

A SYSTEMATICS LITERATURE REVIEW: THE IMPACT OF ICT ON STUDENTS' MATHEMATICAL LITERACY

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ABSTRACT *This research aims to describe the effect of ICT on increasing students' mathematical literacy. A systematic literature review (SLR) was used in this study because it was necessary to identify, review, evaluate, and analyze all research related to the impact of ICT on mathematical literacy skills. It is hoped that this research can provide information about the influence of ICT on mathematical literacy abilities. The Science Direct, Scopus, Eric, and Google Scholar databases were used to search for literature studies. Literature search inclusion criteria were that the research subjects were students, research results had been published in journals, and there were only a few articles from 2013 to 2022. Based on the inclusion and exclusion criteria, literature was selected and analyzed. Based on predetermined inclusion criteria, data related to keywords were obtained from 16 journal articles that were relevant and eligible for systematic review. Most research uses computers and Edmodo, and 15% each is used to improve mathematical literacy skills; this shows that ICT has a practical impact on increasing mathematical literacy.*

Keywords: *ICT, mathematical literacy, systematic literature review.*

INTRODUCTION

Mathematics in the Large Dictionary Indonesian (KBBI) is "the science of numbers, the relationship between numbers, and the operational procedures used in solving questions about numbers". This shows the close relationship between learning and mathematics, especially in relation to the numbers and operations that help solve them. However, math is not just about numbers; it also teaches students how to think systematically and rationally, how to solve problems, and how to be conscientious and diligent. Therefore the curriculum in all countries, especially Indonesia, requires mathematics lessons at every level of education. In mathematics, students' abilities are assessed not only from their numeracy skills but also from their ability to solve problems logically, critically, and methodically. This is a problem that needs to be solved regularly. Mathematical literacy refers to this type of ability. The ability to read and write is the meaning of the English word "literacy" (Sugiarto, 2019). Wong (Hurst, 2018) defines mathematical literacy as the skill of solving problems, justifying information, and evaluating it. Furthermore, Stacey & Turner (2015) argues that, in

the context of mathematics, literacy means being able to use mathematical arguments to find solutions to problems encountered in each activity so as to be able to face challenges in life. To help them solve real-world problems, students need to know how to use numbers and formulas. Therefore, students must be able to understand and recognize math problems in order to be successful. It is not enough for students to only have knowledge of mathematics. Mathematics is everywhere and used every day in our lives, so students should stop thinking that it only happens in the classroom. Instead, mathematics is used in everyday activities.

The ability of students to connect knowledge with the real world, master ICT, and collaborate is emphasized in the 21st century learning paradigm (Janah et al., 2019). In addition, using mathematical concepts to communicate and explain the phenomena encountered is necessary for mathematical literacy. Someone with a strong mathematical foundation will be aware of how mathematical concepts relate to the phenomena or problems they face. Someone who is proficient in mathematics will recognize and understand which mathematical concepts will be applied to a problem to solve it. The ability to formulate a problem mathematically to solve it grows from this awareness. This process involves exploring, associating, reasoning, and other mathematical thinking processes. With an understanding of mathematical literacy, it will be easier to understand the role or application of mathematics in one's activities. (Puspitasari et al., 2015). In today's society, mathematics literacy education is needed to process, communicate, and read mathematical information in various contexts (Genc & Erbas, 2019; OCED, 2017; Pradana et al., 2020).

By utilizing ICT and the growth of information technology, educators have responded to the importance of students' mathematical literacy skills through various educational studies and practices. The infrastructure and components that make modern computing possible are known as information and communication technologies, or ICTs. It includes all devices, applications, systems and parts of networks that enable people to obtain information or communicate with each other in the digital world. ICT aims to increase the effectiveness of learning so that it can assist students in learning as well as possible, and the inclusion of ICT applications in educational materials or media can enhance learning. The teacher's role as a facilitator can shift due to the use of ICT in education (Batubara, 2017). Suryadi (2007) observes that technology not only contributes to the creation of a learning environment that benefits students' way of thinking, but also functions as a tool or tool that facilitates student work and, of course, teaches technology skills.

