# STUDENT MATHEMATICAL LITERACY SKILL
# OF MADRASAH IN INDONESIA WITH ISLAMIC CONTEXT

Lia Kurniawati*, Ramdani Miftah, Kadir, Abdul Muin

Syarif Hidayatullah State Islamic University of Jakarta, Indonesia

E-mail: lia.kurniawati@uinjkt.ac.id

## Abstract

Mathematical literacy (ML) skill is important because the activities of everyday life are related to mathematics and require prompt and in-depth understanding. Therefore, this study aims to examine the ML skill of madrasah students in Indonesia both as a whole and based on the level of madrasah (MI, MTs, and MA). The sampling technique was then adopted Random Assignment, which obtained a total of 3,285 students from 26 regions in Indonesia. Furthermore, a qualitative descriptive method with a survey technique was used. The instrument used for the was the PISA design with an Islamic context in the form of a description. The results showed the ML skill of madrasah students in Indonesia has an average of 17.23%, with Madrasah Ibtidaiyah (MI) having 6.39%, Madrasah Tsanawiyah (MTs) with 20.01%, and Madrasah Aliyah (MA) with 25.29%. The low ML skill is because most of the students do not understand the context in the questions. The context in the assessment of this skill is important because it helps students to remember what they have learned, relate them to the problems, and offer a solution that fits the given context. Another cause is the lack of using problems that have the characters of PISA questions in the learning process. Therefore, the students are less trained in working on contextual questions and require high-level thinking.

**Keywords:** mathematical literacy; PISA design; Islamic context

## Abstrak

*Kemampuan literasi matematis sangat penting karena kegiatan yang dilakukan manusia dalam kehidupan sehari-hari banyak sekali yang berkaitan dengan matematika dan memerlukan pemahaman literasi dalam penyelesaiannya. Penelitian ini bertujuan untuk mengkaji kemampuan literasi matematis siswa madrasah di Indonesia baik secara keseluruhan maupun berdasarkan tingkat madrasah (MI, MTs, dan MA). Penelitian ini dilaksanakan di 26 wilayah yang ada di Indonesia dengan teknik sampling yang digunakan adalah Random Assignment dan diperoleh sampel penelitian sebanyak 3285 siswa. Metode penelitian yang digunakan adalah metode deskriptif kualitatif dengan teknik survey. Instrumen penelitian yang digunakan dalam penelitian ini berupa instrumen tes kemampuan literasi matematis menggunakan desain PISA dengan konteks keislaman yang berbentuk uraian. Hasil penelitian ini menunjukkan bahwa kemampuan literasi matematis siswa madrasah di Indonesia memiliki rata-rata 17, 23%. Kemampuan literasi matematis untuk siswa Madrasah Ibtidaiyah (MI) sebesar 6,39%, untuk siswa Madrasah Tsanawiyah (MTs) sebesar 20,01% dan untuk siswa Madrasah Aliyah (MA) sebesar 25,29%. Salah satu penyebab rendahnya kemampuan literasi matematis siswa madrasah di Indonesia dikarenakan kebanyakan siswa tidak memahami konteks dalam soal. Konteks dalam penilaian literasi matematis merupakan hal yang sangat penting, sebab konteks membawa pola pikir siswa untuk mengingat ulang konsep-konsep yang telah dipelajarinya, menghubungkan dengan permasalahan yang ada dalam konteks, kemudian memformulasikan suatu solusi yang sesuai dengan konteks yang diberikan. Penyebab lain adalah kurangnya penggunaan masalah yang memiliki karakter seperti soal PISA dalam proses pembelajaran sehingga siswa kurang terlatih dalam mengerjakan soal yang kontekstual dan menuntut untuk berpikir tingkat tinggi.*

*Kata kunci: literasi matematis, desain PISA, konteks keislaman*

## Introduction

Mathematical literacy (ML) skill requires prompt understanding, and its application is closely related to activities of everyday life, hence it needs to be developed. Kusumah (2012) stated that in living in this modern age, everyone needs ML to face various problems related to work and duties. Literacy is important to help overcome various state problems, including economic, social, and cultural (Arslan & Yavuz, 2012; Pamungkas & Franita, 2019). The higher the understanding level of a nation's literacy, the faster, more precise, and rational the policies issued and this will ultimately lead to the nation's prosperity (Akyüz, 2014; Mujulifah et al., 2015).

