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Using the Palembang's Local Context in PISA-Like Mathematics Problem for Analyze Mathematics Literacy Ability of Students

Nurma Lestari[1], Ratu Ilma Indra Putri[2]

[1, 2]Master of Mathematics Education Study Program, Faculty of Teaching and Education, Sriwijaya University
Email: ratuilma@unsri.ac.id

Abstract

This research is descriptive research that aims to describe how the ability of students' mathematical literacy in solving mathematical problems in the PISA model uses the Palembang context. The research subjects were 10th class in senior high school students. The data collection techniques used are written tests, observations, and interviews. The third technique is used to find out what mathematical abilities that arise when students work on mathematical problems in the PISA model using the Palembang context. There are seven mathematical abilities that emerge, such as 84% communication skills; 88,63% mathematical abilities; 100% representation ability; 68,21% reasoning and argument skills; 86,35% ability to choose strategies to solve problems; 70,45% ability to use symbolic, formal language, and techniques and operations; and 68,17% ability to use mathematics tools so that it can be concluded that the 10th class in senior high school students, who were the subjects of the study had mathematical literacy skills that were good enough.

Keywords: Mathematical Literacy Skills, PISA, Palembang

Abstrak

Penelitian ini adalah penelitian deskriptif yang bertujuan untuk menggambarkan bagaimana kemampuan literasi matematika siswa dalam meyelesaikan soal matematika model PISA menggunakan konteks Palembang. Subjek penelitian yaitu siswa kelas 10 SMA. Adapun teknik pengumpulan data yang digunakan yaitu tes tertulis, observasi dan wawancara. Ketiga teknik tersebut digunakan untuk mengetahui kemampuan matematis apa saja yang muncul saat siswa mengerjakan soal matematika model PISA menggunakan konteks Palembang. Terdapat 7 kemampuan matematis yang muncul, yaitu 84% kemampuan komunikasi; 88,63% kemampuan matematisasi; 100% kemampuan representasi; 68,21% kemampuan penalaran dan argument; 86,35% kemampuan memilih strategi untuk memecahkan masalah; 70,45% kemampuan menggunakan bahasa simbolik, formal, dan teknik serta operasi; dan 68,17% kemampuan menggunakan alat-alat matematika. Sehingga dapat disimpulkan bahwa siswa kelas 10 SMA yang menjadi subjek penelitian memiliki kemampuan literasi matematika yang sudah cukup baik.

Kata kunci: Kemampuan Literasi Matematika, PISA, Palembang

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INTRODUCTION

Indonesia is one of many countries that have participated in The Program for International Student Assessment (PISA) since 15 years ago, namely, in 2003. The Program for International Student Assessment (PISA) is a study of student assessment programs (age 15 years) international level held every three years by the Organization for Economic Cooperation and Development (OECD) or organization for economic cooperation and development (OECD, 2016). The focus of PISA is to emphasize the skills and competencies of students obtained from school and can be used in daily life and in various situations (OECD, 2010; Johar, 2012; Mansur, 2018). There are four types of skills in PISA that will be assessed, namely scientific literacy, reading literacy, mathematical literacy, and financial literacy (OECD, 2016).

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PISA is designed and designed to collect information through rotating 3-year assessments to determine student literacy in reading, mathematics, and science (Johar, 2012; Setiawan, Dafik, & Lestari, 2014). PISA also provides information about the factors that influence the development of students' skills and attitudes both at home and at school and also assesses how these factors integrate so as to influence the development of a country's policy (OECD, 2010; Johar, 2012). One measure to see students' mathematical literacy skills is based on the results of the PISA study (Simalango, Darmawijoyo, & Aisyah, 2018; Dinni, 2018). This is in accordance with the opinion of Jufri (2015), which states that the purpose of PISA is that students have mathematical literacy skills.