Today's students have easy access to information technology. In the past, students got information from television and print media, but now the internet makes it easy to get information. Students quickly find information on the Internet and information can be found and distributed within seconds. The internet supports the teaching and learning process well at this time, so it needs to be optimized and used as a learning tool for students to improve the quality of education. Various ICT tools have become

an important part of education and social life. In education, the use of ICT as a learning tool is becoming more common. Students can be taught through the use of learning media (Widodo & Wahyudin, 2018). According to Nugroho (2017), in order for students to absorb material effectively, the process of learning mathematics requires the use of the learning environment as a support for learning. The idea of information and communication technology (ICT) certainly adds a new dimension to the educational process which so far only relied on the presence of teachers. In addition, using technology can encourage students to participate more actively in the learning process and increase the effectiveness and interest in student learning (Izza Khoirin Nida et al., 2017).

Previous research has shown that ICT can be applied to improve students' mathematical literacy skills in a consistent manner that encourages students' exploration and involvement in mathematics (Novita & Herman, 2021). However, the findings of other studies vary and do not fully demonstrate that ICT is effective in increasing students' mathematical literacy. As a result, all research findings regarding the impact of ICT on students' mathematical literacy require methodical investigation. According to Sakti & Sulung (2020), literature review is a research method in which relevant literature sources are selected and analyzed to produce new concepts. The purpose of this research is to describe the effect of ICT on increasing students' mathematical literacy. The questions in this research are as follows:

1. What is the description of the results of the influence of ICT on mathematical literacy skills?
2. What ICTs are used to improve mathematical literacy?
3. What are the trends in the publication of articles related to ICT and mathematical literacy skills?

RESEARCH METHODS

A systematic literature review (SLR) was used in this study to identify, evaluate and review all relevant research to answer a set of research questions. A systematic literature review will be conducted according to the PRISMA guidelines to provide a comprehensive overview of the existing literature on ICT literacy and mathematics skills. The PRISMA flowchart is shown in Figure 1.

