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The Characteristics of Mathematical Literacy Based on Students' Executive Function

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Abstract: Literacy ability is an individual's ability to reason, formulate, solve, and interpret mathematically to solve problems related to daily life. Executive function is a cognitive aspect that has a relation with mathematical literacy. One of some aspects that affects the low mathematical literacy ability is the aspect of executive function. This study aims to investigate the characteristics of mathematical literacy based on the executive function aspects of 15 years old students. A qualitative method with a descriptive approach is employed in this study. The present research applies interview guidelines, questionnaires, and students' mathematical literacy tests as the instruments. Research subjects are junior high school students in grade VIII from two different schools. The result shows that the students' executive function influences mathematical literacy ability. Students' mathematical literacy ability is not fully achieved by fulfilling all the indicators involved. Another aspect found in the research is the low critical thinking ability impacts the achievement of mathematical literacy ability indicators.

Keywords: *Executive function, mathematic, mathematics literacy, PISA.*

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Introduction

Mathematical literacy is knowledge to understand and apply basic mathematics in everyday life (Ojose, 2011). Meanwhile, according to the Organization for Economic Cooperation and Development (OECD, 2021), literacy ability is an individual's ability to reason, formulate, solve, and interpret problems in daily life mathematically. Literacy includes concepts, procedures, facts, and tools to describe, explain and predict phenomena or events. It helps individuals to identify the role of mathematics in everyday life. Meanwhile, Stacey and Turner (2015) state that mathematical literacy can formulate, use, and interpret mathematics in various contexts, including mathematical reasoning, using concepts, procedures, facts, and mathematics tools. To describe, explain, and predict phenomena to help individuals in making constructive and reflective decisions. Literacy skills consist of three main processes, namely formulating, employing, and interpreting. Formulating is the ability to transform problems in a short story related to daily life into mathematical form (Taufik et al., 2019). Based on the definition of PISA 2019, formulating is an individual's ability to recognize and identify problems. Then, the individual applies mathematics to solve problems contextually (OECD, 2021). Employing is an individual's ability to apply mathematical concepts, facts, procedures, and reasoning to solve mathematically formulated problems to obtain mathematical conclusions. Interpreting is an individual's ability to reflect on mathematical solutions, results, or conclusions and interpret them into real-life context (OECD, 2021). According to PISA standards, mathematical literacy skills can be achieved through seven indicators that show the mathematical literacy process: communication, mathematizing, representation, reasoning, argument, devising strategies for solving problems, and using symbolic, formal, and technical language and operations, and using mathematical tools.

The definitions above show that literacy is the ability to formulate, use, and interpret mathematical problems closely related to everyday life. Thus, the students' mathematical literacy ability is required (Umbara & Suryadi, 2019; Wardono et al., 2016). Mathematical literacy ability is a fundamental ability that students need to develop to succeed in the learning process. The role of the mathematical literacy process is essential because mathematical literacy is one way to be successful in learning mathematics (Kilpatrick, 2001). It is one of the skills that become the focus of the PISA

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test organized by the OECD. It consists of reading literacy, mathematical literacy, and scientific literacy. Based on OECD (2019), it shows that the mathematical literacy ability of students in Indonesia is in the low criteria by being on the tenth rank from below in the PISA category.

Furthermore, the mathematical literacy ability of Indonesian students is still below the average PISA score. The achievement of literacy skills is still at the second level. It means that the literacy skill is still at the simple level, and they have not been able to solve complex problems. The low mathematical literacy ability is caused by the lack of students' ability to think critically about the issues they face (Maslihah et al., 2020; Rizki & Priatna, 2019; Sukestiyarno et al., 2019). Critical thinking is essential for achieving good mathematical literacy skills (Novitasari et al., 2020). According to PISA, there are seven indicators in achieving mathematical literacy skills: communicating, organizing, representation, reasoning, and argument; devising strategies for solving problems; using symbolic; formal, technical language and operations; and using mathematical tools. The achievement of the seven indicators in the literacy process requires thinking critically, criticizing and understanding mathematical literacy problems. Following the definition, critical thinking ability is the ability to think rationally. Therefore, they can make decisions (Feriyanto & Putri, 2020). As a result, it requires one stage in the mathematical literacy process which is critical thinking ability.

Improving critical thinking skills and mathematical literacy are interrelated. So, it is necessary to develop critical thinking skills to achieve good mathematical literacy skills. Many factors affect the students' critical thinking ability and mathematical literacy, including the learning process in schools, the assessment system in schools, and the cognitive aspects of students. The present study focuses on the cognitive aspects of students, which are closely related to mathematical literacy abilities. Following Peng et al. (2018) research, achieving good mathematical abilities is influenced by cognitive aspects in the thinking process. In this case, the aspect that has not been discussed sufficiently is the executive function. Executive function is a cognitive aspect related to a person's ability in mathematics, such as mathematical literacy (Abreu-Mendoza et al., 2018). The executive function regulates the cognitive processes (Miyake et al., 2000) and organizes goal-directed behavior (Anderson et al., 2010). Executive function is defined as cognitive skills related to goal-directed behavior, and it is an indicator of a person's mathematical ability (Wei et al., 2018). The executive function consists of different behavioral and cognitive elements. It plays an important role in learning and academic achievement (Baggetta & Alexander, 2016). The executive function has a role in mathematics education, which predicts the students' mathematical abilities in schools (Clements et al., 2016; Joswick et al., 2019; Magalhães et al., 2020). Executive function is described as a process of adaptation, self-control, attitudes, and emotions in achieving the goals (Purpura et al., 2017). It consists of 3 main items: working memory, inhibitory control, and cognitive flexibility (Diamond, 2013). Thus, the level of the executive function aspect directly results in mathematical literacy skills.

