ISSN 2355-4185(p), 2548-8546(e)
DOI: 10.24815/jdm.v8i2.21644

Mathematical Literacy Based on Ethnomathematics of *Batik Sidoarjo*

Janet Trineke Manoy[1*], Mayang Purbaningrum[2]

[1,2]Mathematics Education Department, Universitas Negeri Surabaya, Indonesia
*Email: *janetmanoy@unesa.ac.id*

Received: 9 July 2021 ; Revised: 12 July 2021 ; Accepted: 23 August 2021

Abstract. *Mathematical literacy is defined as one's ability to formulate, apply, and interpret mathematics in the real world. Ethnomathematics is a daily mathematical representation or mathematics associated with cultures used to motivate students to learn. This qualitative descriptive aims to describe the mathematical literacy of Year 10 students of Senior High School 1 Sidoarjo in solving ethnomathematics problems related to batik Sidoarjo. Five students were selected using a purposive sampling technique. Data were collected through a mathematical literacy test and interview. The test and interview results were analyzed utilizing a triangulation method proposed by Miles, Huberman, and Saldana. The findings revealed that, in general, Year 10 students of Senior High School 1 Sidoarjo performed adequate mathematical literacy. Teachers need to pay great attention to designing mathematical literacy problems to accustom students to solve mathematical problems in their surroundings.*

Keywords: *mathematical literacy, ethnomathematics, batik Sidoarjo*

Introduction

Mathematics is part of human activities, meaning that every human activity can be counted using mathematics. A problem is likely to emerge when one fails to do their activity well. It may also appear once the activity varies and becomes more complex, making it challenging to solve. Thus, the individual is expected to carry out his activities well. According to (Sammons, 2018), besides the ability to understand mathematical content, one should have the ability to solve daily life problems. To achieve the goal, mathematical learning is expected to connect to students' lives (Fuadi, Johar, & Munzir, 2016).

However, expectation and reality have not yet been reflected in recent mathematical learning. This argument is confirmed by previous research, reporting that students are getting bored and less motivated to learn mathematics since teachers tend to employ direct learning (Al-Azawi, Al-Faliti, & Al-Blushi, 2016). Also, students remember mathematical concepts without understanding the problem in real-life contexts (Manoy & Indarasati, 2018). In addition to that, an interview with a Year 10 mathematics teacher in Senior High School 1 Sidoarjo reported that students could solve a problem using a formula but encounter difficulties in applying it in a real-world problem. Those issues impacted PISA (Programme for International Student Assessment) results in 2018, taking Indonesia in 72nd place out of 78 countries (OECD, 2019). PISA is an international assessment that assesses several skills; one of them is mathematical literacy. Definition of mathematical literacy proposed by OECD

(2021) and Stacey (2010) is one's ability to formulate, apply, and interpret mathematics in solving problems in the real world. According to Khikmiyah and Midjan, (2017); Nurdianasari, Rochmad, and Hartono (2015), mathematical literacy is students' ability to formulate, apply, and interpret mathematical problems in daily-life contexts, followed by activities of analyzing, justifying, and delivering ideas effectively. Mathematical literacy helps one understand the role and the use of mathematics in life and is used to make the right decision (Hayati & Kamid, 2019). Therefore, according to Anggoro, Julie, Sanjaya, Rudhito, and Wiadnyana (2019) and OECD (2021), mathematical literacy is one of the components that individuals should have in this 21st century.

A daily-life problem is a phenomenon that can be explained with mathematical concepts. Problems in a particular area will be handled differently from those in other areas due to the cultures embraced in the areas. Keesing (2010) states that culture is a complex symbolic behavioral heritage that contains knowledge, beliefs, arts, morals, law, customs, and capabilities humans acquire as members of society. Culture blends in students' lives, but teachers have not linked mathematics to students' culture in mathematical learning. According to Mania and Alam (2021), one of the factors to cause students not to apply mathematics in solving daily-life problems is that teachers do not connect mathematics with the culture that exists in students' surroundings. Culture-based mathematics can trigger students' motivation to learn mathematics. According to Rosa and Orey (2011), Rubio (2016), Sochima and Nig, (2013), mathematics is a construction of human culture.

Mathematics eventually has been widely used in people's lives anywhere and is part of their culture. Teachers have a prominent role in introducing formal mathematics, often called school mathematics, and comprehensive ethnomathematics that comprises mathematical activities in daily life or outside school (Cimen, 2014; Fouze & Amit, 2018). For that reason, mathematical learning should be connected to real contexts of students' life (Van den Heuvel-Panhuizen & Drijvers, 2020). Culture will influence an individual's behaviors and play a role in developing one's understanding, including mathematical learning (Simamora, Saragih, & Hasratuddin, 2018). Students given mathematical content oriented to culture have better mathematical understanding when employed a realistic mathematics learning approach than conventional learning (Febriani, Widada, & Herawaty, 2019). Mathematical values that orient culture appear in various life aspects, specifically art, such as building temples and producing *batik* and handicrafts, which use patterns inseparable from mathematics. As such, culture is highly suitable to be embedded in materials for learning mathematics.

