Students' creative thinking skills in solving PISA-like mathematics problems related to quantity content

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Abstract

The introduction of the Merdeka curriculum mandates that teachers emphasize the development of creative thinking abilities and incorporate learning into local contexts. For this reason, this study aims to describe the creative thinking skills of class VII students in answering PISA-like mathematics problems on quantity in the context of Palembang tourism using *the Pendidikan Matematika Realistik Indonesia (PMRI)* approach. This study used a descriptive study with 28 students from junior high school number 26 in Palembang. Tests, interviews, and observations were used to collect data. The analytical method used is descriptive. The PMRI technique learning is carried out in this study by providing student worksheets. The task of students to discuss each other's problems with different levels of difficulty, followed by two PISA-like mathematics problems in quantity content and the context of Palembang tourism. The results showed that students' average creative thinking skills were at a moderate level, with fluency and elaboration indicators appearing the most. However, only a few students have indicators of originality. Overall, the creative thinking ability of grade VII students in answering PISA-like mathematics problems in the quantity content and Palembang tourism by utilizing the PMRI approach is good because students can imagine questions because they use content and contexts that they have experienced.

Keywords: creative thinking; PISA; quantity

Introduction

Creative work is to be inventive, innovative, and supportive of new ideas. As a result of considering long-term employment, creative thinking tends to highlight characteristics that deviate from critical appraisal (Bailin, 1987). Fluency, adaptability, creativity, and thinking are the four characteristics of creative thinking (Babij, 2001). Their ability to think creatively can help students adjust to a society that is changing quickly and needs adaptable people with '21st-century' skills beyond literacy and numeracy (OECD, 2021). The imagination and curiosity of the students lead the learning process. Creativity is a means of understanding students even in the context of the established learning objectives (Beghetto & Plucker, 2006).

The Organization for Economic Co-operation and Development (OECD) and many other participating nations, including Indonesia, created the Program for International Student Assessment (PISA) to measure students' academic performance worldwide. PISA 2021 defines *creative thinking* as the capability to contribute to developing, improving actively, and producing ideas that can result in practical solutions, progress knowledge, and influence the expression of imagination (OECD, 2019). However, Indonesians still need to improve their capacity for original thought. According to data from the Global Creativity Index, Indonesia is ranked 115th out of 139 countries for creativity (Florida et al., 2015). Asking for PISA-like mathematics problems is one way to gauge students' capacity for creative thought. Because it adheres to the standards for PISA-like mathematics problems that need creative thinking skills, the question of designing the PISA- like mathematics problems can be utilized as a benchmark for students' creative thinking abilities. It will motivate students to find solutions or original responses to a mathematical problem (Nusantara et al., 2020a). The PISA program can also inspire children to work through life's challenges in order to be able to live in any circumstance, one of which is COVID-19 (Nusantara et al., 2021a).

Kadir and Masi (2014) stated that the use of context can engage students in the learning process. Students should be able to relate to the context since it applies to their everyday life (Zulkardi et al., 2020). The use of content can give some advantages; PISA-like mathematics problems with a quantity content focus give students practice opportunities and present a fun evaluation challenge (Kristanto & Yunianta, 2021).

The *Pendidikan Matematika Realistik Indonesia (PMRI)* can be utilized to teach through the integration of daily activities (Zulkardi & Putri, 2010). One of the situations that may be used as teaching resources for students to increase interest in learning a subject is instructional materials relevant to daily life, such as travel destinations, regional culture, games, and others.

The underwhelming performance of Indonesian students in the PISA demonstrates the critical need for further emphasis on students' creative thinking skills (Nusantara et al., 2021b). Previous research on the development of PISA-like mathematics problems was completed is focused on algebra (Nusantara et al., 2020b), geometry (Sistyawati et al., 2022), uncertainty and data (Nusantara et al., 2020a). Moreover, other research that discusses creative thinking only focuses on number pattern material (Anggraini & Zulkardi, 2020).

However, little research still uses the PMRI approach to focus on the quantity of content and tourism context in Palembang. In this regard, researchers desire to understand the field conditions more deeply and intensely about students' creative thinking skills in PISA-like mathematics problems in quantity content and the context of Palembang tourism by using the PMRI approach in class VII.