This present research analyzes the process of mathematical literacy in executive function and explains the stages and processes in students' mathematical literacy. It is used to produce the descriptions and findings related to the mathematical literacy process, especially from the executive function point of view.

Methodology

Research Design

The design in this study is a descriptive qualitative research design by describing students' mathematical literacy skills based on the executive function. The present research aims (1) to analyze the students' mathematical literacy process based on PISA indicators and (2) to clarify the characteristics of mathematics literacy based on executive function.

Sample and Data Collection

The data of the research was taken from the students of grade VIII of Junior High School. It involved thirty participants as the subjects of the study. Thirty research subjects were then selected three research samples using the purposive sampling technique. Purposive sampling is a sampling technique of data sources with specific considerations (Sukestiyarno, 2020). The concern in this study is to select a sample with criteria with executive, high, medium, and low. Subjects with low executive function were then named S1, subjects with medium executive function were called S2, and subjects with high executive function were named S3.

This study applied PISA literacy test, executive function questionnaires, and interviews to gather the data. PISA literacy test used the adjusted PISA test standard. In contrast, the executive function questionnaire was adapted from the Teenage Executive Function (TEXI) questionnaire developed by Thorell et al. (2020), which was then adjusted and developed according to the needs. In this study, applied qualitative analysis to collect the data sources and triangulate the data.

Expert judgment validated the instrument of the PISA literacy test. The research instrument was designed to the objectives, and then the researcher conducted a limited test of the research instrument. The results of item validity showed that eight mathematical literacy questions were included in the valid and reliable categories. Meanwhile, expert judgment in psychology validated the Teenage Executive Function (TEXI) interview guide and questionnaire.

Teenage Executive Function (TEXI) consisted of twenty-four questions composed of three categories: working memory, inhibitory control, and cognitive flexibility.

Analyzing of Data

The data obtained from the research results was done by following the procedure of a qualitative model, which consists of collecting data, selecting data, separating data, making an analogy, and making a hypothesis (Sukestiyarno, 2020). The research subjects were given a mathematical literacy test and then given an executive function questionnaire. The researchers separated the data based on the questionnaire results, divided into criteria for high executive function, medium executive function, and low executive function. Then, from the executive function questionnaire results, an analysis of solving mathematical literacy problems was carried out. The study conducted in-depth interviews to deepen the analysis of aspects of mathematical literacy and executive function on selected subjects.

The conclusions process was carried out by testing the hypothesis by repeating data collection. Triangulation was conducted to validate the data, namely a combination of mathematical literacy tests, executive function questionnaire results, in-depth interviews, observation, and documentation. Data reduction is made to eliminate data that is not needed in the study.

Findings / Results

The study results were divided based on the level of executive function of the research subjects, such as high, medium, and low executive functions. Executive function classification was obtained based on the results of the questionnaire given to the subjects. The results of the executive function questionnaire are described in the following table.

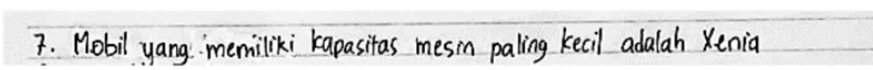
Table 1. Subject Executive Function Level

Executive Function	Criterion
High	Subjects can absorb information well, have good self-awareness, can make plans, focus, and are not easily influenced by external factors
Medium	Subjects can absorb information well, have low self-awareness, can make plans, lack focus, and are easily influenced by external factors
Low	Subjects are less able to absorb information well, have low self-awareness, are unable to make plans, are not focused, and are easily influenced by external factors

Subjects were selected based on the results of the student's executive function level. Furthermore, the researchers gave a mathematical literacy test and in-depth interviews related to solving mathematical literacy problems to selected subjects. As follows are the results of the analysis for each subject:

Subjects S1 in Interpreting, Applying and Evaluating Mathematical Outcomes.

Interpreting indicators on subjects with low executive function, measured using questions that show a comparison table of cars and their engine capacities. The problem given was that the subject must choose a vehicle with the smallest engine capacity. The interpreting process in the subject of S1 is shown in question number 7 as follows.



Translation:
7. The car that has the smallest engine capacity is the model with the Avansa brand

Figure 1. The Interpreting Process of Subject S1

The results of subject S1 showed that the subject did not carry out the Mathematizing process well since the subject's method could not be translated into a source of information in answering questions. The Devising Strategies indicator did not appear in the working process. The subject only mentioned the wrong conclusion. researcher conducted a more in-depth interview to find out the mindset of subject S1 for further detail.