In mathematics, students are not only required to have numeracy skills but must also have logical and critical reasoning skills in solving problems, solving these problems is not merely a matter of routine questions but rather problems that faced in everyday life, such abilities are known as mathematical literacy skills (Masjaya & Wardono, 2018). Mathematical literacy is defined as a person's ability to formulate, apply and interpret mathematics in various contexts, including the ability to reason mathematically and use concepts, procedures, and facts to describe, explain or estimate phenomena/events (OECD, 2016; Jufri, 2015; Khoirudin, Setyawati, & Nursyahida, 2017; Dewi, Zulkardi, & Yusuf, 2017). Ojose (2011) defines mathematical literacy as a knowledge to know and apply the mathematical basis in everyday life (Fadholi, Waluya, & Mulyono, 2015; Hertiandito, 2016; Sari, 2015).

The math problem of the PISA model has two components, namely, content and context. The content in PISA aims to assess students ' ability to solve real-life problems, which relates to phenomena or events, while the context in PISA is closely related to students (OECD, 2016). A characteristic of the question that PISA uses is context-based to measure the skills of mathematics literacy of 15-year-old students (OECD, 2013; Simalango, Darmawijoyo, & Aisyah, 2018).

According to Fatmawati and Ekawati (2016), context or situation is part of the real world students where the problem or task is placed, while the context of the item is a special setting of the situation. A situation or phenomenon related to the mathematical concepts that students learn is called context (Zulkardi & Putri, 2006; Nizar, Putri, & Zulkardi, 2018). According to Jablonka, a context can become familiar (known) for some students but not for other students (Lange, 2007; Charmila, Zulkardi & Darmawijoyo, 2016). This leads to the use of the unknown context of students in a learning and assessment instrument that can eliminate the function of context itself (Charmila, Zulkardi & Darmawijoyo, 2016).

There are several benefits to the use of contexts namely: the formation of concepts, access, and motivation against mathematics, forming models, providing tools to think using procedures, notation, drawings and rules, reality as the source and domain applications, and exercise specific ability of certain situations (Zulkardi & Putri, 2006). Thus, it is important to integrate the context in the environment around which the learning takes place into learning, including in its assessment activities (Charmila, Zulkardi & Darmawijoyo, 2016). So, using contextual questions related to the daily life of students can activate the student's mindset in the learning process, questions like this will also challenge students ' mathematical thinking process (Kadir & Masi, 2013). The two studies on the development of the model of PISA with the context of the area of research: Charmila, Zulkardi, and Darmawijoyo (2016) with the context of Jambi and the research of Putra, Zulkardi, and Hartono (2016) in the context of Lampung.

Palembang is the capital city of South Sumatera province. One of the most famous characteristics of this city is its food, Pempek Lenjer. In addition, there are also the Ampera bridges, which are the main bridge in the city as well as the transport of the rapid light transportation (LRT), which makes the city of Palembang become a modern city. The local context of Palembang city has a lot of potentials that can be used as a source of reference in learning mathematics at school and also contains the concept of mathematics, including the content that exists in PISA.

Based on the explanation above, the objective of this research is to find out how an overview of students 'mathematical literacy skills in resolving PISA model mathematics using the local context of Palembang.

METHODS

This study is a qualitative descriptive study that aims to describe how students' mathematical literacy skills in solving mathematical problems in PISA model by using Palembang local context. The research subjects were 44 of 10th-grade high school students. The variable of this research is the students' mathematical literacy skills. The seven basic mathematical abilities used in the mathematical literacy process (OECD, 2016; Steen, 2001; Ojose, 2011) were communication ability; mathematical ability; representation ability; reasoning ability and arguments ability; Ability to choose strategies to solve problems; Ability to use symbolic, formal language, and techniques and operations; and ability to use mathematical tools. However, according to Pulungan (2014), mathematical literacy ability is an ability that includes mathematical problem-solving abilities, mathematical communication, mathematical reasoning, mathematical connections, and mathematical representations.

