The Ability of Mathematical Literacy in Elementary School Students Based on Cognitive Style

Sutama[1]([✉]), Sofyan Anif[1], Harsono[1], Harun Joko Prayitno[1], Diana Purwita Sari[1], Mazlini Adnan[2], and Hesti[3]

[1] Faculty of Education, Universitas Muhammadiyah Surakarta, Surakarta, Indonesia
{sutama,sofyan_anif,Harun.Prayitno}@ums.ac.id
[2] Faculty of Education, Universiti Pendidikan Sultan Idris, Perak, Malaysia
mazlini@fsmt.upsi.edu.my
[3] Faculty of Education, Universitas Muhammadiyah Lampung, Lampung, Indonesia
hestipbi@uml.ac.id

Abstract. Literacy is an important skill in the 21st Century. The research aims to describe the ability of elementary school students with field dependent and field independent cognitive style in Mathematical literacy. Type of this research was qualitative research. The research subject was student of SDIT Ar-Risalah Kartasura in academic year 2022/2023. The research instruments were a questionnaire of cognitive style and a problem-solving task on Mathematical literacy. Data analyses were done through data collection, data reduction, data presentation, and drawing conclusion. 1) Students with field independent cognitive style require a long time to solve the problems, the results tend to be accurate, and they are always careful when solve the problem. The students were able to: working on the questions sequentially, can solve the problems by applying simple strategies, and can explain the reasons for the answers given during the mathematical literacy test. 2) Students with field dependent cognitive style need a short time to solve problems. Students were in a hurry to solve problems and the answer was wrong. Students give inaccurate answers. Students answer questions with known contexts, they can identify parts of objects, and they are able to show actions according to the given stimulation.

Keywords: Mathematical literacy · elementary school · cognitive style

1 Introduction

Regulation of the Minister of Education and Culture Number 23 of 2015 seeks to foster student ethics through a series of activities that must be carried out by students, teachers, and education staff that aim to cultivate good habits and form a generation of positive character, or what is called habituation activities. Familiarizing and motivating students to read and write to cultivate ethics is one of the goals of developing the "School Literacy

Movement". This movement is expected in the long term to produce a generation with high literacy skills.

Khairi et al. [3] explains that good practices in the school literacy movement emphasize principles including; a literacy program integrated with the habituation curriculum and literacy learning in schools which is the responsibility of all teachers in all subjects. In learning activities in any subject, reading and writing skills are needed. Therefore, student literacy needs to be taught in all subjects, including mathematics. Maslihah et al. [4] argues that literacy is crucial in current educational projects. One of the literacies applied in elementary schools is mathematical literacy. In the mathematics learning process, literacy skills are one of the abilities that students must have. Mathematical literacy has an essential role in helping students solve problems related to the application of mathematics in everyday life [7].

Although the development of students' mathematical literacy skills is vital to develop, in reality, students' ability to solve various problems in everyday life is still low. Facts on the ground state that the achievement of Mathematics literacy in Indonesia is still relatively low. This is regarding academic quality between nations through Program for International Student Assessment (PISA) in Mathematics; in 2003. Indonesian students were ranked 39th out of 40 countries. In 2006 Indonesia was ranked 38th out of 41 countries. In 2009 Indonesia was ranked 61st out of 65 countries, then in 2015, Indonesia was ranked 62nd out of 70 countries. Furthermore, in 2018 Indonesia's ranking decreased. This is evidenced by the results of tests conducted by two international studies, namely Trends in International Mathematics and Science Study (TIMSS) and PISA. The results of the PISA study released on Tuesday, December 3rd, 2019, stated that the PISA ranking for the Mathematics category in 2018 has decreased. Indonesia is ranked 7th from the bottom, 73 out of 79 countries, with an average score of 379.

Based on this data, the literacy ability of Indonesian students has not experienced a significant increase from 2003 to 2018 because it has increased and decreased so it is still relatively low. This shows that Indonesian students' ability to solve study questions, give reasons, communicate, and solve and interpret various problems is still shallow. This is a common correction that Mathematics problems in PISA studies measure more the ability to reason and solve problems, and argue that measuring memory and calculation skills [2]. Bloom, in his theory, divides the level of human thinking into 6 levels which include remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6) as well as the questions presented in PISA require students to think at the C4-C6 level or what is called higher order thinking skills [5].