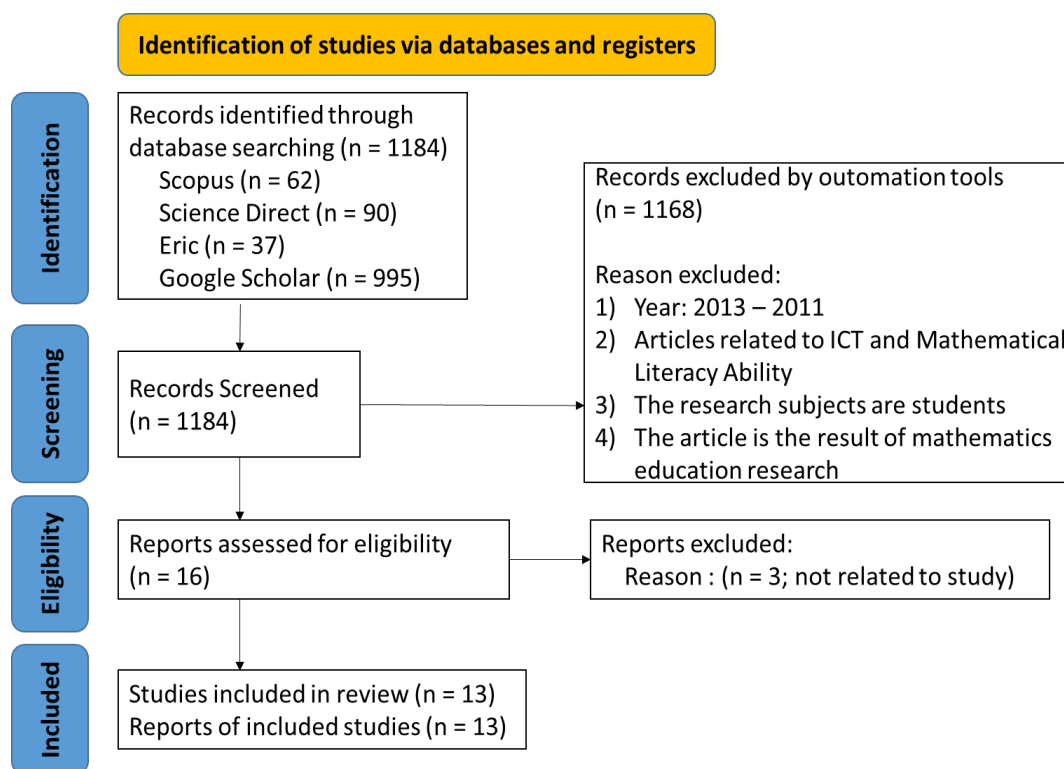


Figure 1. PRISMA flowchart

Identification

Literature study searches were carried out on the Science Direct, Scopus, Eric, and Google Scholar databases. While ("TIK" OR "Information and Communication Technology" OR "Technology") AND ("Mathematical literacy" OR "Mathematical literacy skill" OR "Mathematical literacy ability" OR "Mathematical literacy process")) are the keywords used.

Screening

The inclusion criteria used in the literature search included results

1. Articles applied from 2013 to 2022
2. Articles related to ICT and Mathematical Literacy Ability
3. The research subjects are students, and
4. Article has been published in a journal,

Eligibility

In SLR research, data will be evaluated based on questions of quality assessment criteria, such as whether the literature is in the form of journal articles, whether the research problems relevant to this research are written in the literature, and whether the research subjects are students.

RESULT AND DISCUSSION

The results found only 13 articles that met the criteria that fit the needs of the inclusion criteria. This section discusses the following research questions.

1. What is the description of the results of the influence of ICT on mathematical literacy skills?

Table 1. ICT Research Results & Mathematical Literacy Ability

Researcher and Year	Journal	Research result
(Wardono et al., 2018)	Journal of Physics: Conference Series	Students IX's mathematical reading skills were improved by using a sci-fi approach to PBL learning supported by Edmodo
(Khotimah, 2018)	Gauss: Journal of Mathematics Education	Data analysis revealed that students who received Geogebra-assisted metacognitive guidance developed their math reading skills more effectively than students who received conventional instruction.
(Surani et al., 2021)	AL-ISHLAH: Journal of Education	Based on the findings of this study, there are differences in learning independence, entrepreneurial abilities, and mathematical literacy before and after using Android media.
(Hairunnisah et al., 2019)	Unnes Journal of Mathematics Education Study	Based on research findings, Edmodo-assisted PBL is effective for students' mathematical literacy skills. It is evident that students who learn Edmodo-assisted PBL achieve student abilities and have better mathematical literacy than PBL students.
(Dianawati, 2018)	Unnes Journal of Mathematics Education Study	The results showed that classes with PMRI learning and blended learning had a better average mathematical literacy than classes with PMRI learning, where the average classical completeness was at least 70 percent of students.
(Mansah & Safitri, 2022)	AKSIOMA: Journal of the Mathematics Education Study Program	Based on the findings of this study, students' mathematical literacy can be improved through the use of the Facebook application. According to survey findings, the use of the Facebook application for math literacy is in the "very good" category. The same goes for the Facebook app's math literacy test, which returned a "good" result.
(Fauzi & Chano, 2022)	Journal of Education and Learning	During the COVID-19 pandemic, there were differences in mathematical literacy abilities before and after online learning. The N-Gain score of 0.35 in the moderate category also supports this.
(Angreanisita et al., 2021)	Unnes Journal of Mathematics Education Study	This study shows that Moodle-based blended learning with PjBL is effective in increasing students' independent learning and mathematical literacy.