Preparation Phase

The researchers analyzed curriculum 2013, framework PISA 2015, and mathematics teacher instruments at the research school. The teacher's instruments include lesson plans and students' mathematics textbooks. The goal is the researchers will know the extent of the material that has been taught to the students, and the researchers also interview the teachers about the students' mathematical abilities. Then, the researchers started to make learning instruments such as question cards, assessment rubrics, teacher instructions, and lesson plans. The questions developed by the researcher were eight units of mathematical questions in the PISA model by using Palembang local context.

However, in this study, the researchers will discuss one of PISA's questions with the context of pempek lenjer, which will explain the students' mathematical literacy skills when they are answering the questions. After making the questions, the researcher takes care of a letter for doing research at school. After that, the researcher and three mathematics teachers together validated the questions and other instruments. The validation process is based on the characteristics of the questions that can be valid in terms of content, constructs, and language. Besides doing the validation with the teachers, the researcher also validated the questions with two colleagues who were the students of magister mathematics education. After completing the validation process, the researcher immediately revised the question instrument based on the results of comments and suggestions from the validators.

Implementation Phase

In this stage, the researchers tried out the mathematics questions of the PISA model to 44 of ten grade students who had different mathematical abilities. Each student worked individually when the students were answering the questions, the researcher observing and interviewing students in order to know the extent of students' mathematical literacy abilities.

Data Collection Phase

In this study, the data collected were the results of student answers, video recordings during interviews, and observation records. Therefore, the data collection techniques used were tests, interviews, and observations. The following is an explanation of each stage:

- Test.

  The test is carried out to obtain the results of the student's answer in Unit 1 that will be used to see the ability of literacy students
- Interview.

  The interview is conducted after the students completed the assignment. The interviews are carried out to clarify student thought in completing Unit 1. In addition, to strengthen the evidence of the research, the researcher puts additional video and recording during the interview.
- Observation.

  The observations are carried out to find out the students' activities while they are doing the assignment.

The following is an indicator table of 7 basic math skills of students based on the PISA 2015 framework (literacy skills). Page 69 (PISA 2015 framework).

Table 1. Indicators of students' mathematics skills

Mathematics Skills	Indicators
Communication	Read, decode, and make sense of statements, questions, tasks, objects or images, in order to form a mental model of the situation
Mathematical	Identify the underlying mathematical variables and structures in the real world problem, and make assumptions so that they can be used
Representation	Create a mathematical representation of real-world information
Reasoning and Arguments	Explain, defend or provide a justification for the identified or devised representation of a real-world situation
Ability to choose strategies to solve problems	Select or devise a plan or strategy to mathematically reframe contextualised problems
Ability to use symbolic, formal language, and techniques and operations	Use appropriate variables, symbols, diagrams and standard models in order to represent a real-world problem using symbolic/formal language
Ability to use mathematical tools. However, according to Pulungan	Use mathematical tools in order to recognise mathematical structures or to portray mathematical relationships

Data Analysis Phase

In this study, the results of students' answers (data) were analyzed not by scores or values, but by looking at the students' mathematical literacy abilities (7 students' basic mathematical abilities) that can be seen when the students finishing the assignment. Then, the percentage of each ability is calculated. The aim is to find out what the students' abilities that will appear when they are doing mathematical questions of PISA in Unit 1 from 44 students. Here's how to determine the percentage of each ability.