Q1: "What is your process in solving question number 7?"

S1: "I choose the smallest, sir."

Q1: "How do you choose? I don't see how you do it?"

S1: "In my opinion, the Xenia, sir, is the smallest."

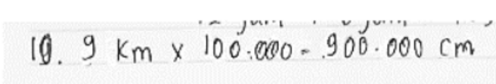
Q1: "How did you get to choose Xenia?"

S1: "I think xenia is the car with the smallest engine capacity."

The interview results showed that the subject S1 had a low understanding of fractions, especially fractional numbers. Thus, the indicator of Using symbolism in subjects S1 was low in understanding mathematical concepts. The reasoning indicator in the subject S1 was also not following the context of the problems at hand. Overall, the indicators of mathematizing, devising strategy, and using symbols in the interpretation of the subject S1 were low, depending on the difficulty in solving problems.

Subject S1 in Employing Mathematical Concepts, Facts, Procedures, and Reasoning

Employing indicators are measured using problems related to measuring distance, speed, and time on the way up the mountain. The process of employing in subject S1 was shown in the process of doing on question number 10 as follows:



Translation:
10. $9\ km \times 100.000 = 900.000\ cm$

Figure 2. The Employing Process of Subject S1

Based on the work results, it appeared that subject S1 was confused about the problem or the intent of question number 10. Thus, subject S1 was not able to answer the question. The researcher conducted interviews more about the subject's process of completing question number 10.

Q1: "How was your process in solving question number 10?"

S1: "I am confused about how to do it."

Q1: "What have you written in your work?"

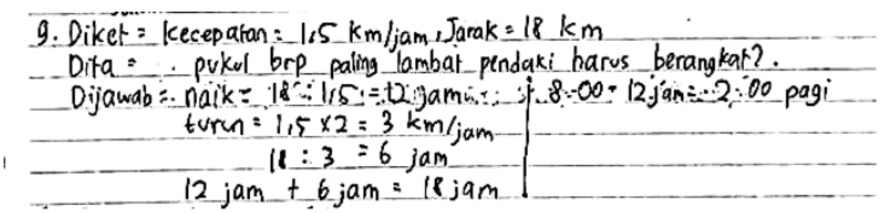
S1: "I multiplied it Sir so that km (kilometers) becomes cm (centimeters)"

The results of the interview showed that the subject was confused in understanding the context of the question. These results showed that the mathematizing indicator underlies how students' process in solving problems. If the subject had difficulty in mathematizing indicators, the other indicators would be difficult to fulfill correctly.

Subject S1 in Formulating Situations Mathematically.

Formulating situations mathematically are measured using problems related to measuring distance, speed, and time on the way up the mountain.

The process of formulating in the subject S1 was shown in the process of answering question number 9 as follows:



Translation:
Known: speed 1.5 km/h, distance 18 km
Asked: What time is the latest for climbers to depart?

Answered: Depart: ($\frac{18\ km}{1.5\ km/hour} = 12\ hours$
Return/down $1.5 \times 2 = 3\ km/hour$
$\frac{18km}{3km/h} = 6\ hours$
12 hours + 6 hours = 18 hours
18 hours + 12 Hours = 2 am

Figure 3. The Formulating Process of Subject S1

Working in the subject S1 on the Mathematizing indicator showed that the understanding related to the problem was quite good. The subject was able to model the problem into a mathematical form. The devising strategies indicator for subject S1 was correct by first calculating the total duration of the journey to the desert. The subject was able to determine the whole time needed to climb and descend from the mountain. However, the final calculation was wrong. It meant that the indicator of Using Symbolic from the subject S1 was still low and not accurate. The researcher conducted in-depth interviews with subject S1 as follows.

Q1: "Are there any difficulties in solving problem number 9?"

S1: "I understand, sir."

Q1: "Try to explain if you understand!"

S1: "So we calculate what time we depart at the latest, so I look for the total time and then I subtract it, sir"

Q1: "Do you think what you are doing is right?"

S1: "Yes, sir"

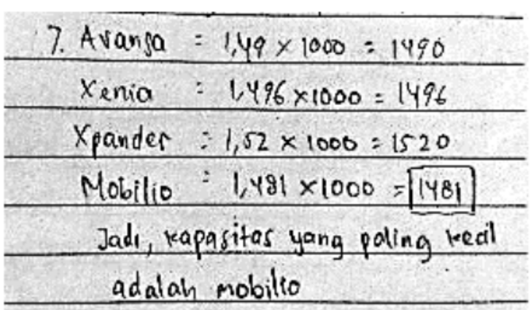
The results of the interview showed that subject S1 had a good understanding of the problem. Therefore, the mathematizing indicator could be done well. Reasoning and Communication indicators showed that the subject S1 had the right mindset in the process he was working on. The subject also believed what was being done was correct. Even though there was an error in the final calculation process, subject S1 was not careful in the final process.