According to the Program for International Student Assessment (PISA) data in 2000, 2003, 2006, 2009, 2012, and 2015, Indonesian students' ML is still low. In 2000, it was in 39th position out of 41 countries, in 2003 at 38th out of 40, in 2006 at 50th out of 57, and in 2009 at 61st out of 65 countries. Also, in the period between 2003 and 2009, almost 80% of students reached just below the level 2 limit line out of 6 levels of tested questions. In 2012, Indonesia was ranked 64th out of 65 countries, with a score of 375 which was only superior to Peru in the lowest position, while the international score was set at 494 (OECD, 2013:19). The results of the latest PISA test in 2015 showed a slight increase at 64th position out of 72 countries, with a score of 386 from the set average of 490 (OECD, 2016:3).

PISA's mathematical questions, which are considered difficult to understand, also contribute to the low level of students' literacy (Edo et al., 2013; Mahdiansyah & Rahmawati, 2014). According to Mahdiansyah and Rahmawati (2014), the PISA test uses various foreign contexts that are not familiar to students in remote areas, such as skateboards, maglev trains, or the telephone system in hotels and electronic cards. The context in the assessment of ML is important because it helps students to remember what they have learned, relate them to problems, and offer an appropriate solution. Also, context is important in learning and assessing mathematics because students are prepared to meet future challenges, hence, they need to be introduced to various contexts that can be applied every day (Freudenthal, 1968; Gravemeijer., 1994; De Corte, E., Greer, B., & Verschaffel, 1996; Stacey, 2011). Therefore, the use of context in classroom learning should use topics that are familiar to students (St. Clair, (2018).

Another cause is the lack of using problems that have characters such as PISA questions in the learning process (Wardhani & Rumiati, 2011). Consequently, the students are less trained in working on contextual questions and require high-level thinking (Budiman & Jailani, 2014). This has an impact on their ML skill that does not increase significantly. Therefore, the mathematics learning process needs to accommodate and develop the skill tested on the PISA test.

The government issued several policies and programs to develop and improve students' mathematical literacy skills in Indonesia. Regulation of the Minister of National Education Number 22 of 2006 states that the purpose of mathematics subjects is to empower students to understand, reason critically, solve problems, communicate, and have a positive attitude towards mathematics. This means ML skill needs to be continuously developed through learning. Also, in 2017, the government revised the 2013 curriculum with several points of improvement, including (1) integrating Strengthening Character Education (PPK) in learning, (2) integrating

literacy skill, (3) developing 21st-century skills or the term 4C, consisting of Creative, Critical thinking, Communicative, and Collaborative, and (4) integrating higher-order thinking skill (Kemendikbud, 2017).

From the various government policies and programs mentioned above, it is necessary to evaluate the results and effectiveness of their implementation, especially in the development of students' ML skills in Indonesia. Furthermore, the results of the PISA research can be used as a measuring tool for literacy skills. One of the values that can be integrated with learning is Islamic values (Asianti, 2003; Nugroho, 2013). This provides an opportunity for students to be more motivated related to Islamic behavior or deeds that are usually carried out in daily life and increase their belief in the Islamic religion. Bishop et al., (2000) stated that cultural values affect mathematics learning. Therefore, different cultures will lead to different values developed in learning, especially mathematics. In addition to the learning process, this Islamic context can also be integrated into a test instrument, including in designing the PISA model questions. Lutfianto and Sari (2017) stated that the design of PISA questions can be developed by integrating Islamic values into the context.

Based on several rationalizations accompanied by the data and facts above, it is necessary to study the analysis of students' mathematical literacy skills in solving PISA design questions with an Islamic context as an effort to map the ML skill of Madrasah students in Indonesia. Based on the background of the problem described, several problems are formulated as follows: (1) how is the Mathematical Literacy skill of madrasah students in Indonesia as a whole, (2) how is the Mathematical Literacy skill of madrasah students in Indonesia based on each level (MI, MTs, and MA), (3) The students' difficulties in solving problems related to Mathematical Literacy skills.

## Mathematical Literacy

Literacy is often associated with letters, which means the ability to read and write. According to the UNESCO declaration (2003), it is the ability to identify, determine, find, evaluate, effectively create and organize, use, as well as communicate information to solve various problems. Isnaini (2010) stated that ML is the skill of students to understand facts, principles, and operations, as well as solve mathematical problems. This is in line with Kusumah (2012) who defined ML as the ability to compose a series of questions (problem-posing) to formulate, solve, and interpret problems based on context.