Bridging culture and mathematics is called ethnomathematics. Ethnomathematics embodies daily-life mathematics or culture of a certain community in a social environment

(Abiam, Abonyi, Ugama, & Okafor, 2016; Rosa & Orey, 2011; Sochima & Nig, 2013). Mathematics can be found in the community's culture; it can connect and revive students' reasoning and critical thinking and foster students' tolerance of cultural differences (D'Ambrosio, 2016). Ethnomathematics is a learning approach that potentially develops students' metacognition in solving mathematical problems (Herawaty, Widada, Novita, Waroka, & Lubis, 2018), which they can foster their reasoning ability. Besides, the ethnomathematics approach assists in developing students' intellectual, social, emotional, and political learning using their own culture by cultivating knowledge, skills, and attitudes in students (Fouze & Amit, 2018; Pytlak, Rowland, & Swoboda, 2012; Rosa & Orey, 2011). Ethnomathematics and mathematical literacy are two important notions in introducing real-world mathematics. Ethnomathematics emphasizes the competency of people developed in different cultural groups in daily life, while mathematical literacy focuses more on mathematical and social needs for community competency (Wedege, 2010). Hence, the combination of ethnomathematics and mathematical literacy is an essential aspect for students.

Ethnomathematics learning is potentially implemented in Indonesia because of Indonesian culture diversity from Sabang to Merauke. East Java, especially Sidoarjo, has many cultures, such as *Batik Sidoarjo, Batik Tulangan,* Milkfish Auction, *Nyadran, Reog Cemandi, Banjarkemuning* Dance, *Pari* Temple, *Sumur* Temple, *Pamotan* Temple, and *Medalem* Temple. *Batik Sidoarjo* is the most distinctive art from Sidoarjo.

Several researchers have studied the ethnomathematics of Sidoarjo. For example, Sholihah, Dewi, and Mariana (2021) have explored mathematical concepts in *batik Jetis Sidoarjo* to transform mathematical learning contexts in elementary schools. Rachmawati (2012) has investigated the ethnomathematics of the Sidoarjo community. Fakhruddin and Masrukan (2018) studied mathematical literacy ability and respect for local culture in Pogil learning associated with ethnomathematics. Lubis, Widada, Herawaty, Nugroho, and Anggoro (2021) examined mathematical problem-solving ability through ethnomathematics-based realistic mathematics learning. Kurniati and Mariani (2020) studied a qualitative analysis of students' mathematical literacy ability and responsibility in realistic mathematics education learning with ethnomathematics. Wurdani and Budiarto (2021) investigated ethnomathematics in the rattan weaving business of the Gresik community from a mathematical literacy perspective. However, research on mathematical literacy based on ethnomathematics of Sidoarjo has not existed yet. Meanwhile, the mathematical literacy of Sidoarjo students necessitates solving daily problems, such as designing *batik*. The problems include the proportion used to mix colors, rotation concepts, reflection, dilatation of *batik* motifs, and the number of batik pieces produced from existing materials such as *wori* cloth, *malam*, wax, and petroleum.

Considering the insufficient ability of Indonesian students in solving PISA mathematical literacy problems, the need for attractive culture-based learning, and mathematical concepts-rich Siodarjo art, the researchers intend to investigate the mathematical literacy of Year 10 students in terms of ethnomathematics of batik Sidoarjo. Therefore, we propose a research question: how is the mathematical literacy of Year 10 students of Senior High School 1 Sidoarjo in solving ethnomathematical problems of batik Sidoarjo? It is expected that this study will benefit teachers in designing learning to improve students' mathematical literacy based on their surroundings.

Method

The present study is qualitative descriptive research that aims to identify the mathematical literacy ability of Year 10 students in solving ethnomathematical problems of *batik Sidoarjo.* The research procedure consists of (1) designing a research instrument; (2) validating the instrument; (3) collecting data; (4) analyzing data; and (5) writing a report. Data sources in this study were five subjects selected using a purposive sampling technique and those with an IQ score greater than 136. Senior High School 1 Sidoarjo was selected because it is located near the center of *batik Jetis Sidoarjo*. Instruments employed in this study comprised primary and supporting instruments. The primary instrument consisted of researchers, while the supporting instrument included a student mathematical literacy test and interview guide.

The data collection method consisted of a test, i.e., mathematical literacy questions, such as T1 on Figure 1, validated by an advisor and Year 10 senior high school teachers. T1 was employed to identify the mathematical literacy ability of Year 10 students of Senior High School 1 Sidoarjo in solving ethnomathematical problems of *batik Sidoarjo*. Another method is an interview that was used to support data of students' mathematical literacy test results. The interview was conducted individually and alternately to delve and obtain more detailed information on students' work. Data of the test and interview results were analyzed using a triangulation method (Miles, Huberman, & Saldana, 2014). That is, (a) reduction data stage, consists of the data selection process, omission of unnecessary information, and organization of interview results; (b) Data presentation, is presenting data of interview results including identifying data; and (c) Conclusion drawing, is drawing a conclusion from all data on mathematical literacy test and interview results, including identifying mathematical literacy of Year 10 students of Senior High School 1 Sidoarjo in solving ethnomathematical problems of *batik Sidoarjo*. Mathematical literacy test (T1) on ethnomathematics of *batik Sidoarjo* and mathematical literacy indicator and category are presented in Figure 1.

Father has a *batik* industry. To manufacture a piece of *batik*, he needs several materials: 1 piece of *mori* cloth, 5 bags of fabric dye, ½ kg of wax, and 1 liter of petroleum. He keeps 40 pieces of *mori* cloth, 37 bags of fabric dye, 8 kg of wax, and 11 liters of petroleum in the warehouse. Could you please help father determine the maximum number of pieces of *batik* produced using the materials in the warehouse?