Table 2. Summary of Analysis of Subject S1

	Interpret	**Employ**	**Formulate**
Description of Mathematical Literacy	Subject fulfilled indicators of Representation, Devising Strategies, Reasoning was	Mathematizing indicators, Devising Strategies had not been fulfilled	The Mathematizing indicator was fulfilled, but the Devising Strategies indicator had not been fulfilled.
	Working Memory	**Inhibitory Control**	**Cognitive Flexibility**
Description of Executive Function	Able to receive information. Having difficulty in interpreting information, especially in math problems	Still fully managed by others, unable to self-regulate yet	Cognitive flexibility was still lacking and tended to be low. Since they tended to give up when faced with difficulties. Having difficulty in determining another point of view

Subjects S2 in Interpreting, Applying and Evaluating Mathematical Outcomes.

Subject S2 showed the interpreting process in solving the problem in question number 7. It was a question related to the interpreting process. The following was the process of working of subject S2, as shown in Figure 4.



Translation:

Avansa	: 1,49 × 1000 = 1490
Xenia	: 1,496 × 1000 = 1490
Xpander	: 1,52 × 1000 = 1490
Mobilio	: 1,481 × 1000 = 1490

So the smallest car engine capacity is mobilio

Figure 4. The Interpreting Process of Subject S2

In-depth analysis showed that subject S2 could interpret the table containing the data source of information to solve the problem. The ability of Subject S2 in interpreting tables was fulfilling the Representation indicator by being able to understand information from tables. Solving the problem showed that the subject of S2 uses a different method by performing the multiplication operation of each car capacity with the number 1000. Subject S2 used different strategies and techniques. It helped the subject determine the correct answer according to the criteria from the Devising Strategies indicator. Subject S2 shown a reasoning indicator where he could conclude the interpretation of the largest car capacity. Thus, subject S2 is capable of making the correct conclusions. The researcher conducted an in-depth interview with subject S2 to find out how the process of subject S2 in thinking about solving the problems in question number 7.

Q1: "How did you solve the problem in number 7?"

S2: "Choose the smallest engine capacity from the others, sir."

Q1: "How do you get the smallest engine capacity?"

S2: "Multiply each number by 1000 first, sir"

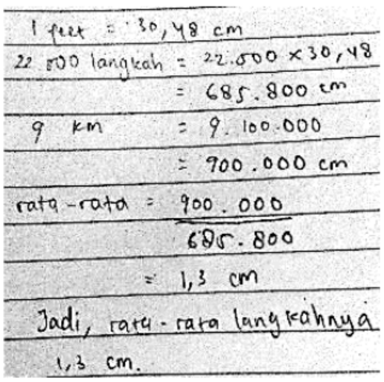
Q1: "Why do you have to multiply by 1000 first?"

S2: "So I can do it easily, sir, since there is no comma anymore."

The interview results demonstrated that subject S2 had a strategy in overcoming his difficulties in determining the smallest number. Subject S2 argued that multiplying it by 1000 would make it easier to solve the problem. It showed that the subject of S2 met the criteria of reasoning. Communication indicators appeared when Subject S2 created a workflow process and conveyed the process of solving the problem.

Subject S2 in Employing Mathematical Concepts, Facts, Procedures, and Reasoning

The subject of S2 shows the process of formulating on the was in solving problem number 10.



Translation:
1 feet = 30,48 cm
22.000 steps $= 22.000 \times 30.48$
$= 685.800\ cm$
9 km $= 9 \times 100.000$
$= 900.000\ cm$
Average $= \frac{900.000}{685.000}$
$= 1.3\ cm$
So, the average footstep is 1.3 cm

Figure 5. The Employing Process of Subject S2

In the initial process of answering question number 10, subject S2 used the unit of measure "feet," then it converted into "cm" (centimeter). Subject S2 wrote the solution about feet measure, even though there was no explanation about "feet" and no relationship between the unit of feet and the question. Subject S2 showed that the capacity of the subject in mathematizing, which translated the information of the question, was still low. The Devising Strategies indicator appeared when subject S2 could apply the method to determine the distance of each step in the question. However, there was an error at the beginning that caused the process to go wrong. Researchers conducted in-depth interviews to the subject S2 as follows.

Q1: "Why do you multiply the conversion result from feet to cm by the number of steps you take?"

S2: "Yes, because I am looking for the distance per step, sir."

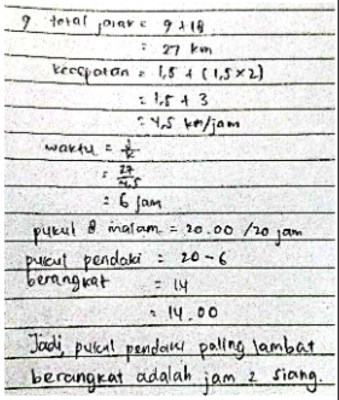
Q1: "You answered that the average result for each step is 1.3 cm. Do you think it is true that each person's step is 1.3 cm?"