Based on this definition, ML is defined as an individual's skill to formulate, use, and interpret mathematics in various contexts which include reasoning and the use of mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena. This helps to recognize the role of mathematics in life and to make good judgments and decisions that are needed by a constructive and reflective population. The various understandings above emphasize that ML skill is not only concerned with mastering the material, but also pays attention to the mastery of the use of reasoning, concepts, facts, and tools in solving everyday problems. It also requires the ability to communicate and explain phenomena through mathematical concepts.

According to Thomson (2013), PISA has a framework that is based on (1) the content of mathematics, (2) the process that students need to do when observing a symptom, connecting the symptom to mathematics, then solving the problem they observe, and (3) situation and context.

Furthermore, the components of mathematical literacy are explained as follows: 1) Content of mathematics, defined as material or objects of mathematics lessons learned at school, include space and shape, change and relationship, quantity, and data uncertainty; 3) Mathematical process components, as stated by the ML assessment framework in PISA, involve (1) communication; (2) mathematizing; (3) representation; (4) reasoning and arguments; (5) devising strategies for solving; (6) using symbolic, formal, technical language, operation; and (7) using mathematics (OECD, 2010); 4) Situation or context. In context aspect, mathematical literacy is measured in personal, societal, occupational, and scientific contexts (OECD, 2013)

In designing PISA questions, especially about mathematical literacy skills, it can be developed by integrating the Islamic context. The objectives of integrating the Islamic context into mathematical literacy questions for Madrasah students are to (1) adapt to the situation and condition of students who receive Islamic materials every day at school; (2) indirectly make students learn Islam through ML questions; (3) increase their belief in Islam through a mathematical approach; and (4) eliminating the paradigm that mathematics is a general science far from religion.

The Islamic context that is integrated into mathematical literacy questions is related to the verses of the Qur'an, Al-Hadith, Sirah Nabawiyah, and events in everyday life. The following describes the relationship of context according to PISA with the Islamic context in terms of mathematical literacy in figure 1.
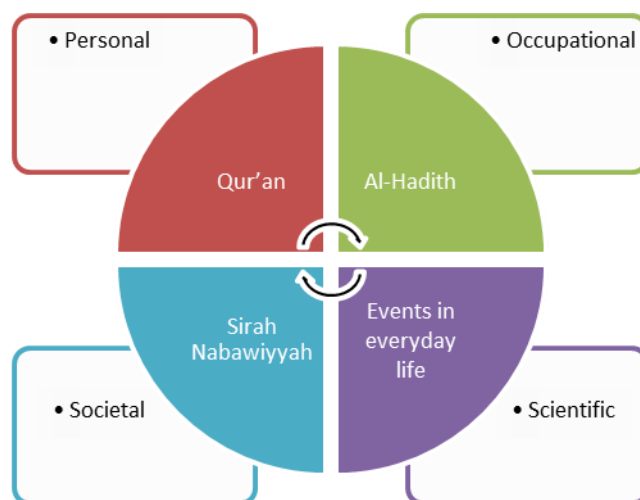


Figure 1.  Relationship of Context according to PISA with Islamic Context

From the explanation above, teachers need to adjust the mathematics learning process in dealing with students' difficulties in solving ML problems, especially in the Islamic context. This is important because almost all students learn mathematical concepts, completely depending on the experience when the teacher teaches in the classroom. Therefore, teachers should understand the concepts, as well as student and master learning strategies that are in accordance with student characteristics (Fery et al., 2017).

## Method

This study used a qualitative descriptive method to reveal the occurrence of symptoms that emerged from the subject and to determine the student's skill in solving ML questions in terms of the components of the Islamic context and the level of PISA assessment. This was used to formulate students' thinking processes in solving mathematical literacy problems in Islamic contexts. Data collection was carried out in the following stages: 1) The pre-field stage involved compiling a study design that include questions of students' mathematical literacy skills with PISA. This was developed by adopting and modifying the PISA model questions that are integrated with the Islamic context. This test was used to determine the ML skill of Madrasah students (MI, MTs, and MA) in Indonesia; 2) The fieldwork stage was by placing a research team member as an active participant, an assessor, and an analyzer of students' ML skills through a given test; 3) The multi-stage stratified random sampling technique was used, where only 16 provinces were selected from 34. Several cities from each province were then selected with several Madrasah schools at each level. The school selection was based on 3 types of strata (stratified), namely (a) type of education unit, (b) school status (public and private), and (c) quality (good, moderate, or poor). These strata were made implicitly and proportionally reflect the composition of strata in the population of Madrasah students throughout Indonesia. Furthermore, from each school that was selected as a sample, the students were selected as a sample class (multi-stages) totalling 3,285.