Researcher and Year	Journal	Research result
(Aritonang & Safitri, 2021)	Scholar's Journal: Journal of Mathematics Education	During the Corona pandemic, the quality of student learning in basic mathematics education was influenced by the use of mixed learning methods. In addition, it is known that mixed learning methods have an effect of 30% on students' mathematical literacy, while traditional learning methods only have an effect of 2.44%. So it can be concluded that the mixed learning method has a difference in learning outcomes of 24.76% compared to traditional learning methods.
(Sari et al., 2022)	Element Journal	The research findings show that mixed learning based on RME, conventional learning, and SRL all work together to improve students' ML. Associated with a high SRL level, students who receive RME-based learning have a higher increase in ML than students who receive conventional learning, and vice versa for low SRL levels. In addition, when students with high SRL participate in RME-based learning, their ML improves slightly more than when students with low SRL participate in conventional learning.
(Chen & Chiu, 2016)	International Journal of Science and Mathematics Education	Metacognitive self-regulation related to math control and performance on follow-up questions was better among students working with collaborative scripts, the findings found. However, because there were no statistically significant differences between students with and without scripts in planning aspects of metacognitive self-regulation or lower questions about achievement of mathematical literacy, these results should not be considered as definitive.
(GÜLTEN, 2013)	Educational Research and Reviews	According to the research findings, there is no significant difference in the level of self-efficacy for math literacy based on gender, academic achievement, views on quantitative subjects, use of the internet to learn mathematics, and educational background of parents. In addition, those who read e-books about mathematics had a higher level of self-efficacy for math literacy than those who did not. In addition, students enrolled in distance education have high levels of math literacy and self-efficacy.

Researcher and Year	Journal	Research result
(Kuznetsov a et al., 2021)	Journal of the Balkan Tribological Association	The study findings indicate that mathematical modeling, discrete mathematics, and computational process theory serve as the cultural basis for leveraging Web technologies to influence school students' mathematical literacy when learning complex mathematical knowledge through the use of structured mathematical language.

Based on the research results of the 13 articles, it is shown that most researchers state that ICT can help students improve their mathematical literacy. According to Koysuren et al. (2018), the use of ICT makes the learning process more enjoyable, students' confidence in understanding mathematical relationships in everyday life increases, and they can understand mathematical concepts better with visualization. But ICT can also have a negative impact (Hu et al., 2018). Therefore, on the one hand, information communication technology must be included in the world of education because it can be a solution to various educational problems. On the other hand information communication technology must be used with caution in educational situations.

2. What ICTs are used to improve mathematical literacy?

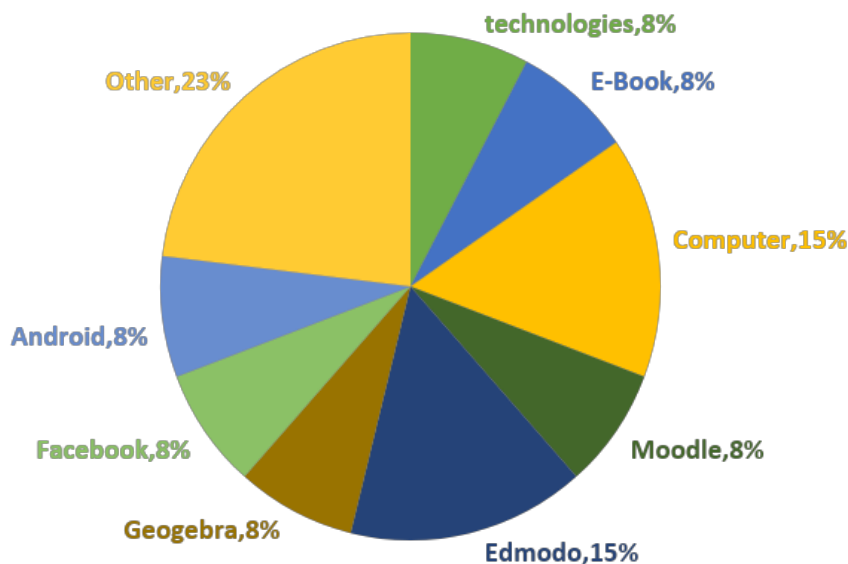


Figure 3. Distribution of TIK approach

The type of ICT used in improving mathematical literacy skills is shown in Figure 3. The results of the analysis revealed that most of the types of ICT used were Edmodo (15%, n = 2) (Hairunnisah et al., 2019; Wardono et al., 2018) and types of computer ICT