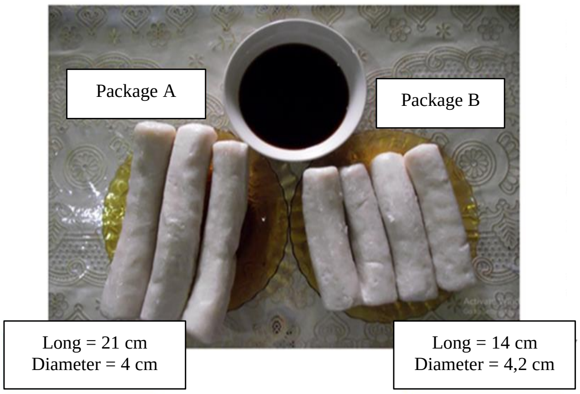
$$Percentage = \frac{the\ number\ of\ students\ who\ bring\ up\ literacy\ abilities\ (each\ ability)}{the\ total\ number\ of\ students} \times 100\%$$

(Modifications from Sudjana, 2009)

The data from observations were analyzed descriptively to observe student activities while doing questions to support their mathematical literacy abilities. Overall, all observation activities were carried out by video recording. Interview data were analyzed descriptively to get clarity from students' thoughts or clarify the strategies students used in completing Unit 1 PISA questions.

RESULTS AND DISCUSSION

PISA-like mathematics problems that were done by students are Unit 1 with pempek lenjer context. This problem consists of one question with its characteristics are personal context, change, and related content, and its prediction level is four. The following is a figure of the Unit 1 problem done by students.



At the pempek lenjer store, there are two choices of pempek lenjer packages namely package A and package B. If the prices of the two packages are the same. Which package would you choose? Give your reasons.

Figure 1. PISA-like mathematics problem Unit 1

Problem Unit 1 asks students to determine which package to choose if the two packages have different sizes and numbers of pempek. This problem is included in the comparison material and tube material. In order for students to be able to answer this problem, reasoning skill is needed to associate the weight with the volume of the tube. This level of question is included in level 4 because students can solve questions effectively with implicit models and in concrete but complex situations that have obstacles or make assumptions (OECD, 2016)

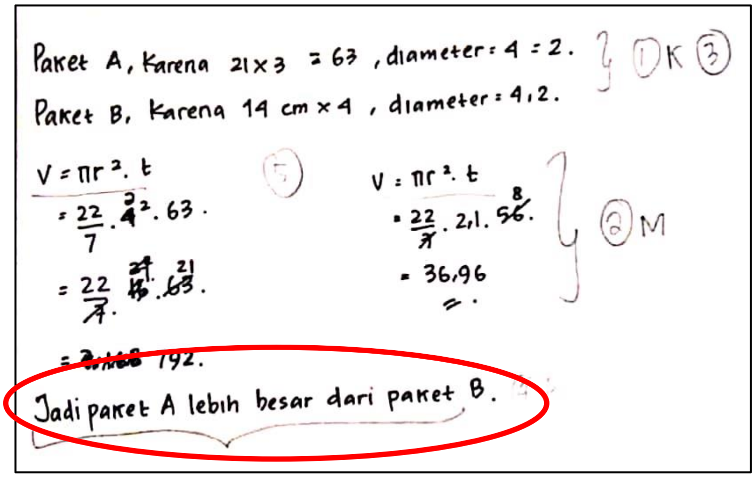
Based on the answers from 44 students while working on the PISA-like mathematics problem Unit 1 with the context of pempek lenjer, the results obtained are as follows.

Table 2. Percentage of mathematical abilities that appear

Mathematics Ability	Percentage
Communication	84%
Mathematical abilities	88,63%
Representation	100%
Reasoning and Argument	68,21 %
Ability to choose strategies to solve problems	86,35%
Ability to use symbolic, formal language, and tehniques and operations	70,45%
Ability to use mathematics tools	68,17%

Based on the table, it can be seen that for communication, and mathematical abilities almost appeared in each student, 37 and 39 students, while for the knowledge of representation has appeared in each student when working on PISA-like mathematics problems Unit 1 with the context of pempek lenjer. It means there are no problems with the three mathematical abilities. This is in line with the results of research on PISA by Permatasari, Putri, & Zulkardi (2018) which states that the results of learning show that almost all students are able to solve problems well and involve their mathematical literacy skills, such as mathematical ability, representation, and communication.