## Results and Discussion

The first step of this study was to make a test instrument of ML skill for each level in the form of a description. The instrument validity test was carried out by experts, both in terms of content and context. After the test results were obtained, then an assessment was carried out based on the rubric that has been made. Furthermore, the results were descriptively analyzed to obtain information on the mapping of mathematical literacy skills of students in Indonesia. Data on the test results of students' ML skills based on the level of the madrasah which completes the average score of their literacy skill can be seen in Table 1.

Table 1.  Average Score of Students' Mathematical Literacy Skills

| No | Madrasah Level | Average Score | Percentage |
|----|----------------|---------------|------------|
| 1 | Madrasah Ibtidaiyah (MI) | 1,92 | 6.39 |
| 2 | Madrasah Tsanawiyah (MTs) | 6,00 | 20.01 |
| 3 | Madrasah Aliyah (MA) | 7,59 | 25.29 |

Table 1 shows the average score of ML skill for Madrasah Ibtidaiyah (MI) students was 1.92, Madrasah Tsanawiyah (MTs) was 6.00, and for Madrasah Aliyah (MA) was 7.59. This means the highest average scores are students of Madrasah Aliyah (MA) followed by Madrasah Tsanawiyah (MTs) and Madrasah Ibtidaiyah (MI). The results of students' ML skill scores in general based on the madrasah level are presented in the following figure 2.
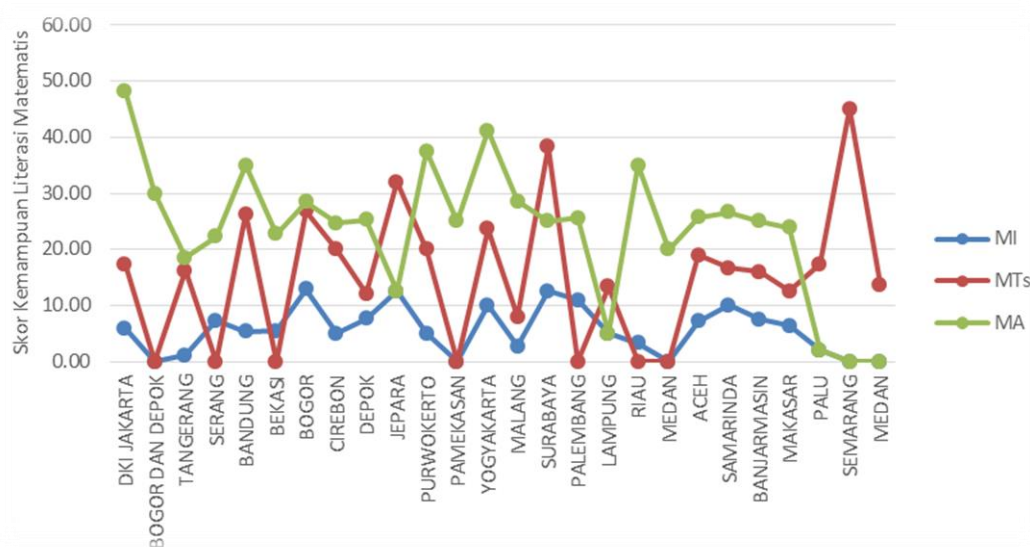
Figure 2. Graph of Mathematical Literacy Skill of Madrasah Students by Region

Figure 2 shows that at the Madrasah Ibtidaiyah (MI) level, the area with the highest average score was Bogor, while the lowest was Medan and Depok. At the Madrasah Tsanawiyah (MTs) level, the highest average score was Semarang while the lowest were Depok, Serang, Bekasi, Pamekasan, Riau, and Medan. Furthermore, at the Madrasah Aliyah (MA) level, the highest average score was Jakarta and the lowest was Semarang and Medan.

The analysis showed the ML skill of madrasah students in Indonesia has an average of 17.23%, with MI having 6.39%, MTs with 20.01%, and MA with 25.29%. Based on the distribution of the area, it can be seen that the average of the highest Mathematical Literacy (ML) skill of MI students is in the Bogor area which gets an average having 12.86.00%, followed by the Jepara and Surabaya areas with 12 .50%, Palembang area with 11.00%, Samarinda and Yogyakarta with 10.00%, while the lowest average score percentage is Semarang area which only reaches an average having 0,00%. Meanwhile, the highest average Mathematical Literacy (ML) skill score of MTs students was in the Semarang area having 45.00%, followed by Surabaya and Jepara areas with 38.33% and 32.00%, the Bogor area and the combined Jakarta with 26.84% and 26.32%, while the lowest percentage of the average score was North Jakarta which only reached an average having 6.67%. Meanwhile, the average score of the highest Mathematical Literacy (ML) skill of MA students was in the Jakarta area having 48.24% followed by the Yogyakarta area with 41.11%, the Purwokerto area with 37.50%, the Bandung and Riau regions obtained the same average with 35.00%, Bogor and Depok areas with 30.00%, while the lowest average score percentage was Palu region which only achieved an average having 2.00%.