S2: "It is like the result of the calculation, sir, so I wrote the answer, sir."

The interview results showed that the main mistake of subject S2 understood the reading context. It means that the mathematizing indicator could not be fulfilled. The reasoning indicator on the S2 subject revealed that the subject S2's reasoning ability was still low. The subject could not correlate the results into reality since the distance of a step 1.3 cm was illogical.

Subject S2 in Formulating Situations Mathematically

Subject S2 has displayed the employing process in the problem-solving process. The method of working on question number 9 was as follows.



Translation:

Total distance $= 9 + 18$

$= 27$ km

Speed $= 1{,}5 + (1{,}5 \times 2)$

$= 1{,}5 + (3)$

$= 4{,}5$

Time $= \frac{distance}{speed}$

$= \frac{27}{4.5}$

$= 6$ *hours*

at 8 o'clock = 20.00 / 20 jam

when the climber goes to the mountain

= 20 - 6

= 14

= 14.00

so, the slowest time for climbers to

Figure 6. The Formulating Process of Subject S2

The process of the subject S2 in answering question number 9 showed several indicators of mathematical literacy, one of the indicators was mathematizing. The mathematizing indicator appeared at the stage where subject S2 could translate the problem into mathematical form. Therefore, subject S2 could process or use information as a source. In the problem-solving process or the Devising Strategies stage, the subject experienced an error in using the information as a completion step. Subject S2 made an error when adding up the climb speed with descending the mountain and determining strategies that affected the other processes in the problem-solving approach. This error leads to wrong conclusions as well. Another mistake made by subject S2 was misinterpreting the total mileage. This misinterpreting related to the Representation indicator since the subject S2 used information and performed arithmetic operations based on information from reading. As a result of these two errors, subject S2 could not solve problem number 9 correctly. The researcher conducted an in-depth interview with subject S2 to discover the thinking process and deepen the analysis of subject S2.

Q1: "What is your process in solving question number 9?"

S2: "Because the question asks about time, then I calculate the time by dividing the distance by the speed."

Q1: "How do you find the time if there is different departure and return speeds?"

S2: "I add up, sir, "

Q1: "Why do you add up?"'

S2: "To calculate the total speed of departure and return."

The interview results from subject S2 showed that the subject understood the problem asked in the question. However, the use of strategies in solving these problems was not appropriate. In Devising Strategies or completion plans, the subject had a wrong understanding by adding up to 2 different speeds. The reasoning indicator showed that subject S2 misinterpreted the formula for the distance and speed in the question.

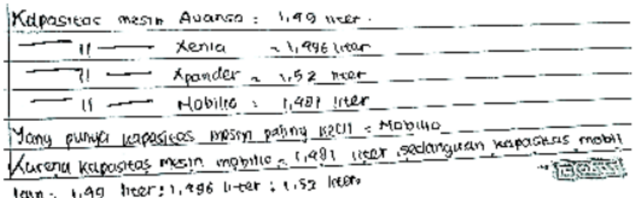
The formulating process showed that Subject S2 had an excellent Mathematizing ability. However, in the indicators of devising strategies, reasoning and representation were not appropriate.

Table 3. Summary of Subject S2 Analysis

	Interpret	**Employ**	**Formulate**
Description of Mathematical Literacy	Representation, Devising Strategies, Reasoning Indicators were fulfilled.	Mathematizing indicators, Devising Strategies had not been fulfilled	Mathematizing indicator was fulfilled, but Devising Strategies indicator had not been fulfilled
	Working Memory	**Inhibitory Control**	**Cognitive Flexibility**
Description of Executive Function	Be able to receive information appropriately, but lack of follow-up on data, especially planning	Be able to do a little self-control. Still heavily influenced by other aspects and easily distracted	Early-stage of cognitive flexibility. Difficulty in determining another point of view

Subject S3 in Interpreting, Applying and Evaluating Mathematical Outcomes

Subject S3, with the high executive function shown, the interpreting process was as follows.



Translation:
car engine capacity

Avansa	: 1,49 *liters*
Xenia	: 1,496 *liters*
Xpander	: 1,52 *liters*
Mobilio	: 1,481 *liters*

The car that has the smallest engine capacity is mobilio.
because the capacity of the mobilio engine is 1.481 liters, while the capacity of other cars is 1.49 liters; 1,496 liters; 1.52 liters

Figure 7. The Interpreting Process of Subject S3

The results of student work showed that subject S3 could solve the problem in question number seven by answering correctly. Subject S3 understood the concepts of fractions and rounding fractions. Thus, subject S3 had no difficulty choosing the smallest unit in the table given in the question. Based on the indicator of mathematical literacy ability, the Representation indicator was seen when the subject S3 could interpret the table shown in the question. Then the subject could obtain the correct information to solve the problem. Indicators using symbols, formal and technical language and operations were fulfilled when the subject S3 ranks the car's engine capacity from the largest to the smallest. Reasoning and Communicating indicators could be seen when the subject S3 argued that the Mobilio brand car had the smallest engine capacity compared to other car brands. For further information, the interview was conducted with subject S3 as follows.