Based on the results of researchers' interviews with teachers at SDIT Ar-Risalah Kartasura, information was obtained that students in the class have different ways of solving problems according to their abilities, especially for Mathematics problems that demand high reasoning skills. Researchers made observations to determine how students' abilities can solve HOTS-type problems. The observation results show that no student has been able to complete the C4-C6 level questions. The observation results also showed that 75% of 36 completed C1-C2 questions, and 25% of students could solve C3 questions. Thus, most students have not been able to work on story questions requiring student reasoning. Students have not been able to select, compare, and evaluate precisely the problem-solving strategies related to what is required of the problem.

Thus, it can be concluded that the results of interviews and observations conducted by researchers show that the mathematical literacy ability of grade VI students of SDIT Ar-Risalah Kartasura is still relatively low. Students can only solve C1-C3 or low order thinking skill questions where the questions are problems with a context that is quite well known to students and requires simple mathematical operations. Naturally, students' ability to solve Mathematics problems varies, both in how they approach learning situations and how to receive and organize and connect their experiences. Saxena and Jain [8] suggests that the difference in individuals solving problems is due to differences in the psychology of each individual, one of which is the cognitive style aspect.

Sholahuddin et al. [9] explains that cognitive style is a characteristic of individuals in using cognitive functions (thinking, remembering, solving problems, and so on) that are consistent and long. Warli and Fadiana [12] suggests that students with different cognitive styles will have different approaches or information processing and solve Mathematical problems differently. Therefore, students with different cognitive styles may also have different abilities in solving Mathematical literacy problems. This is also in line with the opinion of Rahayuningsih et al. [6], who explained that students with different cognitive styles would solve problems differently, so that differences in cognitive styles will trigger differences in students' abilities to solve Mathematics problems related to daily life.

Cognitive styles are divided into several kinds, but in this study, they are limited to cognitive styles *Field Dependent* (FD) and *Field Independent* (FI). FD cognitive style is a characteristic of a person who tends to depend on the environment and is also easily influenced by his environment [10]. In contrast, the FI cognitive style is the character of a person who tends to be able to analyze a problem himself [10]. The environment does not easily influence individuals with FI cognitive style. Based on the description, researchers aim to describe the ability of mathematical literacy in elementary school students based on cognitive style.

2   Research Methods

This research used qualitative research. Qualitative research emphasizes on meaning that is closely related to specific values, more emphasis on process rather than measurement, describes, interprets, and gives a meaning that is not sufficient by little explanation because it utilizes multiple methods in research [11]. The research was conducted at SDIT Ar-Risalah Kartasura for academic year 2022/2023. The selection of research subjects was based on purposive sampling using snowball sampling. First of all, the researchers selected six students including 3 students with Field Dependent cognitive styles and three students with Field Independent cognitive styles. Subject selection can be developed according to the research. The categories of Field Dependent and Field Independent cognitive style with the indicator used namely Group Embedded Figure Test (GEFT). Data analyses were done through data collection, data reduction, data presentation, and drawing conclusion. The instruments of Mathematical literacy can be seen as follow.

A. *Mathematical Literacy Problem Solving Test Level 1*

The image beside is the eraser that Aqila has. Do you know how to calculate the volume of the eraser?

B. *Mathematical Literacy Problem Solving Test Level 2*

Dina has a pencil spot in the shape of a beam. The pencil case stores various stationery such as pens, pencils, erasers, and correction pens. If the pencil case has a length of 20 cm, a width of 8 cm, and a height of 10 cm, then determine the volume of the pencil case!

III. *Mathematical Literacy Problem Solving Test Level 3*

Andri has a lunch box with a cube shape. The lunch box has a length of 15 cm, a height of 6 cm, and a volume of 990 cm^3. Determine the width of Andri's lunch box!

IV. *Mathematical Literacy Problem Solving Test Level 4*

Intan has 50 cm x 50 cm carton paper. The paper will be used to make a tube with a radius of 7 cm and a height of 15 cm. Determine the remaining area of unused carton paper! Can the rest of the carton be used again to make tubes of the same size? Explain!

E. *Mathematical Literacy Problem Solving Test Level 5*

A cider drink seller has a product with packaging sized as in the image above. The product is made in new packaging in the form of a tube with a radius 5 cm. What is the height of the new packaging?

F. *Mathematical Literacy Problem Solving Test Level 6*
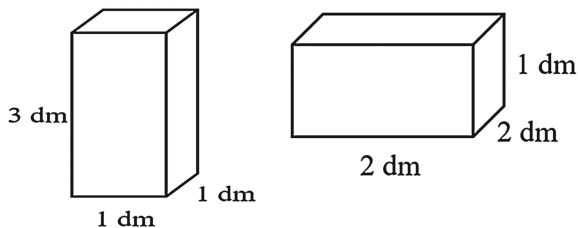
Uncle gives a challenge to Bagus. Without a measuring tool, Bagus must fill a bucket with 5 L of water. The aids provided are only two containers in the form of cuboids with the size shown on the side.