Figure 1. Mathematical literacy test (T1)

Table 1. Mathematical literacy indicator

Mathematical Processes	Mathematical Literacy Indicator
Formulating situation mathematically (Formulating Stage (FS))	- Identifying mathematical variables and structures in real-world problems and making assumptions. - Employing understanding of the contexts to guide or accelerate the mathematical problem-solving process, such as working on the accuracy level that suits the contexts.
Employing mathematical concepts, facts, procedures, and reasoning (Employing Stage (ES))	- Conducting an effective and continuous control mechanism in all multi-procedures oriented to mathematical solutions, conclusions, or generalizations. - Explaining, defending, or justify on process and procedure used to determine mathematical results or solutions. - Connecting pieces of information to arrive at mathematical solutions, make generalizations, or argumentation of multi-steps.
Interpreting, applying, and evaluating mathematical outcomes (Interpreting Stage (IS))	- Mathematical results are interpreted in various formats that correspond with situations or usage, comparing or evaluating two or more representations associated with a situation. - Building and communicating explanation and argument in terms of problem contexts.

(Source: OECD, 2021)

Based on the mathematical literacy indicator listed in Table 1, the category of mathematical literacy is given in Table 2.

Table 2. Mathematical literacy category

Mathematical literacy category	Indicator
Good	Fluency, accurate computation, and idea development is optimal.
Adequate	Fluency, accurate computation, and idea development is not optimal yet.
Inadequate	Fluency, inaccurate computation, and idea development is not optimal.

(Source: Lailiyah, 2017)

Results and Discussion

Year 10 students of Senior High School 1 Sidoarjo with an IQ score of 136 above was administered a mathematical literacy test (T1). Based on the test results, five subjects selected were coded as S1, S2, S3, S4, and S5 and their mathematical literacy was investigated further.

Subject 1 (S1)

The result of S1's work is illustrated in Figure 2.

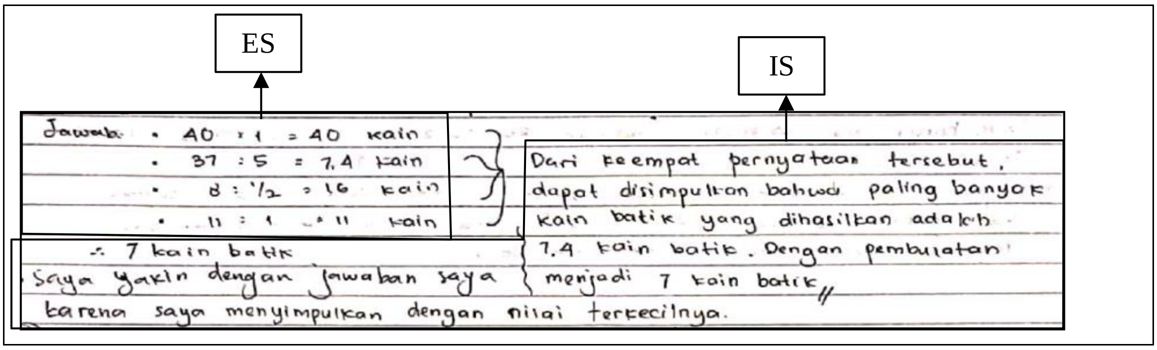

Figure 2. The result of S1's work on ES and IS

In the formulate stage (FS), the question proposed relates to how S1 receives and understands Problem T1, as shown below.

Q	:	*Have you ever seen a problem like the T1 context*
S1	:	*Never.*
Q	:	*What is known and asked in T1?*
S1	:	*Calculate how many batik pieces can be produced if the number of materials needed is known and the number of existing materials is known.*
Q	:	*What do you have in your mind when you see T1 for the first time?*
S1	:	*Using division.*

Based on the interview excerpt with S1, S1 understood the context to guide and accelerate the problem-solving process for T1, or S1 solved the problem at the accuracy level corresponding to the T1 context. Referring to Table 2, S1 has a good ability in formulating mathematical contexts.

Based on the result of S1's work on the employ stage (ES), it can be concluded that S1 was able to explain, defend, and justify the process and procedure taken to obtain a solution for T1. The student also connected the information with the solution but did not thoroughly reason why the process and procedure were used to solve T1. Based on Table 1, S1 has an adequate ability to employ mathematical concepts, and it was clarified further as in the interview excerpt below.

The questions proposed are:

Q	:	*What strategy did you use to solve T1?*
S1	:	*For this problem, I used the division of two data given, then I concluded by the smallest data result and rounded it down as the conclusion.*
Q	:	*Why did you use that strategy?*
S1	:	*Because this strategy is the easiest one for me.*

The result of S1's work on the interpret stage (IS) concludes that S1 tried to develop and communicate his explanation and argumentation in the T1 context. S1 could interpret mathematical results by giving the correct answer related to the T1 context. S1 also could reason why the conclusion he obtained is correct. According to Hayati and Kamid (2019), S1 has a good ability in interpreting, applying, and evaluating the result he obtained. Further, it was clarified in the interview excerpt.

