

# Develop Students' Mathematical Literacy in Learning

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## ABSTRACT

Indonesia consistently ranks in the bottom ten in the international PISA (Program for International Student Assessment) assessment results. This PISA shows that the literacy ability, especially the mathematical literacy of Indonesian students, is still a concern. One of the main factors that affect students' knowledge is the ability of teachers to carry out the learning process. Therefore, teachers as learning agents must play an active role in improving students' mathematical literacy skills. The writing methodology used is a literature review which contains a review of mathematical literacy from various library sources. This article discusses mathematical literacy, efforts to develop mathematical literacy through learning and learning media, which are expected to be alternative solutions in developing Indonesian students' mathematical literacy. Further research needs to be done, considering that mathematical literacy skills are very important in everyday life.

**Keywords:** *develop, mathematical literacy, students, PISA, learning.*

## 1. INTRODUCTION

The rapid development of today's era certainly requires every country to produce human resources who have good abilities, skills, and competencies so that they can compete in various fields. This condition causes multiple countries to compete to improve the quality of their human resources [1]. With quality human resources, a country can be said to be a developed country. Of course, education plays a very important role in shaping human resources in accordance with the demands of the times in the 21st century. For this reason, the government mandates 21st-century learning in the world of education. The characteristics of 21st-century learning are certainly different from previous centuries. Where education in the 21st century must be able to ensure that students have the skills to learn and innovate, the skills to use and utilize information technology and media, can work and survive using life skills.

21st-century learning has a learning paradigm that emphasizes critical thinking skills, connects science with the real world, masters information technology, and communicates and collaborates [2]. Of course, by emphasizing these abilities, students need to have 21st-century life skills. In life skills in lifelong education, there are three types of competencies that must be mastered,

namely basic skills ( basic literacy ), competence, and character [3]. Literacy is one of the life skills and must be mastered in facing the challenges of the 21st century.

Literacy etymologically comes from the Latin "literatus" which means "people who learn" [4]. Literacy is an important thing that needs to be owned by everyone because it is the basis for the progress of a nation. This is in line with the opinion of Nugraha and Octavianah [5] literacy is a basic competency that must be possessed by a person in the context of the needs of society and the times. Literacy is starting to develop, not just reading and writing but has grown to cover other fields. One of them is mathematical literacy. Mathematical literacy is an ability that is so essential for students because it can invite students to apply mathematics in students' daily lives. Mathematical literacy ability is related to how individuals can apply knowledge in real-world problems (real world) every day so that the benefits can be felt directly [4]. The need for mathematical literacy skills makes developed countries think to continue to develop mathematical literacy from an early age.

One of the programs to measure achievement for 15-year-old children at the international level in the fields of mathematics, science, and reading literacy is through PISA (Program for International Student Assessment).

PISA is an international test that is held every three years to see math, natural science, reading, and global abilities. The current PISA assessment has been used as a reference and evaluation of the education quality of a participating country from PISA [6]. Indonesia is one of the participating countries in this assessment program. Based on PISA data, the scientific literacy ability of Indonesian students is still below the average when compared to the international average score. Following are the results of the PISA study on mathematical literacy, which is conducted every three years, it is revealed that the mathematical literacy of Indonesian students from various years is presented in Table 1 below.

**Table 1.** Indonesian Students' Mathematical Literacy Data

Year of Study	Indonesia Average Score	International Average Score	Indonesia Ranking	Number of Study Participating Countries
2000	367	500	39	41
2003	360	500	38	40
2006	391	498	50	57
2009	371	496	61	65
2012	375	494	64	65
2015	386	490	62	70
2018	379	500	73	79

<sup>a</sup>. Sources: [2], [6], [7], [8]

Based on table 1, the results of seven surveys conducted by the OECD Institute (The Organization for Economic Co-operation and Development) from 2000 – 2018 show that Indonesia is consistently below the average set international standards. The low test results also indicate that students are still weak in connecting mathematical concepts that have been studied with problems in everyday life [7]. PISA results regarding the low level of mathematical literacy are also supported by the results of several studies conducted by Patih et al. [9] and Styawati and Nursyahida [10] which found that overall students were still dominated by low mathematical literacy skills. Furthermore, the results of research on the mathematical literacy ability of prospective teachers were found by Rafianti [11] that the mathematical literacy ability of prospective mathematics teachers was in the moderate category, even Riana and Zenizela [12] found that the mathematical literacy ability of prospective elementary school teachers was still not optimal.

The results obtained have the impact of thinking that the quality of Indonesian education is not in accordance with global community standards and is below other countries in the world. The low result of mathematical literacy is suspected to be related to the process of learning mathematics that has been carried out so far. This is a big task for the Indonesian people to

compete in the international arena and Tangguh in facing the challenges of the 21st century.

Based on the description above, the formulation of the problem in this study is: "how to develop the mathematical literacy skills of Indonesian students in learning?" The purpose of this study is to examine ways to develop the mathematical literacy skills of Indonesian students in learning. The benefits to be achieved in this study are as a reference or input for both teachers or prospective teachers as well as for education practitioners in improving students' mathematical literacy skills so that they are able to compete in the international arena. In addition, this study is expected to build awareness about the importance of developing mathematical literacy in learning, especially in the 21st century.