(15%, $n = 2$) (Chen & Chiu, 2016; Dianawati, 2018). From the 2 articles that discussed Edmodo, it was shown that it had a positive impact on increasing students' mathematical literacy, as seen from the research by Wardono et al., (2018) concluded that increasing the mathematical literacy of class IX students in Enhanced PBL class with a realistic scientific approach supported by Edmodo. In addition, the 2 articles discussing computers also had a positive impact on increasing students' mathematical literacy. Other findings also show that the types of ICT used are Web-technologies, E-Books, Moodle, Geogebra, Facebook, and Android. This shows that a variety of ICT tools can be used in the learning process to improve students' mathematical literacy, so that they are not fixated on just a few ICT tools that can be used. In addition, more than one ICT tool can be used simultaneously to support each other in the learning process.

3. How is the trend of publication of articles related to TIK and mathematical literacy ability?

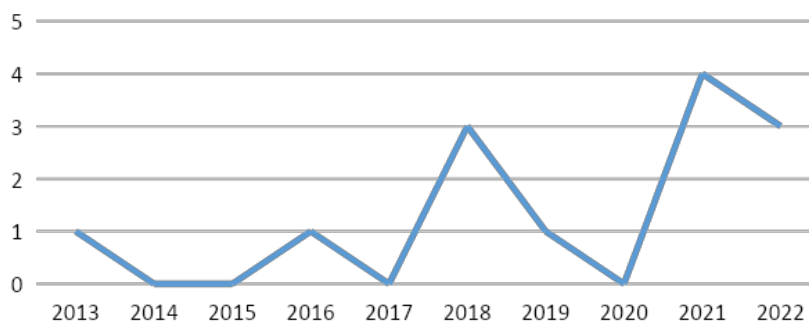


Figure 2. Number of articles by year

Based on the trend of publications that meet the criteria since 2013 as shown in Figure 2, a significant increase has occurred in 2021 due to the COVID pandemic so that most of the learning process takes place online and the use of ICT tools is increasingly being used in the learning process (31%, $n = 5$) (Angreanisita et al., 2021; Aritonang & Safitri, 2021; Kuznetsova et al., 2021; Surani et al., 2021) and there were no publications that fit the criteria in 2014, 2015 and 2020. In 2021 most of the published articles come from Indonesia.

In the studies studied, the majority of researchers come from Indonesia; In addition, only one author each comes from Turkey, China, and Russia, and only 10 out of 13 articles mention the ICT tools used, and of the various ICT tools that can be used in the process of increasing mathematical literacy, some of which are the most widely used, namely Edmodo and computers. From all the articles studied, the results show that the use of ICT can improve students' mathematical literacy skills to be better when compared to conventional learning processes that do not use ICT. So this indicates that ICT-based mathematical literacy can be developed to improve students' mathematical literacy, and current technological advances adapt it to

the conditions of local schools or students. Such as the implementation of an Android-based mathematical literacy program in urban schools, where most students are also familiar with the media. The effectiveness of learning media depends on how well the teacher can make or design it, use it, disclose it to students, and integrate it with learning models or strategies that are appropriate to the media and material. This ensures that students are engaged, not bored, and have fun while learning.

CONCLUSIONS AND RECOMMENDATIONS

The existence of ICT in education makes learning easier, such as through the use of educational videos, presentations and online learning. The role of ICT in education is as an educational tool, in this case it is hoped that ICT can help schools as a way to load information or knowledge that can be accessed easily and more broadly. Many ICT tools are currently available to integrate information such as magazines, e-books, articles, and digital libraries to support student learning processes and improve students' basic math skills, including students' mathematical literacy skills.

To further improve students' mathematical literacy skills by applying ICT in mathematics education, future research must conduct a lot of additional research on the implications and benefits of ICT in education, especially the development of mathematical literacy skills. If further research shows the success of ICT with diverse populations, this will be a positive incentive for teachers to incorporate ICT into the classroom learning process.

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