For reasoning and arguments, abilities are categorized well because they have appeared in 30 of 44 students. This is in line with the results of Efriani, Putri & Hapizah's research (2018), which states that the dominant ability arises when students work on PISA-like mathematics problems using context rows are reasoning and representation abilities. There were 15 students who did not emerge this ability; one of them was Student KN. Student KN seem to still not be able to conclude that volume/weight of pempek = volume of the tube, because to choose a package, students must first determine which package weighs more and that student only mentions package A is greater than package B. For more details, see the following figure.



Translation

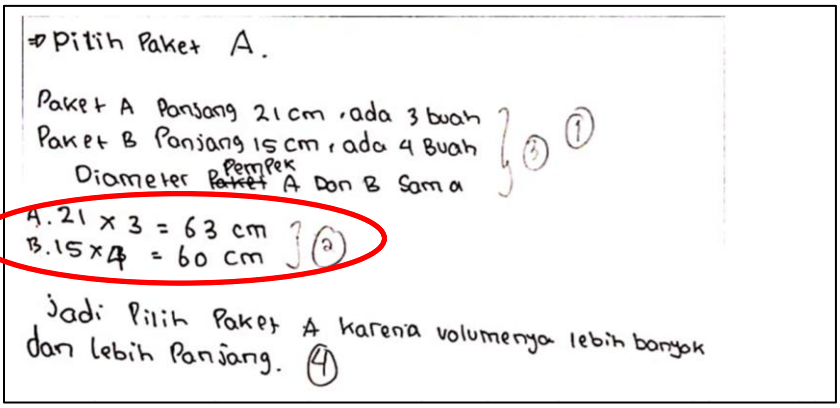
So, package A greater than package B

Figure 2. Student KN's answer

Based on the answers of Student KN, it was seen that Student KN was able to calculate the volume of the tube or volume (weight) of pempek, but student KN could not conclude that the weight of the tube = volume of the tube, even though he had solved the problem using the tube formula, but he did not write a relationship between the volume of the tube with volume/ weight of pempek so that it can be concluded that Student KN has not appeared reasoning and arguments abilities. Furthermore, the researcher interviewed Student KN about her answer, as for the results of the interview as follows.

Researcher : *Why do you use the tube formula?*
Student KN : *Because in the problem there is diameter and length, and the pempek is also shaped like a tube, so I use the tube formula.*
Researcher : *Oh like that". (While looking at students when solving problem). What does package A mean bigger than package B?.*
Student KN : *The volume of package A is greater than package B.*
Researcher : *Are you done?*
Student KN : *I'm done.*

Furthermore, the ability to choose strategies to solve problems also appeared in 38 students, and there were six students who did not show up this ability. It caused by students have not been able to determine what formula is used to solve PISA Unit 1 problem. This is in line with the results of Simalango, Darmawijoyo & Aisyah's research (2018), which states that the more dominant difficulties when students work on PISA questions are to change real problems into mathematical forms. One of the six students who had difficulty was Student YN. Student YN directly multiplies the numbers without linking the questions to the concepts in the mathematical material that has been taught during junior high school, namely the tube material. For more details, see the following figure.



Translation

Package A, long 21 cm, there are 3
Package B, long 15 cm, there are 4
Diameter of Pempek A and B are same