From the questions given to MI students, the causes of low ML skill include students not understanding the context of the questions, so students are confused about what they know and ask about. Context is important in learning and assessing mathematics because students are prepared to meet future challenges, hence, they need to be introduced to various contexts that can be applied in everyday life (Stacey, 2011; St Clair, 2018).

As a result, students cannot solve the problem because they cannot relate what concepts are related to the problem. They don't know what concept to solve the problem using. In addition, there are many mistakes in using the concept of equations, and inequalities with arithmetic operations of addition, subtraction, multiplication, and division. For example, Students can only re-copy the pictures in the questions presented. The error lies not only in the arithmetic operations they perform, the lack of accuracy/carelessness in calculating. In addition, students are not accustomed to re-checking the solutions that have been made. students are confused, as a result of solving the problem there is an error in the concept used, so the results obtained are not in accordance with what was asked in the question. Another error occurred in the concept of the unit area, many of the students did not understand the concept of the unit why it should be $cm^2$ or $m^2$.

The low ML skill of MTs students when viewed from the results of students' answers is because most students have difficulty understanding the context of the given problem. This is in accordance with the opinion (Stacey, 2011; St. Clair, 2018). This can be seen from the inability of students to write down what is known and asked in the question. In addition, they are confused in finding a concept or formulating a solution to a given problem. This happens because students lack insight into the context of the given problem, for example, the context of the Hilal. Even at the Madrasah Tsanawiyah level, learning about the Hilal is almost never practiced so that students find it difficult to understand the context. In addition, many students cannot make algebraic models from the context of the given problem and lack accuracy in performing calculations. Students also experience errors in making pictures or visualizations of the given problem. Students only draw the problem situation in the form of pictures without knowing how to formulate the solution. They are also not used to checking the answers that have been made.

For MA students, it can be seen that students have understood this problem quite well, but there are difficulties in determining the solution strategy so that students only guess the method used to answer the question. For example: when students use the factorial concept but the numbers used are unfounded, resulting in incorrect answers. Even though the way to answer this question is quite simple, like the answer of Ali bin Abi Talib in a hadith that a number that is divisible by 1 - 10 is the number of times the number of days in a month, the number of months in a year and the number of days in a week or 30 x 12 x 7 = 2520. Students are also able to make appropriate conclusions but are not accompanied by appropriate arguments. For example: when students identify that the time in South Africa and New Zealand is 11 hours apart. There is no explanation for the time difference with Greenwich. The expected answer is that solar eclipses cannot occur in South Africa and New Zealand at the same time because their timings are opposite. With the argument that the solar eclipse occurs in South Africa at 12.00, so in Greenwich = 12 − 2 = 10.00, then in New Zealand = 10 + 13 = 23.00.

The low ML skill is due to the less able to interpret or translate the context of the problem and the lack of students' vocabulary. This is in accordance with (Edo et al., 2013; Mahdiansyah & Rahmawati, 2014; Miftah, Herman, and Kurniawati,2021), and the Islamic insight of Madrasah Ibtidaiyah students is still limited. Also, Madrasah Tsanawiyah students are still lacking in insight into Islam and the ability to interpret context. Therefore, it is difficult to solve problems that measure ML skills. This is different from Madrasah Aliyah students who have received enough learning material about Islamic insights related to the Qur'an, Al-Hadits, Shirah

Nabawiyyah, and those related to daily events. Hence, the results are relatively better compared to others. However, the skill of madrasa students, both MI, MTs, and MA is still very low. This is because most of the students do not understand the context of the question.

The results of the general analysis of both Madrasah Ibtidaiyah (MI), Madrasah Tsanawiyah (MTs), and Madrasah Aliyah (MA) students showed that MA students' ML skill was better than MTs and MI. The following is an example of student answers on mathematical literacy skills.