The questions asked are:

P	:	*Are you sure with your conclusion? Why?*
S1	:	*Yes, I am. Because I choose to round it down, the batik produced is incomplete if I round it up.*
Q	:	*Is there any other way to solve T1?*
S1	:	*I do not think I can find another way.*

Subject 2 (S2)

The result of S2’s work is depicted in Figure 3.

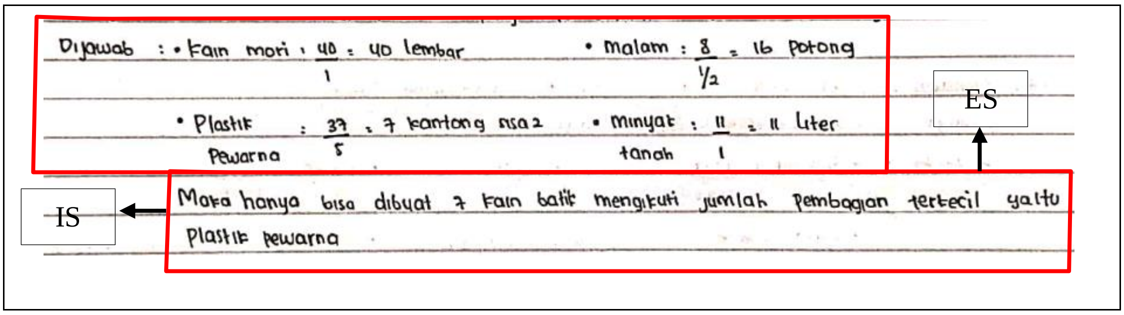

Figure 3. The result of S2’s work on ES and IS

In the formulate stage (FS), questions were associated with how S2 receives and understands Problem T1, as in the following excerpt.

Q	:	*Have you ever seen a problem like the T1 context?*
S2	:	*Yes, I have. If I am not mistaken, it is called an AKM problem.*
Q	:	*What is known and asked in T1?*
S2	:	*I am asked to find how many batik pieces can be produced using the existing materials.*
Q	:	*What do you think when the first time you see T1?*
S2	:	*Divide the existing materials by the needed ones. As such, the number of pieces that can be produced is known from the smallest quotient.*

The interview excerpt indicates that S2 understood the context to orient and accelerate the process of solving T1. In other words, S2 solved the problem at the accuracy level that corresponds to the T1 context. S2 could also identify variables, but when questioned what is known and asked in T1, his answer was not detailed (incomplete). S2 also employed his knowledge to plan a strategy that he explained thoroughly. According to Edo, Hartono, and Putri (2013) and Table 2, S2 has an adequate ability to formulate mathematical contexts.

The results of S2's work at the implementing stage (ES) concluded that S2 could explain, defend and justify the processes and procedures to determine T1 results and connect pieces of information with solutions. However, S2 cannot fully explain or provide reasoning why use them to complete T1. Table 2 shows that S2 has adequate ability in applying mathematical concepts, and later it was clarified in the interview excerpts as follows.

Q : *Which strategy did you use to solve the T1 problem?*
S2 : *To answer the T1 problem, I divided the available materials as needed to know the number of fabrics that could be produced from the smallest division.*
Q : *Why did you use this strategy?*
S2 : *I think this strategy is the easiest for me to understand.*

S2's work at the interpreting (IS) stage indicates that S2 tried to build and communicate its explanations and arguments in the context of T1. However, she/he could not fully explain or provide reasoning why the conclusions were correct. According to Hayati and Kamid (2019) S2 has adequate ability in interpreting, applying and evaluating the results. An interview then clarified the results and the excerpt is as follows.

P : *Are you sure of your conclusion? Why?*
S2 : *I'm sure, because I don't think there's another solution.*

Subject 3 (S3)

Figure 4 presents S3's work.

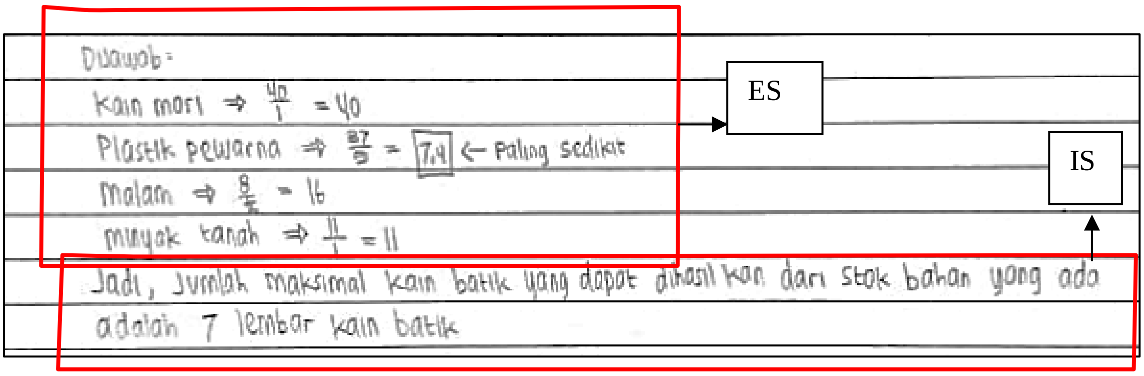

Figure 4. The results of S3's work on ES dan IS

At the formulating stage (FS), the questions asked concerning how S3 accepts and understands the T1 problem; the interview excerpt is as follows.

