animation learning media is very suitable for use in the learning process.

Author	Title	Results
Alfi Syahrin Siregar and Tomi Listiawan	Development of KORS *Mobile Learning* on Composition and Inverse Function Material to Train Critical Thinking Skills	From the development results, *mobile learning was obtained* which was considered feasible by media experts, the implementation results showed that the practicality score from teachers reached 81.33%. Small-scale trials on six students resulted in an assessment that this *mobile learning* was very practical, with a percentage of 82.67% in the very interesting category.
Then Riki Gita Sukma	Development of augmented reality application as a learning media for flat-sided spatial geometry material for class VII of SMP Negeri 13 Mataram	The level of validation of the ARGEO Learning application obtained is very valid. The practicality of the ARGEO Learning application is categorized as very practical. Therefore, ARGEO Learning is said to be effective.

Based on the review of the articles above, we can get the following data:
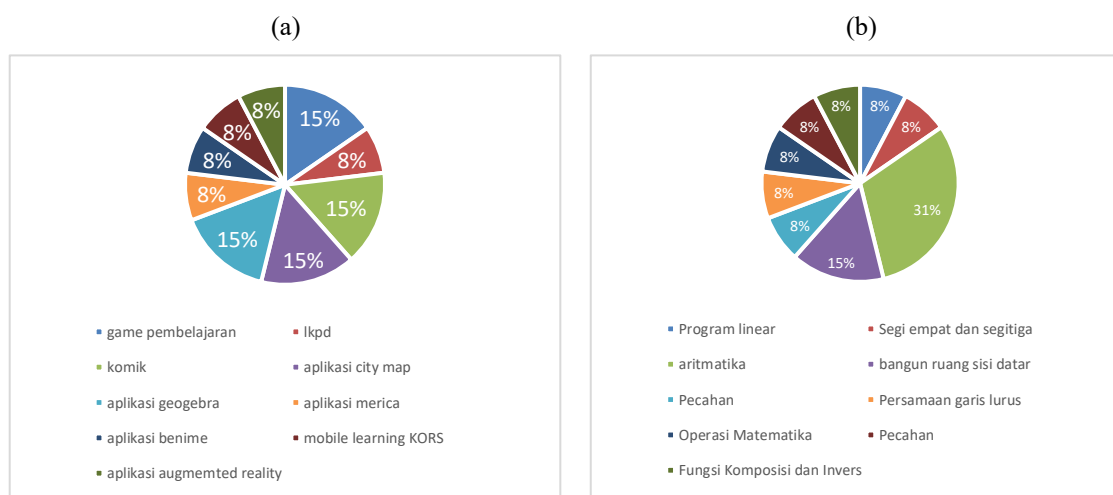

Figure 1. Article information diagram
(a) Application type distribution diagram, (b) Material distribution diagram

Critical thinking is a vital cognitive process that involves strategies and representations used by individuals to analyze information, solve problems, make decisions, and acquire new knowledge. It is an active and reflective process that requires individuals to engage with complex issues, phenomena, or questions in a logical and reasoned manner (Osorio-Saez et al., 2021). Critical thinking enables learners to investigate a situation thoroughly, integrating diverse sources of information to arrive at well-justified conclusions or hypotheses. This process promotes deeper understanding, independent thinking, and the development of intellectual autonomy.

In the context of education, critical thinking can be observed through various student behaviors and skills. These include the ability to pose meaningful questions, conduct simple research or investigations, generate new ideas, and manage time effectively (Bueno et al., 2008; Roblyer & Doering, 2013). Furthermore, students who think critically are typically more engaged in group discussions, demonstrate responsibility in completing academic tasks, apply learning outcomes in collaborative settings, and effectively communicate their conclusions to peers. These indicators reflect not only the cognitive dimension of critical thinking but also its practical application in everyday learning environments.

The integration of technology into education, particularly through mobile applications, offers significant opportunities to enhance the development of critical thinking skills (Courville, 2011). The term "application" refers to a program designed to perform specific functions for users and can be accessed through various

devices, including mobile phones. In the educational context, a learning application serves as a digital platform that facilitates the interaction between students and educators, as well as the delivery of learning content. These applications enable access to instructional materials, promote interaction, and support personalized learning pathways.

An Android-based learning application, specifically, provides numerous advantages that make it highly suitable for modern educational practices. Firstly, it offers user-friendly features that are easy for students to navigate. This simplicity enhances user experience, especially for learners who may have limited technological proficiency (Bandera, 2018; Guo et al., 2017). Secondly, these applications can be accessed at any time and from any location, allowing for flexible and self-paced learning. This is particularly beneficial for students with varied schedules or those engaged in distance learning. Additionally, many Android-based applications function with or without an internet connection, increasing accessibility for students in remote or underserved areas (Faqih, 2021).

Android learning applications also provide opportunities for interactive and engaging learning experiences. When designed using software such as iSpring Suite, these applications can incorporate multimedia elements like videos, animations, quizzes, and simulations. Such features enhance student motivation and facilitate better understanding of complex concepts (Al-Barhamtoshy et al., 2014; Hill, 2018). For instance, in learning topics related to financial institutions, a well-designed Android application can present information in a visually appealing and structured format, enabling students to grasp the material more easily.

Moreover, Android-based learning applications support teachers in delivering content more efficiently. They offer a structured and consistent platform for presenting material, tracking student progress, and providing feedback (Pangestu & Fahruddin, 2024). Teachers can use these tools to develop interactive lessons that promote student participation and critical engagement. Through these applications, educators can also differentiate instruction by tailoring content to meet diverse learner needs and preferences.

In summary, the integration of critical thinking skills with Android-based learning applications represents a powerful combination in contemporary education. While critical thinking encourages learners to become active, reflective, and independent thinkers, learning applications provide the tools and environments that make such thinking possible. Together, they create dynamic and flexible learning experiences that prepare students for the challenges of the modern world. As technology continues to evolve, educators must continue to explore and leverage innovative applications that not only deliver content effectively but also cultivate essential 21st-century skills such as critical thinking, collaboration, and problem-solving.

4.   CONCLUSION

Based on the results and discussion of the literature *review* of 13 articles published in 2020-2023, it can be concluded that; 1) applications as learning media have definitions, goals, and important roles in the field of education, especially in increasing learning motivation so that learning becomes more enjoyable because it is supported by attractive and non-monotonous facilities, 2) there is a significant influence in the use of applications on students' critical thinking skills, this is what researchers get from the 13 articles that explain the achievement of critical thinking ability indicators that can be achieved in the use of learning applications. in the form of increased test scores and research in the article above which proves that applications as learning media can influence the improvement of students' critical thinking skills.

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