A. $21 \times 3 = 63\ cm$
B. $15 \times 4 = 60\ cm$

So, I choose package A because the volume is more and longer

Figure 3. Student YN's answer

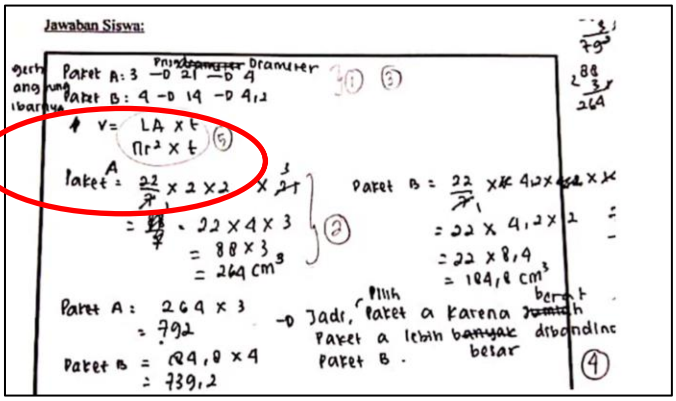
Based on the results of Student YN's answers, Student YN mistakenly determined the strategy in solving problems in Unit 1. The student multiplied the length of pempek with the number of pempek because he considered the diameter of the two pempek to be the same. Student YN assumed the diameter of the two pempek was the same because they only differed by 0.2 cm. In addition, Student YN also mistakenly wrote the length of the pempek in package B. However, the end of the

Student YN's answer was correct, but the resolution process was still wrong. The following is a figure of the results of interviews of researchers with Student YN.

Researcher : *Why do you multiply the lenght of the pempek by the number of pempek?*
Student YN : *Because the diameter is the same, so just multiply it right away, no need to calculate it with the tube formula.*
Researcher : *Are you sure the diameter is the same? try checking again.*
Student YN : *Differ only by 0.2 cm. It seems like it doesn't matter.*
Researcher : *Is that justified?.*
Student YN : *Yes, because even without counting it can be immediately seen that pempek package A is bigger than package B, because the difference in lenght is quite far.*

Based on the conversation between the researcher and the students above, Student YN understood the questions which were given by the researcher, but he assumed why both the diameter of pempek in package A and package B were the same. Students YN multiplied the number and length of pempek because he arranged the pempek in each package, and obtained the length of the arrangement in package A was longer, so he concluded that the pempek in package A had a larger volume. Although the final answer of Student YN was correct, the strategy used was not justified by the researcher.

Furthermore, the ability to use symbolic, formal, and technical languages and operations only appeared in 31 students and did not appear in 13 students. This was due to Student YN's answer, as shown as a figure. 4, did not use a formula, so it did not appear the ability to use symbolic language. One example of students' answers that appears this ability is like the following figure.