Q : *Have you seen a problem similar to T1 context?*
S3 : *Never.*
Q : *What is known and asked in T1?*
S3 : *Determine the number of batik that can be made.*
Q : *What did you think when you saw T1?*
S3 : *Divide the available materials as needed, then compare the results of the division of each ingredient and determine which one is the smallest.*

The interview with S3 shows that S3 understood the context to guide and accelerate the process of solving T. In other words, S3 solved problems at the level of accuracy suitable for the

T1 context. S3 could identify variables, but S3's answer is not detailed (less complete) when asked what is known and asked in T1. Also, S3 could use her/his knowledge to plan a strategy. In summary, S3 has adequate ability to formulate mathematical contexts (Edo, Hartono, & Putri, 2013).

The results of S3's work at the implementing (ES) stage reveal that S3 could explain, defend and justify the processes and procedures to determine T1 results and connect pieces of information for a solution. However, S3 could fully explain or provide reasoning why using them to solve T1. Table 2 shows S3 has sufficient ability to apply mathematical concepts. The results were then clarified based on the interview excerpts, as follows.

Q : *Which strategy did you use to solve the T1 problem?*
S3 : *I divided the number of available materials as needed and compared the results of the division of each ingredient before determining the smallest one.*
Q : *Why did you use this strategy?*
S3 : *I think this strategy is the easiest to understand.*

S3's work at the interpreting (IS) stage indicates that S3 tried to build and communicate its explanations and arguments in the context of T1. However, S3 cannot fully explain or provide reasoning why the conclusions were correct. S3 has adequate ability to interpret, apply and evaluate the results (Hayati & Kamid, 2019). Furthermore, the results were clarified in the interview. The interview excerpts are presented as follows.

P : *Are you sure with the conclusion? Why?*
S3 : *Yes, I am. It is based on my logic.*
Q : *Is there any other way to solve TI?*
S3 : *No, there isn't*

Subject 4 (S4)

The results of S4's work is presented in Figure 5.

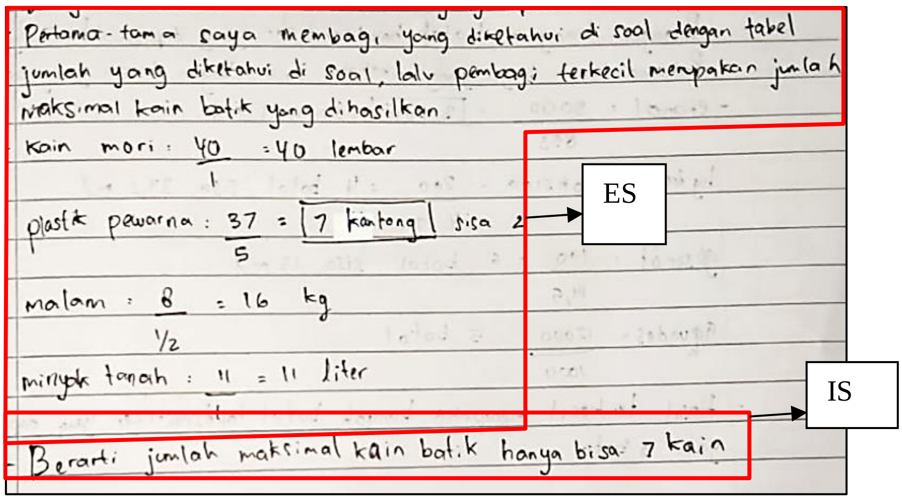

Figure 5. S4's work for ES dan IS

At the formulating stage (FS), the questions asked related to how S4 accepted and understood T1 problem. The interview excerpts are as follows.

Q : *Have you seen a problem similar to T1 context?*
S4 : *Never.*
Q : *What is known and asked in T1?*
S4 : *Number of fabrics to be produced.*
Q : *What did you think when you saw T1?*
S4 : *Analyze the problem so that I can solve it.*

The excerpt from S4's interview shows that S4 understood the context to guide and accelerate solving T1. In other words, S4 solved the problem at the level of accuracy that suited the context of T1. S4 could identify variables, but when asked what is known and asked in T1, his/her answer was not detailed (incomplete); S4 could use his/her knowledge to plan the strategy explained clearly. S4 has adequate ability in formulating mathematical contexts (Edo, Hartono, & Putri, 2013)

S4's work at the implementing (ES) stage reveals that S4 could explain, defend and justify the processes and procedures used to solve T1 and connect pieces of information for a solution. However, S4 could not fully explain (provide reasoning) why using these processes and procedures to complete T1. Table 2 shows that S4 has adequate ability to apply mathematical concepts. An interview then clarified the findings and the excerpt is as follows. The questions asked are:

Q : *Which strategy did you use to complete T1?*
S4 : *I divided the materials needed by the number of ingredients on the table.*
Q : *Why did you choose this strategy?*
S4 : *Because this way, I could get the solution.*

S4's work at the interpreting (IS) stage shows that S4 tried to build and communicate his explanations and arguments in the context of T1. However, S4 could not fully explain (provide reasoning) why the conclusion was correct. S4 has sufficient ability to interpret, apply and evaluate the results (Hayati & Kamid, 2019). This result was further confirmed in the interview, as presented in the following excerpt.

P : *Are you sure with your conclusion? Why?*
S4 : *Yes, I am.*
Q : *Is there any other way to solve TI problem?*
S4 : *I think so.*

Subject 5 (S5)

S5's works are presented in Figure 6. At the formulating stage (FS), the interview questions asked were concerning how S5 accepted and understood the T1 problem, as presented below.