How does Bagus fill the bucket with both containers provided by his Uncle? Explain!

3   Research Results

A. *Subjects with Field Dependent Cognitive Style*

Subjects with field dependent cognitive style utilize 70 min of 90 min of work time to complete the mathematical literacy test. FD subjects can work on two of the six questions, meaning that FD subjects can complete mathematical literacy tests at levels C1 and C2. The two questions that FD can do are presented as follows.

In the question that measures mathematical literacy ability level 1, students are given a question, whose context is familiar and recognized by students, namely the eraser image in the form of a cube. The student is expected to determine the eraser volume formula after observing the presented eraser image. The results of the subject's work on level 1 questions are shown in Fig. 1.

Based on Fig. 1, it can be seen that the student can work on the question at level 1 correctly. FD subjects can write the eraser volume formula well, accompanied by an image and the meaning of each symbol. This shows that the subject can answer the question with the known context in the form of a cube and can identify the image which is the length, width, and height made through the eraser-like image.

In questions that measure level 2 Mathematics literacy skills, students are presented with routine questions that students easily recognize because they are used in everyday life. In the question, single information is presented in the form of the pencil case's length, width, and height. Students are expected to be able to determine the volume of the pencil case after reading the information obtained from the question. The results of the subject's work on level 2 questions are shown in Fig. 2.
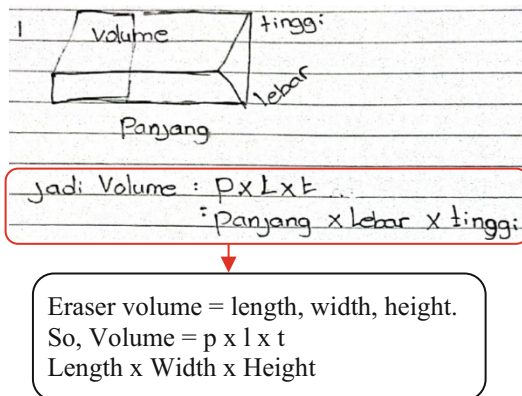
Fig. 1. FD Subject Work Result on level 1 questions

Fig. 2. FD Subject Work Result on level 2 questions

Figure 2 shows that the subject can complete level 2 questions correctly. FD subjects can write relevant information from the question, starting from how long the pencil case is, the width of the pencil case, the height of the pencil case, and what the problem is. After knowing the problem, the subject uses the basic formula, namely the cuboid volume formula to solve the problem of the question and present it singly until the final result is 1.600 cm^3.

On the other hand, there is one question that cannot be done well by FD Subjects, namely question number four which measures literacy ability level 4. In contrast, for questions number three, five, and six that measure literacy ability levels 3, 5, and 6, he cannot do it properly and only answer. This shows that FD subjects cannot solve questions at the HOTS level.

B. *Subjects with Field Independent Cognitive Style*

Subjects with field independent cognitive style utilize 90 min of work time to complete the mathematical literacy test. FI subjects can work on four of the six questions, meaning that FI subjects can complete mathematical literacy tests at levels C1, C2, C3, and C4. The two questions that FI can do are presented as follows.

In the question that measures mathematical literacy ability level 1, students are given a question, whose context is familiar and recognized by students, namely the eraser image in the form of a cube. The student is expected to determine the eraser volume formula after observing the presented eraser image. The results of the subject's work on level 1 questions are shown in Fig. 3.