Q1: "How do you interpret the table in question number 7?"

S3: "Because what was asked was the capacity of the car, I observed the capacity of the car, sir"

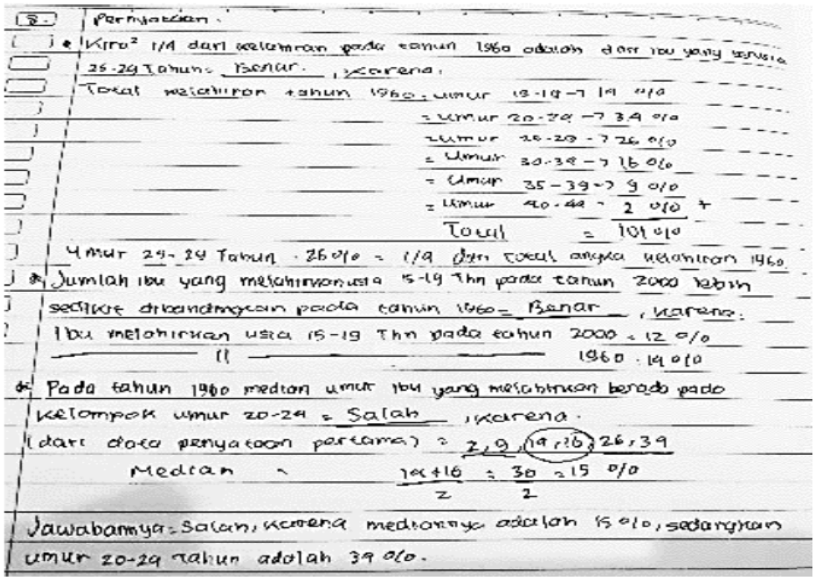
Q1: "How can you interpret that Mobilio has the smallest capacity?"

S3: "I classify first then choose the smallest sir"

Subject S3 was able to read and interpret tables well. Therefore, it means that the subject S3 had good representation skills. Then, using symbols, formal and technical language and operations indicators were well confirmed, as seen from the students' working process. In the interview, students were able to sort from the largest to the smallest cars' capacity. Reasoning and Communication indicators were done well when the subject S3 was being able to argue. Subject S3 was able to explain the arguments he believed in when he was answering question number 7.

Subject S3 in Employing Mathematical Concepts, Facts, Procedures, and Reasoning

The employing process is shown in question number 8. The process of working on the questions by subject S3 is shown in figure 8.



8. Pernyataan:
• Kira² 1/4 dari kelahiran pada tahun 1960 adalah dari ibu yang berusia 25-29 Tahun: Benar, karena.
Total kelahiran tahun 1960: umur 15-19 → 14 %
= umur 20-24 → 34 %
= umur 25-29 → 26 %
= umur 30-34 → 16 %
= umur 35-39 → 9 %
= umur 40-44 → 2 % +
Total = 101 %
umur 25-29 Tahun = 26 % = 1/4 dari total angka kelahiran 1960
• Jumlah ibu yang melahirkan usia 15-19 Thn pada tahun 2000 lebih sedikit dibandingkan pada tahun 1960 = Benar, karena:
Ibu melahirkan usia 15-19 Thn pada tahun 2000 = 12 %
" 1960 = 14 %
• Pada tahun 1960 median umur ibu yang melahirkan berada pada kelompok umur 20-24 = Salah, karena.
(dari data pernyataan pertama) = 2,9,14,16,26,34
Median = (14+16)/2 = 30/2 = 15 %
Jawabannya: Salah, karena mediannya adalah 15 %, sedangkan umur 20-29 tahun adalah 39 %.

Translation:
Question statement
About a quarter of births in 1960 were to mothers aged 25-29 is a true statement because:
Total births in 1960

15-19 years old	= 14%
20-24 years old	= 34%
25-29 years old	= 26%
30-34 years old	= 16%
35-39 years old	= 9%
39-44 years old	= 2%
Total	= 101%

There were 26% of 25-29 years old mothers that represented a quarter of the total births in 1960

The number of mothers who gave birth at the age of 15-19 years in 2000 was less than in 1960 is a true statement, because:
a mother gave birth at the age of 15-19 years in 2000 there were as many as 12%
a mother gave birth at the age of 15-19 years in 1960 there were as many as 14%

In 1960 the median age of mothers who gave birth was in the age of 20-24 years old which was an incorrect requirement, because:
the first statement data obtained 2,9,14,16,26,34
so, the median $\frac{14+16}{2} = \frac{30}{2} = 15\%$
The third statement is wrong, because the median is 15% while 20-24 years old mothers are 34%

Figure 8. The Employing Process of Subject S3

The Representation indicator showed that subject S3 was able to analyze problems related to the displayed diagram. Subject S3 was able to interpret bar graphs that contain information. The Mathematization indicator was seen when the subject S3 could translate the table into a mathematical form adjusted to the question. The strategy used by Subject S3 was to record the percentage of each data in the table. This showed that subject S3 was able to meet the criteria of the devising strategies indicator. Communicating indicators could be seen from the process when the subject was being able to express his opinion in solving the problem in question number 8 through the analysis process. Then the subject S3 could give the correct conclusion. For the detailed information, subject S3 was interviewed related to the completion process.