Q : *Have you seen a problem similar to the context of T1?*
S5 : *Never.*
Q : *What is known on T1?*
S5 : *Materials to make one piece of batik and the ingredients are 40 sheets of mori cloth, 37 bags of fabric dye, 8 kg of wax, 11 liters of kerosene.*
Q : *What was asked on T1?*
S5 : *What asked is the maximum number of batik that can be made from materials available in the warehouse. What known is the ingredients to make a piece of batik and the materials you have.*
Q : *What did you think of when you saw T1?*
S5 : *The available ingredients are divided into ingredients, and I solve the problem by the least result. If it is in decimal, I round it down.*

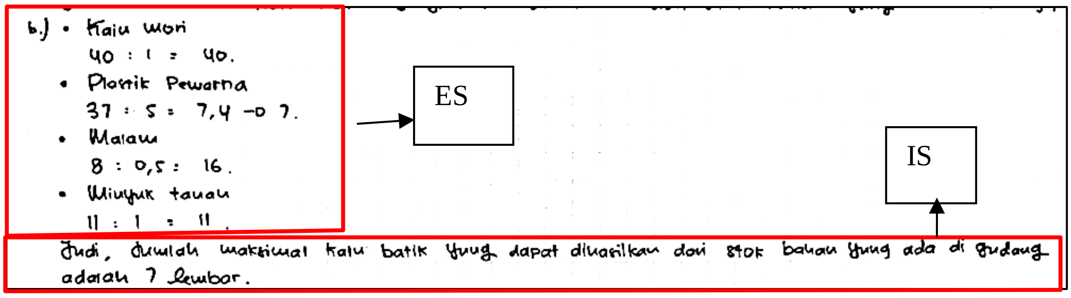

Figure 6. S5’s works on ES and IS

Based on the interview excerpt of S5, it can be concluded that S5 understood the context to guide and accelerate solving T1. S5 solved the problem at the level of accuracy according to T1 context. Table 2 shows that S5 has a good ability to formulate mathematical contexts.

S5's work at the implementing stage (ES) indicates that S5 could explain, defend, and justify the processes and procedures used to solve T1 and connect pieces of information for a solution. However, S5 could not fully explain why using them to solve T1. Table 2 indicates that S5 has adequate ability to apply mathematical concepts. Furthermore, the result was clarified in the interview, and the excerpts are presented as follows.

Q : *Which strategy did you use to solve T1?*
S5 : *The available materials are divided by the materials needed, then the least quotient is the answer. If there's a comma, I'll round it down.*
Q : *Why did you choose this strategy?*
S5 : *Because I think it is the easiest way.*

S5's work at the interpreting (IS) stage reveals that S5 tried to build and communicate his explanations and arguments in T1 context. However, S5 could not fully explain or provide reasoning why the conclusion was correct. S5 has sufficient ability to interpret, apply and evaluate the results (Hayati & Kamid, 2019). Furthermore, the result was also confirmed by the interview excerpts.

P : *Are you sure with your conclusion? Why?*
S5 : *Yes, because I think the strategy or method I used is correct.*
Q : *Is there any other way?*
S5 : *No, it isn’t.*

The summary of the analysis results of students' mathematical literacy in solving ethnomathematical problems of *batik Sidoarjo* is presented in Table 3.

Tabel 3. The mathematical literacy identification of S1, S2, S3, S4, S5

Mathematical literacy indicator	S1	S2	S3	S4	S5
Formulating a mathematical simulation (Formulating Stage (FS))	Good	Adequate	Adequate	Adequate	Good
Applying mathematical concepts, facts, procedures, and reasoning (Employing Stage (ES))	Adequate	Adequate	Adequate	Adequate	Adequate
Interpreting, applying, and evaluating mathematical results (Interpreting Stage (IS))	Good	Adequate	Adequate	Adequate	Adequate

At the formulating stage (FS), the initial question asked to the five subjects was have you seen a problem similar to T1 context. S1, S3, S4, and S5 admitted that they never saw such a problem, while S2 had seen and solved a similar problem in AKM (Minimum Competency Assessment). Based on this finding, the researchers suggest that all educators introduce math problems related to students’ everyday lives. Concerning what is known and asked at T1, S2, S3, and S4 did not mention them in detail. However, all subjects could explain well, meaning that the five subjects could identify the variables and mathematical structures underlying the problems in T1. The next question is related to what they think when seeing T1. The first correct step taken by the five subjects was using division in solving T1. Based on this finding, S1 and S5 are categorized as having good ability. In contrast, S2, S3, and S4 are categorized as having the adequate ability for the indicators of formulating real problems and writing the information in the problem (Utami, Sukestiyarno, & Hidayah, 2020).

At the implementing stage (ES), the question was what strategy was used to solve T1 and why chose that strategy. The five subjects could explain, defend and justify the processes and procedures used to determine the T1 results and connect pieces of information to arrive at a solution. However, they could not fully explain or provide reasoning why they used them to solve T1. It indicates that the five subjects have the adequate ability in applying mathematical concepts (Lailiyah, 2017; Utami et al., 2020)

At the interpreting (IS) stage, the question asked was whether the student was sure of the conclusion and why, and whether there was any other way to solve T1. The five subjects tried to develop and communicate their explanations and arguments in T1 context. However, they could not explain or provide reasoning why the conclusions were true. The five students have adequate ability to interpret, apply and evaluate the results obtained (Hayati & Kamid, 2019; Utami et al., 2020).