Based on Fig. 3, it can be seen that the student can work on the question at level 1 correctly. Students can answer the cuboid volume formula accompanied by a cuboid image. This shows that the FI subject can answer the question with a known context, namely the image of the eraser in the form of a cuboid. In addition, the student draws a cuboid whose bottom describes each symbol from the cuboid volume formula to clarify the answer.
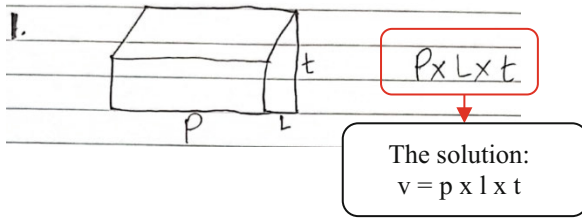
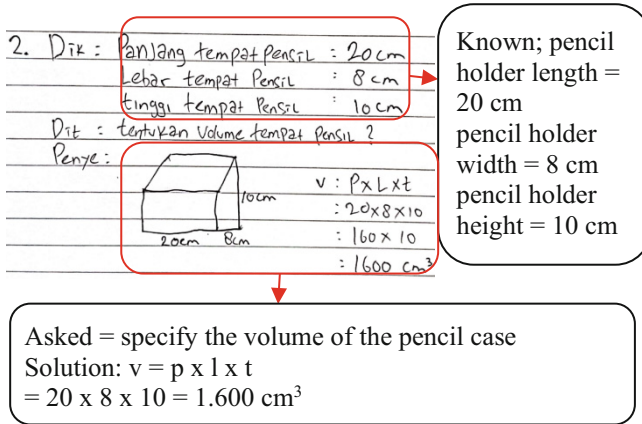**Fig. 3.** FI Subject Work Result on level 1 questions

Fig. 4. FI Subject Work Result on level 2 questions

In questions that measure level 2 Mathematics literacy skills, students are presented with routine questions that students easily recognize because they are used in everyday life. In the question, single information is presented in the form of the pencil case's length, width, and height. Students are expected to be able to determine the volume of the pencil case after reading the information obtained from the question. The results of the subject's work on level 2 questions are shown in Fig. 4.

Based on Fig. 4, it can be seen that the student can work on the question at level 2 correctly. FI subjects can provide complete answers starting from what is known from the problem, what to look for, to how to solve the problem. The FI subject can also interpret and choose important information relevant to the problem so that he can immediately conclude that the formula used to solve the problem is a cuboid volume formula written following the procedure or steps of structured work. In addition, the FI Subject always includes an image when working on a problem. However, in question number 2, the image points more to the cube image instead of the cuboid.

Fig. 5. FI Subject Work Result on level 3 questions

On the level 3 math literacy problem-solving test, the subject is expected to be able to apply a simple strategy to be able to determine the width of Andri's lunchbox and work on it with clear procedures and steps. The results of the subject's work on level 3 questions are shown in Fig. 5.

Based on Fig. 5, it can be seen that the student can work on the question at level 3 correctly. FI subjects can provide complete answers starting from what is known from the problem, what to look for, to how to solve the problem. The subject of FI can solve the problem in the question by using a simple formula strategy, namely, the inverted cuboid volume formula. In addition, FI Subjects can provide answers with clear work procedures and are done in sequence. FI subjects can also interpret and use their views related to the information obtained from the problem to solve the question.

On the level 4 math literacy problem-solving test, students are expected to be able to separate concepts into several components and connect each other to understand the concept in its entirety. The results of the subject's work on level 4 questions are shown in Fig. 6.

Figure 6 shows that the subject can complete level 4 questions correctly. The subject can use the troubleshooting procedure appropriately. At the end of the settlement, FI subjects can also give reasons appropriately related to the problems at level 4.

On the other hand, two questions cannot be answered by FI subjects, namely questions five and six which measure literacy skills levels 5 and 6. This shows that FI subjects can complete HOTS questions at level 4 or the ability to evaluate.

Fig. 6. FI Subject Work Result on level 4 questions

4   Discussion

Based on the study's results, the time FD and FI Subjects needed to complete the mathematical literacy problem-solving test is different. Subject FD takes 70 min and Subject FI takes 90 min. This shows that FI Subjects take a long time to complete the math literacy problem-solving test compared to FD Subjects.

The results show that FD subjects can work on two of the six questions, meaning that FD subjects can complete mathematical literacy tests at levels C1 and C2. FI subjects can work on four of the six questions, meaning that FI subjects can complete mathematical literacy tests at levels C1, C2, C3, and C4. Based on these results, it can be seen that the mathematical literacy level of students with the cognitive style of Field independence is better than those with the cognitive style of Field Dependent. This is in line with what Silma et al. [10] stated, which states that the way of thinking of FI students is higher in solving mathematical problems compared to FD students. This is also in line with [12] which states that FI students understand the problem better than FD students.

The subjects with field independent cognitive style can work on level remembering, understanding, applying, and analyzing. The results of data analysis show that FI students can use their reasoning well in solving complex problems. FI students can connect complex assumptions to determine the strategy used, which requires good reasoning to solve a problem correctly. This is in line with Izzatin et al. [1] which states that FI students are more analytical in receiving and processing information and can expand the results of problem-solving and mathematical thinking. The strategies used are also appropriate and varied in solving a problem. This is in line with the opinion of Witkin [13] who said that FI students prioritize motivation in themselves in solving problems. This is also in line with Warli and Fadiana [12] who states that FI students tend to think analytically and can choose the right stimulus or way to solve problems based on the given situation.