## Problems Example

To determine the beginning of the month of Ramadan this year, the Ministry of Religion observes the moon (*hilal*) at sunset at the end of Sha'ban month using binoculars mounted at an angle as shown in the following Figure 3. When the height of the new moon (x) is more than or equal to $2°$, it can be ascertained that it is already the 1st of Ramadan. Take a look at the illustration to answer the questions.
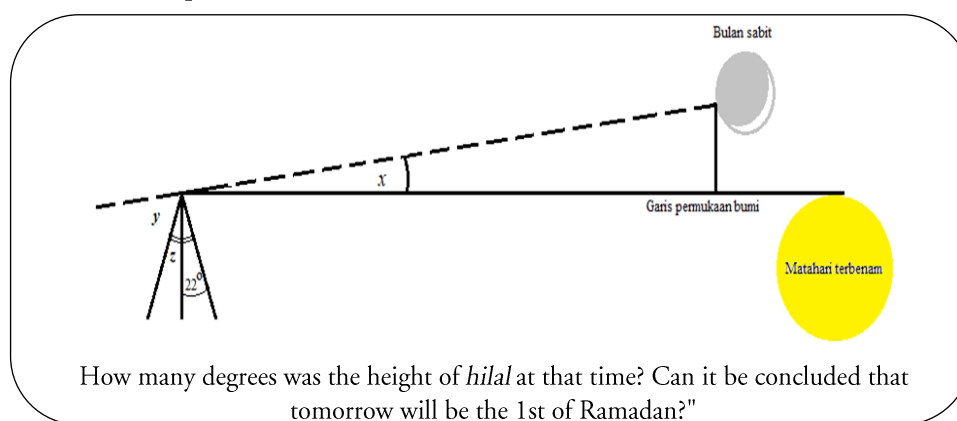


Figure 3. The Moon (*Hilal*)

From these questions, students were asked to understand the context of the new moon for determining the beginning of the month of Ramadan. Furthermore, they were asked to solve using the concept of angles. Unfortunately, most of the students could not solve the problem.

Based on the results obtained from student answers, shows most students have difficulty understanding the context. This can be seen from their inability to write down what is known and asked in the question. Also, they were confused in finding concepts or formulating solutions. This is due to the lack of insight about Hilal as the determination of the beginning of the month of Ramadan. Even for the Madrasah Tsanawiyah level, this topic is seldom practiced making it difficult to understand the context.

Based on the research findings that the overall mathematical literacy ability, based on the level of madrasah, and region is in a low category. By looking at the results obtained, it is necessary to make an effort to improve mathematical literacy skills, one of which is by designing learning that can develop mathematical literacy skills. Some examples of learning that can improve students' mathematical literacy skills and have been tested include learning that is based on constructivism, including problem-based learning, project-based learning, problem-solving, and challenge-based learning. This is in accordance with (Nichol M, at al, 2016; Kurniawati, Mardhiyah, and Miftah, 2019; Miftah, Herman, and Kurniawati, 2021)

## Conclusion

Based on the results of data analysis, findings, and discussions described in the previous chapter, the following conclusions were obtained: (1) the mathematical literacy skills of madrasah students in Indonesia are still in the low category. This can be seen from the average percentage score of students' overall ML skills of 17.23%, (2) the average percentage score of mathematical literacy skills at Madrasah Ibtidaiyah/MI was 6.39%, Madrasah Tsanawiyah (MTs) was 20.01%, and Madrasah Aliyah/MA was 25.29%, and (3) one of the causes of the low ML skill of students is that they have difficulty understanding the context of the problem. The context in the assessment of ML is important because it helps students to remember what they have learned, relate them to the problem, and offer an appropriate solution.

The mathematical literacy skill of madrasah students in Indonesia is still in the low category both overall, by region, and by madrasah level. So that, understanding the context is the most difficult problem experienced by madrasah students in Indonesia, so there is a need for learning efforts that present more questions in the form of problem contexts, especially Islamic contexts. It is necessary to study designed so that students can carry out mathematical activities and construct their own understanding with the guidance and direction of the teacher. The learning in question is constructivism-based learning, including problem based learning, project based learning, problem solving, challenge based learning, and realistic. Therefore, in learning mathematics at madrasah/schools, teachers are suggested to use methods that develop mathematical literacy skills designed to explore all students' potential, perform mathematical activities, and develop their understanding. Teaching materials that can facilitate students in developing ML skills are needed. This study is limited to examining ML skills measured with the PISA design using an Islamic context, it is recommended that further studies explore the aspects of errors in solving Mathematical Literacy skills specifically based on Nolthing or Newman theory.

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