Overall, students' ability to formulate, apply and interpret T1 or in other words, students' mathematical literacy in solving ethnomathematical problems of *batik Sidoarjo* is adequate.

This finding is in line with Hayati and Kamid (2019) reporting that the mathematical literacy of high school students majoring in science and social studies is adequate. The interviews showed that most subjects had never had real-world context problems, so they had not been trained to solve problems based on mathematical literacy indicators. Furthermore, students lacked an understanding of mathematical literacy and experience in solving problems requiring deeper reasoning (Hidayat & Rusilowati, 2021; Khoirudin, Dwi Styawati, & Nursyahida, 2017).

Conclusion

The results and discussion concluded that the overall Year 10 students' mathematical literacy in working on the ethnomathematical problems of *batik Sidoarjo* was adequate. However, teachers must develop mathematical literacy problems to familiarize students with solving mathematical problems related to daily life. Students' mathematical literacy skills will enhance as students develop the habits of solving ethnomathematical problems. Further research is recommended to identify students' mathematical literacy related to the cultural context in other regions.

References

Abiam, P., Abonyi, O., Ugama, J., & Okafor, G. (2016). Effects of ethnomathematics-based instructional approach on primary school pupils' achievement in geometry. *Journal of Scientific Research and Reports*, *9*(2), 1–15. https://doi.org/10.9734/jsrr/2016/19079

Al-Azawi, R., Al-Faliti, F., & Al-Blushi, M. (2016). Educational gamification vs. game based learning: comparative study. *International Journal of Innovation, Management and Technology*, (July), 131–136. https://doi.org/10.18178/ijimt.2016.7.4.659

Anggoro, A. Y., Julie, H., Sanjaya, F., Andy Rudhito, M., & Wiadnyana, D. P. (2019). The mathematics education department students' ability in mathematical literacy for the change and relationship problems on the PISA adaptation test. *Journal of Physics: Conference Series*, *1397*(1). https://doi.org/10.1088/1742-6596/1397/1/012085

Cimen, O. A. (2014). *Discussing ethnomathematics: Is mathematics culturally dependent?* 523–528. Procedia-Social and Behavioral Sciences.

D'Ambrosio, U. (2016). State of the art in Ethnomathematics. In current and future perspectives of ethnomathematics as a program. *Springer International Publishing*, 11–37. https://doi.org/10.1007/978-3-319-30120-4

D'Ambrosio, Ubiratan. (2001). In my opinion: what is ethnomathematics, and how can it help children in schools? *Teaching Children Mathematics*, *7*(6), 308–310. https://doi.org/10.5951/tcm.7.6.0308

Edo, S. I., Hartono, Y., & Putri, R. I. I. (2013). Investigating secondary school students' difficulties in modeling problems PISA-model level 5 and 6. *Journal on Mathematics Education*, *4*(1), 41–58. https://doi.org/10.22342/jme.4.1.561.41-58

Fakhruddin, D. F., & Masrukan, M. (2018). The analysis of mathematical literacy skill and respect to local culture toward pogil learning with ethnomathematics. *Unnes Journal of*

Mathematics Education Research, *7*(79), 145–151. Retrieved from https://journal.unnes.ac.id/sju/index.php/ujmer/article/view/24697

Febriani, P., Widada, W., & Herawaty, D. (2019). Pengaruh pembelajaran matematika realistik berbasis etnomatematika terhadap kemampuan pemahaman konsep matematika siswa SMA Kota Bengkulu. *Jurnal Pendidikan Matematika Raflesia*, *04*(02), 120–135. Retrieved from https://ejournal.unib.ac.id/index.php/jpmr/article/view/9761/4795

Fouze, A. Q., & Amit, M. (2018). Development of mathematical thinking through integration of ethnomathematic folklore game in math instruction. *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(2), 617–630. https://doi.org/10.12973/ejmste/80626

Fuadi, R., Johar, R., & Munzir, S. (2016). Peningkatkan kemampuan pemahaman dan penalaran matematis melalui pendekatan kontekstual. *Jurnal Didaktik Matematika*, *3*(1), 47–54. https://doi.org/10.24815/jdm.v3i1.4305

Hayati, T. R., & Kamid, K. (2019). Analysis of mathematical literacy processes in high school students. *International Journal of Trends in Mathematics Education Research*, *2*(3), 116. https://doi.org/10.33122/ijtmer.v2i3.70

Herawaty, D., Widada, W., Novita, T., Waroka, L., & Lubis, A. N. M. T. (2018). Students' metacognition on mathematical problem solving through ethnomathematics in Rejang Lebong, Indonesia. *Journal of Physics: Conference Series*, *1088*. https://doi.org/10.1088/1742-6596/1088/1/012089

Hidayat, Y. N., & Rusilowati, A. (2021). Analysis of mathematics literacy ability observed from metacognition in learning realistic synectics assisted by schoology. *Unnes Journal of …*, *10*(1), 41–47. Retrieved from https://journal.unnes.ac.id/sju/index.php/ujmer/article/view/34606

Keesing, M. R. (2010). *Antropologi budaya suatu prespektif kontemporer*. Jakarta: Erlangga.