## 2. METHOD

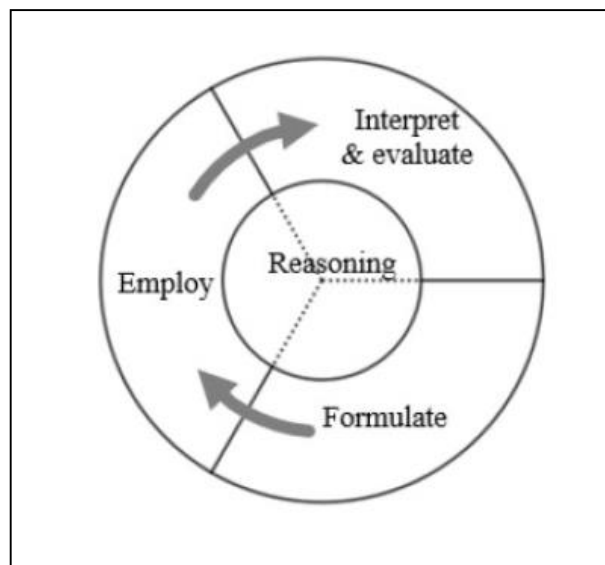
The writing method used in this article is the library method. The library is used to obtain data or materials needed by researchers in accordance with the purpose of this paper, namely to examine ways to develop Indonesian students' mathematical literacy skills in learning. This literature review only identifies and cites the literature briefly. This data is obtained by using documentation which includes documents of laws and regulations or government regulations, research results from various sources, including from journals that are relevant to this article.

## 3. DISCUSSION

### 3.1. Mathematical Literacy

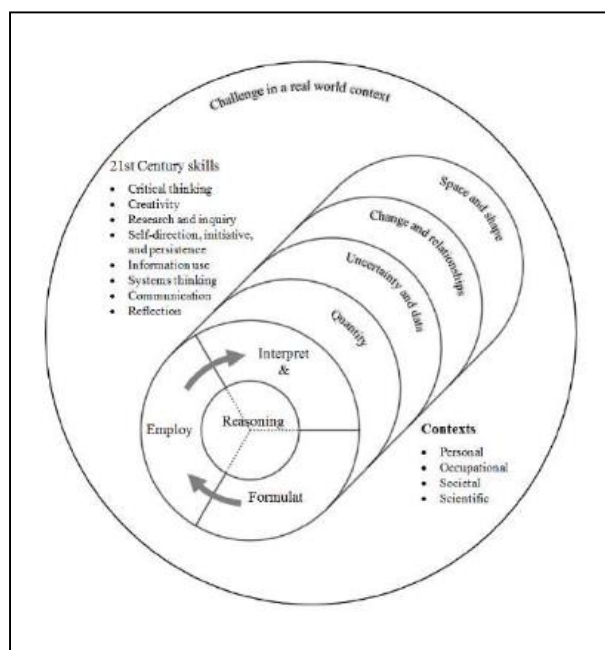
Mathematical literacy is PISA's central idea for the field of mathematics. Mathematical literacy, according to PISA 2012, is defined as follows: "Mathematical literacy is an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain and predict phenomena." [13]. Based on the explanation above, mathematical literacy is an individual's ability to formulate, use, and interpret mathematics in various contexts. Mathematical literacy includes mathematical reasoning and uses mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena. At PISA 2012, mathematical reasoning is at the center of mathematical literacy. The OECD retained the PISA 2012 definition of mathematical literacy in 2015 and 2018 PISA. However, in 2021 mathematical literacy skills were redefined by the OECD. In the draft of the 2021 PISA framework, mathematical literacy is said to include a synergistic and reciprocal relationship between mathematical thinking and computational thinking [13]. Thus, mathematical literacy 2021 will not only focus on mathematical reasoning but also pay

attention to very fast technological advances. The following is an overview of PISA 2012 and PISA 2021.



b. Source: [13]

**Figure 1.** PISA 2012 The relationship between mathematical reasoning and mathematical modeling



c. Source: [13]

**Figure 2.** PISA 2021. Relationship between Mathematical reasoning, mathematical modeling, mathematical content, context, and 21st century skills.

Based on Figure 2 above, it can be seen that mathematical literacy in PISA 2021 does not only pay attention to the reasoning aspect as shown in Figure 1, namely PISA 2012 but also pays attention to aspects of 21st-century skills, rapid technological developments, content, and mathematical context. Thus, mathematical literacy will help individuals to recognize the role of mathematics in everyday life, which can be taken into

consideration in making decisions. Of course, with the role of computational thinking. The PISA framework illustrates that computational thinking can play a role in the problem-solving process, both when formulating problems and when doing mathematical reasoning, among others, by selecting the right computing tools in the analysis and problem-solving process [13]. Based on the definition of mathematical literacy above, students need to be prepared from an early age to have mathematical literacy skills, which are expected to help students face future challenges.