The subjects with field dependent cognitive style can work on level remembering, and understanding. The way of FD subject interprets the meaning of the problem and how to solve it is good. They can interpret the information used to determine strategies for solving problems. However, in FD, if the student is faced with a problem involving several complex assumptions, they find it difficult to connect the assumptions to solve the problem. FD tries to work on HOTS questions at the level of analyzing, evaluating, and creating but the strategy used is still not appropriate. This is in line with the opinion of Witkin [13], who states that FD tends to find it difficult to separate information received from things in the surrounding context and are not selective in absorbing information.

Furthermore, Silma et al. [10] also mentions that FD, tends to think globally so that their perceptions are easily affected by environmental changes, are easily confused, lack focus on working on questions, and often rely on teachers to complete mathematical literacy skills tests. This is indicated by the lack of analytical skills in working on mathematical literacy problem-solving tests on HOTS category questions. This is because student has not been able to determine strategies for solving HOTS questions.

There are some categories of individual cognitive style. Focus on this research was.

5   Conclusion

Students with field independent cognitive style require a long time to solve the problems, the results tend to be accurate, and they are always careful when solving the problem. The students were able to: working on the questions sequentially, can solve the problems by applying simple strategies, and can explaining the reasons for the answers given during the mathematical literacy test.

Students with field dependent cognitive style need a short time to solve problems. Students were in a hurry to solve problems and the answer was wrong. Students give inaccurate answers. Students answer questions with known contexts, they can identify parts of objects, and they are able to show actions according to the given stimulation.

There are some categories of individual cognitive style. Focus on this research aims to describe the ability of elementary school students with field dependent and field independent cognitive style in Mathematical literacy. How about the ability of the other characteristics of cognitive style in Mathematical literacy?

References

1. M. Izzatin, S. B Waluyo, Rochmad, and Wardono, "Students' cognitive style in mathematical thinking process," Journal of Physics: Conf. Series, vol 1613, pp. 1-4, 2020.
2. Kemendikbud, Peringkat dan Capaian PISA in https://www.kemdikbud.go.id, 2016.
3. A. Khairi, R. N. Sasongko, and M. Kristiawan, "Literacy of lower classes students primary school in the 2013 curriculum during the pandemic covid-19," Linguistic, English Education and Art, vol 4, pp. 375-386, 2021.
4. S. Maslihah, S. B. Waluya, and A. Suyitno, "The role of mathematical literacy to improve high order thinking skills," Journal of Physics: Conf. Series, vol 1539, pp. 1-6, 2020.
5. T. S. Mislia, S. Indartono, and V. Mallisa, "Improving critical thinking among junior high school students through assassment of higher-level thinking skills," Advances in Social Science, Education and Humanities Research, vol 323, pp 326-333, 2019.
6. S. Rahayuningsih, Sirajuddin, and Nasrun, "Cognitive flexibility: exploring students' problem-solving in elementary school mathematics learning," Journal of Research and Advances in Mathematics Education, vol 6, pp 59-70, 2021.
7. L. M. Rizki, and Priatna, "Mathematical literacy as the 21st century skill," Journal of Physics: Conf. Series, vol 1157, pp 1–5, 2019.
8. S. Saxena, and R. K. Jain, "Impact of cognitive style on problem solving ability among undergraduates," International Journal of Academic Research in Psychology, vol 1, pp 6-10, 2014.
9. A. Sholahuddin, E. Susilowati, B. K. Prahani, and Erman, "Using a cognitive style-based learning strategy to improve students' environmental knowledge and scientific literacy," International Journal of Instruction, vol 14, pp 791–808, 2021.
10. U. Silma, I. Sujadi, and F. Nuhasanah, "Analysis of students' cognitive style in learning mathematics from three different frameworks," The 2nd International Conference on Science, Mathematics, Environment, and Education (AIP Publishing), vol 1, pp 1–8, 2019.
11. Sutama, Metode Penelitian Pendidikan Kuantitatif, Kualitatif, PTK, R&D, Surakarta: Fairus Media, 2015.
12. Warli, and M. Fadiana, "Math learning model that accommodates cognitive style to bulid problem-solving skills," Higher Education Studies, vol 5, pp 86–98, 2015.
13. A. H. Witkin, Group Embedded Figure Test, California: Mind Garden, 1971.