Q1: "What do you get from question number 8?"

S3: "Question number 8 is a question that is rather difficult to understand, it needs accuracy."

Q1: "How do you solve the problem?"

S3: "At first I was confused to move, then I reread, and I found the right way"

Q1: "How is that?"

S3: "Since in the graph, the number of each pole is not clear, I just guest it in percentage form, so it's easier for me to guest."

Q1: "so it is in determining the amount, isn't it? why do you use percentage to guest?"

S3: "Because I still want to learn about the percentage that I learned before, so I use that method."

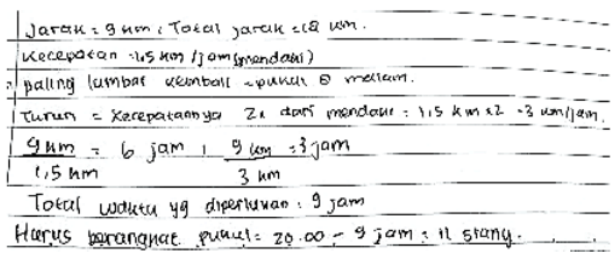
Q1: "Then, what method do you use to answer the question?"

S3: "first, I divide the total by 4, then for part b, I will add the total, and I will divide the total by 2?"

The interview results showed that Subject S3 had a good understanding and the ability to reason for problems based on the Reasoning indicator. This was manifested in the ability to argue and process the subject in understanding the problem. The Employing process showed that the subject S3 had a good capacity by fulfilling the Mathematization, Devising Strategies, Reasoning, Representation, and Communication indicators. However, it has some shortcomings in the Using Symbols indicator.

Subject S3 in Formulating Situations Mathematically

The formulating process was one of the processes in mathematical literacy skills based on PISA standards. The PISA test developed by the researcher consisted of 30% of questions that were included in the Formulate process. The formulating process on the subject S3 was shown in the process as follows.



Translation:
Distance 9 km with a total distance of 18 km
speed 1.5 km/h (climbing)
no later than back to basecamp at 8 pm
descending at twice the speed of climbing is 1.5 km/hour = 3 km/hour
$\frac{9km}{1,5km} = 6\ hours, \frac{9km}{3km} = 3hours$
total time required is 9 hours
So, it must be up to a maximum of 8 pm so that it is 8 pm - 9 hours (travel) so that it departs at the latest at 11 pm.

Figure 9. The Formulating Process of Subject S3

The literacy ability of the subject S3 in the formulate process was shown when the subject was working on question number 9. The subject S3's work showed the subject's ability to mathematize or changed the problem into a mathematical form. Subject S3 made questions to be easier to understand and solve mathematically. The devising strategies indicator was shown when subject S3 designed a solution by calculating the total distance and then dividing the total distance by speed. Thus, the time required could be found. Indicator Using Symbol was shown when the subject performed a calculation operation by dividing distance by speed. Subject S3 also concluded that the result was a unit of time, namely hours. This process showed the subject's understanding of the relationship between distance, speed, and time. The reasoning indicator was depicted when the subject could reason in determining the latest time to climb the mountain. Researchers conducted more in-depth interviews with the research subject to obtain a complete description of the thinking process of the subject S3.

Q1: "How did you solve question number 8?"

S3: "I solve by calculating the distance, then I divide by the speed of departure and speed of descent."

Q1: "Why do you do that?"

S3: "Because I am looking for the time he has to leave."

The interview results described how the subject S3 understood the context of the problem in question number 8. Then the subject S3 was able to communicate their opinion about how he should do to solve it. This could meet the Communicating indicator, which was communicating their work. In general, subject S3 could meet the indicators of mathematization, devising strategies, Using Symbols, reasoning, and communicating well in the formulating process.

Table 4. The Summary of Analysis of Subject S3

	Interpret	**Employ**	**Formulate**
The description of Mathematical Literacy	Representation, Using Symbolic, Reasoning and Communicating Indicators were fulfilled	Representation, Mathematization, devising strategies, Communicating Indicators were fulfilled	Mathematization, devising strategies, Indicator Using Symbol, Communicating Indicators were fulfilled
	Working Memory	**Inhibitory Control**	**Cognitive Flexibility**
The description of executive function	Be able to process information appropriately and do it by planning	Be able to carry out the goals but still had distractions such as cellphones, computers, and games	Be able to make alternative solutions, have good motivation to make improvements and evaluate

The results showed the process of subject mathematical literacy with executive function criteria from different levels. Subjects with high executive function achieved three mathematical literacy processes: interpret, employ, and formulate. The subject was able to perform representation, mathematizing, and communicating which was the initial stage in understanding the context of the problem. Therefore, the subject met other indicators such as devising strategies for problem-solving and using symbolic, formal, and technical language and operations. The reasoning indicator was the key that subjects with high executive function could achieve good mathematical literacy skills. Subjects were able to criticize and understand the context of the problem. Thus, this made it easier to do the next solution. Meanwhile, subjects with moderate and low executive function seemed to have difficulty understanding the problem or the context of the problem. As a result, there are errors and difficulties in representation, mathematizing, and communicating.