Mathematical literacy is a literacy that must be possessed by students. This is in line with the opinion of Nugraha and Octavianah [5]. Mathematical literacy is a very important literacy in human life because it will make a person able to think calculative, numerically, and spatially in everyday life. With mathematical literacy, students are expected to have: 1) the ability to define and describe mathematical knowledge that can be expressed by programming, which allows students to dynamically model mathematical concepts and relationships [13], 2) the ability to communicate problems and present problem-solving results, 3) the ability to change problems from the real world into the mathematical form or vice versa, namely interpreting a result or mathematical model into the original problem. 4) the ability to present back (representation) of a problem or an object of mathematics through things like selecting, interpreting, translating, and using charts, tables, pictures, diagrams, formulas, equations, and the object of concrete to photograph issues that more clearly. 5) reasoning ability to analyze the information to produce conclusions was unreasonable. 6) the ability to use strategies to solve problems. 7) the ability to use symbolic language, formal language, and technical language. 8) the ability to use mathematical tools, for example, taking measurements, operations, and so on. Once the importance of mathematical literacy, it is hoped that teachers need to help to develop mathematical literacy from an early age.

### 3.2. Develop Students' Mathematical Literacy in Learning

Learning is the most important part of determining the achievement of mathematical literacy skills. Of course, teachers have an important role in developing mathematical literacy in learning. For this reason, the teacher must design learning as well as possible so that the objectives can be achieved. This is in line with the opinion of Yuniawatika et al. [14] that improving the quality of education can be performed if teachers can prepare the learning process properly and maturely. By looking at the current conditions, of course, learning needs to be designed according to the characteristics of the 21st century, namely 21st-century learning. One of

the characteristics of 21st-century learning is student-centered, where the teacher is not the only source of learning for students.

In mathematical literacy, learning can be done using interactive, innovative, creative, fun learning models and in accordance with the characteristics of 21st-century learning. There are several alternative learning models that are quite effective in building mathematical literacy for students, which are certainly in accordance with the characteristics of the 21st century. The following will discuss several learning models that can develop students' mathematical literacy based on research results.

One of the first alternatives is the problem-based learning model. Why problem-based learning? Given the problem-based learning model in accordance with the characteristics of 21st-century learning, where students become the center of learning. Through various activities in the problem-based learning model where the problem becomes a stimulus and the main focus to solve it can provide a learning experience that is able to develop students' mathematical literacy. There have been many research results that get the influence by using a problem-based learning model. Pamungkas and Pramita [15] found that learning mathematics with problem-based learning can improve students' mathematical literacy skills. The results of this study are in line with the research results of Indah et al. [16]. There is an increase in the mathematical literacy ability of junior high school students after the application of the Problem Based Learning learning model. Even the results of the meta-analysis of Paloloang et al. [17], the application of PBL has a large positive impact on students' mathematical literacy skills compared to the application of the conventional approach.

In addition, Fatwa et al. [18] found that there was an increase in students' mathematical literacy skills with the Problem Based Instruction (PBI) learning model. The PBI learning model presents an active student learning condition and involves students in problem-solving through the stages of the scientific method. Based on the results of the study, it was found that the cause of the increase in mathematical literacy skills is that students are more actively involved in finding formulas that exist in learning so that it affects students' mathematical literacy skills in linking concepts to other fields of mathematics, as well as the real world.

### **3.3. Develop Students' Mathematical Literacy Through Learning Media**

Learning media is important and cannot be separated in learning. Of course, in choosing learning media, it must be in accordance with the learning objectives, teaching materials, and the characteristics of students as learning subjects [19]. In addition, in the selection of media, it is also necessary to pay attention to digital

technology. This is in accordance with the PISA 2021 mathematical literacy framework, namely computational thinking.

Learning media that can be used to improve mathematical literacy and in accordance with computational thinking is using the web. Hapsari et al. [20] found that the mathematical literacy ability of high school students increased after the implementation of a web-assisted problem-based learning model. Another alternative is to use a Learning management system. Nolaputra et al. [21] applied PBL learning with the RME approach assisted by Schoology, and it was found that students' mathematical literacy skills increased after being given treatment. In addition, Wardono et al. [22] found the same thing that there was an increase in mathematical literacy after applying Edmodo Schoology Realistic Problem-based learning. Based on the results of this study, it can be seen that students are more interested and feel happy to learn mathematics when using web-based mathematics learning media and LMS, this is of course, in line with mathematical literacy, which is related to computational thinking and also the characteristics of the 21st century which is very close to technology. Based on the description above, it is necessary to design the use of a technology-based media that utilizes students' computers or smartphones.

## **4. CONCLUSION**

Mathematical literacy is a literacy that must be possessed by students, but from the results of PISA, Indonesia consistently ranks tenth. Improvements to PISA results, especially mathematical literacy, will be very effective in implementing learning through appropriate learning models. Problem-based learning can be an alternative solution that can develop mathematical literacy. In addition, the selection of learning media that includes the role of technology is important in order to improve computational thinking abilities as part of mathematical literacy.

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