Khikmiyah, F., & Midjan, M. (2017). Pengembangan buku ajar literasi matematika untuk pembelajaran di SMP. *Jurnal Silogisme : Kajian ilmu matematika dan pembelajarannya*, *1*(2), 15. https://doi.org/10.24269/js.v1i2.275

Khoirudin, A., Dwi Styawati, R., & Nursyahida, F. (2017). Profil kemampuan literasi matematika siswa berkemampuan matematis rendah dalam menyelesaikan soal berbentuk PISA. *Aksioma*, *8*(2), 33. https://doi.org/10.26877/aks.v8i2.1839

Kurniati, C. N., & Mariani, S. (2020). *Qualitative analysis on mathematical literacy ability and student responsibility with realistic mathematics education learning models of ethnomathematics nuance*. *9*(3), 227–235. https://doi.org/10.15294/ujme.v9i3.44539

Lailiyah, S. (2017). Mathematical literacy skills of students' in term of gender differences. *AIP Conference Proceedings*, *1868*(August). https://doi.org/10.1063/1.4995146

Lubis, A. N. M. T., Widada, W., Herawaty, D., Nugroho, K. U. Z., & Anggoro, A. F. D. (2021). The ability to solve mathematical problems through realistic mathematics learning based on ethnomathematics. *Journal of Physics: Conference Series*, *1731*(1). https://doi.org/10.1088/1742-6596/1731/1/012050

Mania, S., & Alam, S. (2021). *Teachers' perception toward the use of ethnomathematics approach in teaching math to cite this article : Teachers' perception toward the use of ethnomathematics approach in teaching math*.

Manoy, J. T., & Indarasati, N. A. (2018). The computer student worksheet based mathematical literacy for statistics. *Journal of Physics: Conference Series*, *953*(1). https://doi.org/10.1088/1742-6596/953/1/012213

Miles, M. ., Huberman, A. M., & Saldana, J. (2014). *Qualitative data analysis*. A methods sourcebook.

Nurdianasari, H., Rochmad, R., & Hartono, H. (2015). Kemampuan literasi matematika siswa kelas viii berdasarkan gaya kognitif. *Unnes Journal of Mathematics Education Research*, *4*(2).

OECD. (2019). Programme for international student assessment (PISA) results from PISA 2018. *Oecd*, 1–10. Retrieved from https://www.oecd-ilibrary.org/education/pisa-2018-results-volume-iii_bd69f805-en%0Ahttps://www.oecd-ilibrary.org//sites/bd69f805-en/index.html?itemId=/content/component/bd69f805-en#fig86

OECD. (2021). PISA 2021 mathematics framework. Retrieved April 17, 2021, from https://pisa2021-maths.oecd.org/

Pytlak, M., Rowland, T., & Swoboda, E. (2012). *Proceedings of the Seventh Congress of the European Society for Research in Mathematics Education*.

Rachmawati, I. (2012). Eksplorasi etnomatematika masyarakat Sidoarjo. *MATHEdunesa*, *1*(1).

Rosa, M., & Orey, D. C. (2011). Ethnomathematics : the cultural aspects of mathematics Etnomatemática : os aspectos culturais da matemática. *Revista Latinoamericana de Etnomatemática*, *4*(2), 32–54.

Rubio, J. S. (2016). The Ethnomathematics of the Kabihug Tribe in. *Malaysian Journal of Mathematical Sciences 10(S)*, *10*, 211–231.

Sammons, L. (2018). *Teaching students to communicate mathematically*. ASCD.

Sholihah, S. A., Dewi, I. S., & Mariana, N. (2021). Eksplorasi konsep matematika pada batik jetis sidoarjo untuk mentransformasikan konteks pembelajaran matematika di sekolah dasar. *EduHumaniora | Jurnal Pendidikan Dasar Kampus Cibiru*, *13*(1), 76–85. https://doi.org/10.17509/eh.v13i1.23130

Simamora, R. E., Saragih, S., & Hasratuddin, H. (2018). Improving students' mathematical problem solving ability and self-efficacy through guided discovery learning in local culture context. *International Electronic Journal of Mathematics Education*, *14*(1), 61–72. https://doi.org/10.12973/iejme/3966

Sochima, S., & Nig, P. D. (2013). *Effect of ethno-mathematics teaching materials on students' achievement in mathematics in Enugu State*. *4*(23), 70–78.

Stacey, K. (2010). Mathematical and scientific literacy around the world. *Journal of Science and Mathematics Education in Southeast Asia*, *33*(1), 1–16.

Utami, N., Sukestiyarno, Y. L., & Hidayah, I. (2020). Kemampuan literasi dalam menyelesaikan soal cerita siswa kelas IX A. *Prisma, Prosiding Seminar Nasional Matematika*, *3*, 626–633.

Van den Heuvel-Panhuizen, M., & Drijvers, P. (2020). *Realistic mathematics education*. https://doi.org/https://doi.org/10.1007/978-3-030-15789-0_170

Wedege, T. (2010). Ethnomathematics and mathematical literacy: People knowing mathematics in society. *Mathematics Education Research Seminar, Stockholm, Sweden*, 31–46. Linköpings universitet.

Wurdani, W. P. A. ., & Budiarto, M. T. (2021). Etnomatematika usaha kerajinan anyaman rotan masyarakat Gresik dalam perspektif literasi matematis. *Jurnal Pendidikan Matematika*, *12*(1), 94–105.