Discussion

The errors in the mathematizing, representation and communicating indicators result in other indicators, such as devising strategies and using symbols, formal, and technical language and operations. The reasoning and argument indicators showed that the subject misunderstood the problem. Reasoning and argument indicators were correlated with critical thinking skills (Cresswell & Speelman, 2020; Palinussa, 2013; Su et al., 2016). It was because low essential skills of thinking impacted a person's capacity to interpret and argue based on the problems they face. Reasoning indicators that were achieved well showed the process when a person understood mathematical issues from simple to more complex levels (Hasanah et al., 2019; Jeannotte & Kieran, 2017; Saleh et al., 2018; Sukirwan et al., 2018). A good understanding of the reasoning indicators directed the subject to make completion steps or devising strategies easily. Albarracín and Gorgorió (2014) stated that good devising strategies were supported by reconstructed understanding.

In mathematical literacy, the main component was understanding the problem and converting it into a mathematical form. Understanding problems and being able to make solutions required good critical thinking skills. The present research showed that the critical thinking process was related to logical thinking patterns. Then, the ability to interpret the problems faced creating solutions (Aini et al., 2019). The difficulties in literacy skills were shown mainly in the process of understanding the problem. Therefore, it ran incorrectly, resulting in the completion steps in mathematizing, communicating, and representation. Then, the subject used the incorrect mathematical completion steps. Besides the low understanding of the problem, errors in the mathematical literacy process were caused by misunderstanding the solution strategy. Based on research, Musafir and Susiswo (2021), several factors caused errors in using strategy in problem-solving. They were misconceptions, incorrect procedures, technical errors, and writing mistakes. Subjects with low literacy skills experience misconceptions or understanding of problems with solutions that must be done. Thus, the conclusion was wrong. In the formulating process, subjects with moderate executives were able to meet the mathematizing and devising strategies indicators by planning the completion steps. However, there were still some errors in the conclusion step. Based on Musafir and Susiswo (2021), this was a technical error since the subject experienced a mistake at the end of the conclusion.

This study showed that the level of student executive function influenced the literacy process. Subjects with high executive function had good working memory. Thus, they were able to absorb information well. According to research by Purpura et al. (2017), working memory played a role in mathematical abilities such as counting, comparisons, and formulating mathematical problems. In contrast, the cognitive flexibility aspect was related to the conceptual element of mathematical ability (Purpura et al., 2017; Rahayuningsih et al., 2020). The findings in students' mathematical literacy skills showed that the PISA indicators could not appear in achieving mathematical literacy skills when solving PISA questions. Subjects who could solve PISA questions showed that it began with main indicators such as mathematizing, representation, and communicating. The achievement of these indicators made it easier for students to achieve other related indicators such as devising strategies, reasoning, and argument, Using symbolic, formal, and technical language, and operations. The mathematical literacy process required additional indicators to improve literacy skills, such as critical thinking, which was the basis for achieving the main indicators. Critical thinking was the first step to achieve other indicators in mathematical literacy. One of the PISA indicators that were not possible to apply was using mathematical tools because these indicators were adjusted to the criteria and types of problems given.

Conclusion

Provide a statement that what is expected can ultimately result, as stated in the "Introduction" chapter. Based on the discussion that has been carried out, it showed that the executive function had a role in students' mathematical literacy skills. Literacy skills had three processes, namely formulate, employ, and interpret. This included the main indicators such as communication, mathematizing, and representation. Then it was followed by indicators such as reasoning and argument, devising strategies for solving problems, using symbolic, formal, and technical language and operations, which the main indicators influenced it in achieving it. Students' understanding of a problem strongly influenced the achievement of the main indicators. To achieve this, it needed a mathematical literacy skill, namely critical thinking. One of the PISA indicators that could not always be met was using mathematical tools.

Recommendations

The research conducted is to analyze students' literacy ability based on the executive function possessed by the subject. The following research recommendation is an analysis of executive function development to improve mathematical literacy ability. Recommendations for education practitioners is it is important to consider the executive function aspect in compiling mathematics learning, especially mathematical literacy.

Limitations

The limitation of this study was the limited literacy ability of 15-year-old subjects studying at the junior high school level in Salatiga City. This research is still very open for research development related to literacy and executive functions, especially in more detail on hot executive functions and cool executive functions. Another limitation in this study is the need for further research on subjects with children under 15 and adolescents over 15 years old.

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Authorship Contribution Statement

Kusuma: Conceptualization, design, analysis/ interpretation, writing. Sukestiyarno: Editing/reviewing, critical revision of manuscript, supervision, final approval. Wardono: Editing/reviewing, supervision, final approval. Cahyono: Editing/reviewing, supervision, final approval.

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12

PAGE 13

PAGE 14