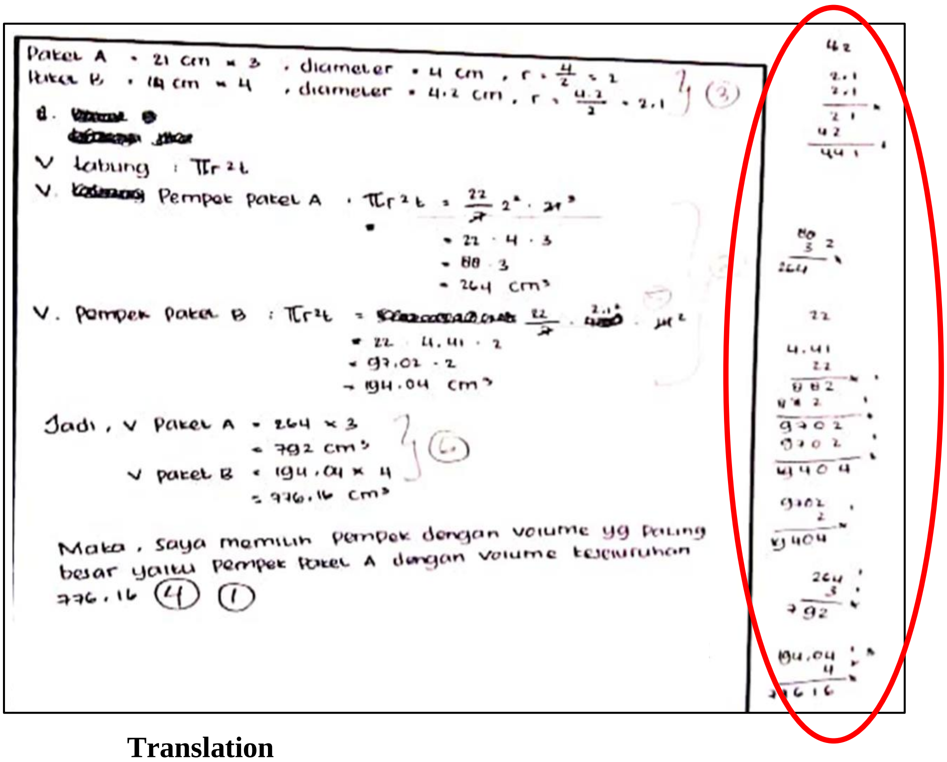
Translation

So, I choose package A because the weight of Package A is greater than package B

Figure 4. Student SRR's answer

Based on SRR students' answers, it appears that the "V" symbol for volume, "LA" for the base area, "t" for height, "r" for radius. There is a " → " which means interconnected between the numbers on the left and right. And there is also "cm3," which is a unit of volume or content.

And for the last ability, which is the ability to use mathematical tools, it appeared that this ability appeared in 30 students and did not appear in 14 students because the fourteen students did not use calculators or any tools and counted manually on their answer sheets. Based on the results of answers from 30, students have emerged indicators of using mathematical tools to recognized mathematical structures or to described mathematical relationships correctly and completely. For more details, you can see examples of student streak when counted on their answer sheets, as shown in the following figure.



Translation

So, I choose pempek with the largest volume, namely pempek package A with a total volume $776{,}16\ cm^3$

Figure 5. Student TP's answer

Based on Student TP's answers, it appears that Students TP counted manually or without a calculator (mathematical tool). This is because the numbers used by researcher in the question include numbers that are not difficult, with the length of pempek are 21 cm and 14 cm which are a multiple of 7, it means that the pi value used is $\frac{22}{7}$, so it did not produce complex decimal calculation values. But there were many students who still used calculators in calculations because they felt unsure about the calculations themselves, which can be seen from the absence of scribbled calculations on the answer sheet.

Based on the results of the explanation above, it was found that the PISA-like mathematics problem Unit 1 was able to bring up the seven students 'mathematical abilities or students' mathematical literacy abilities, so that in accordance with the statements of Simalango, Darmawijoyo, & Aisyah (2018) and Dinni (2018) that one measure to see mathematical literacy skills of the students are based on the results of the PISA study. In line with the statement of Jufri (2015) that the purpose of PISA is that students have mathematical literacy skills.

The researcher made a Unit 1 question using the context of Pempek Lenjer, which is Pempek Lenjer itself is one of Palembang's local contexts that is already well known by most students, and after tested it to students, it was found that 38 of 44 students were able to solve the problem with a strategy correct. This is in line with the benefits of the context according to Zulkardi & Putri (2006), namely by using context can occur the formation of concepts, access and motivation to mathematics, formation of models, providing tools for thinking using procedures, notations, images and rules, reality as sources and domains application, and exercise specific abilities for certain situations.

CONCLUSION

Based on the results of research on 44 of Senior High School (SMA) in Palembang City, a description or description of students' mathematical literacy skills was obtained, which in this case were seven basic mathematical abilities of students in solving mathematical questions in the PISA model using the Palembang local context namely: communication skills appeared in 37 students; mathematical abilities appeared in 39 students; representation ability appeared in all of the students; reasoning and argument skills appeared in 30 students; ability to choose strategies to solve problems appeared in 38 students; ability to use symbolic, formal language, and techniques and operations appeared in 31 students; and ability to use mathematics tools appeared in 30 students, In addition, other findings include the role of the Palembang context for students. This can be seen from the results of the answers of students who are able to solve mathematical questions in the PISA Unit 1 model using the context of pempek lenjer (content change and relationship, personal context, level 4) properly and correctly.

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