Methods

This research uses descriptive research because the problems to be studied are complex. Therefore, it is necessary to use more accurate and reliable data obtained through interviews with participants (Gunawan, 2022). Researchers also have the goal of understanding the conditions in the lab more thoroughly and intensely. The participants in this study were 28 students from SMP Srijaya Negara Palembang's class VII.4 in the odd semester of the 2022/2023 academic year. Researchers assessed creative thinking skills by having them respond to PISA-like mathematics problems on ratio material related to Palembang tourism using the *Pendidikan Matematika Realistik Indonesia (PMRI)* approach during the teaching and learning process. According to the teacher's recommendation, students were chosen by considering their report cards and their engagement in the teaching and learning process. This study used tests, interviews, and observation to collect data. The results of a written test with one descriptive question and a score can be used to gauge students' levels of creative thinking. In this study, there are four measures of creative thinking abilities:

Table 1. Indicators of creative thinking skills

Indicator	Descriptor
Fluency	Fluency of opinion in explaining concepts
Flexibility	Flexibility of opinion in presenting concepts
Originality	Originality presents answers and ideas
Elaboration	Elaboration of opinion presents answers and ideas

Fluency, flexibility, originality, and elaboration are examples of creative thinking abilities included in Table 1 based on Abidin (2016). The capacity to communicate ideas accurately is known as fluency. Being flexible means having the capacity to express novels, engaging, and different ideas. The capacity to convey ideas that are original and distinct from those of others or preexisting sources is known as originality. The capacity for explaining and adding information to thoughts and ideas is known as elaboration.

Additionally, it is mentioned in this book that creative people generally reject conventional methods or formulas, are interested in a wide range of issues, even those that have nothing to do with them, see issues from a variety of angles, and do not view the world as universal or absolute (Nurlaela, 2015). They also engage in trial and error and maintain their optimism to make progress. The value of the student's responses, or their score, is determined by the scoring rubric table, shown in Table 2 below.

Table 2. Scoring rubric of creative thinking skills

Indicator	Descriptor	Skor
Fluency	No answer	0
	Expressing ideas and answers incompletely and unclearly	1
	Expressing ideas and answers incompletely and clearly	2
	Expressing ideas and answers completely and unclearly	3
	Expressing ideas and answers completely and clearly	4
Flexibility	No answer	0
	Gives one way but the calculation process has an error	1
	Gives one way but the calculation process is correct	2
	Gives more than one way but the calculation process has an error	3
	Gives more than one way but the calculation process is correct	4
Originality	No answer	0
	Giving the same answer as someone else's answer	1
	Give answers in their own way and the calculation process is incorrect	2
	Give answers in their own way and the calculation process has an error	3
	Give answers in their own way and the calculation process is correct	4
Elaboration	No answer	0
	Don't expand the situation and don't go into detail.	1
	There is an error in expanding the situation without accompanied by less detailed details	2
	There is an error in expanding the situation and accompanied by less detailed details	3
	Expanding the situation properly and detailing it in detail.	4

Table 2 contains each indicator with a maximum and minimum score; the maximum score is four, and the minimum score is 0, based on Moma (2015). Each question contains four indicators, as shown in Table 1. If students receive the maximum score for each soal, they will receive the maximum score of 16.

The categories of creativity indicators are then grouped as follows after assessing the results of students' test question answers (see Table 3).

Table 3. Categories of creativity indicator

Score	Category
81-100	Very high
61-80	High
41-60	Moderate
21-40	Low
0-20	Very low

Table 3 above contains the grouping of students' creative thinking skills categories. The score is obtained from the student's score divided by the maximum score and multiplied by 100 based on Purwanto and Surjaman (2020).

The preparation stage

The Junior High School Number 26 Palembang offers this learning offline. The preparation, implementation, and final stages are the several phases of descriptive study. The development stage begins with the self-evaluation, expert review, one-on-one, small group, and field test stages because it will employ development questions from PISA-like mathematics problems. There is no restriction on validity and reliability in this study; validity and reliability are assessed through the self-assessment stage, expert review stage, and small group, one-to-one. Fluency, flexibility, originality, and elaboration are the four signs of creative thinking used in PISA-like mathematics problems. The researchers created two PISA-like mathematics problems, each of which had three levels of questions within it. Questions of understanding, application, and reasoning represent the three levels of questions.

At this stage, students are asked questions on understanding the problem in terms of language. Next, the researchers visited Junior High School Number 26 Palembang to ask the institution for permission to conduct the research and determine which class would be used as a school research class. After that, the researchers observed the documents needed to conduct the research.

The implementation stage

| (a) | (b) | (c) |

Figure 1. (a) Learning process; (b) Student activity; (c) Student presentation

The learning process was implemented at the implementation stage in two sessions after the instrument had been improved and deemed valid. The *Pendidikan Matematika Realistik Indonesia (PMRI)* technique was used at the first meeting to utilize worksheets as a learning medium. The teacher will present the worksheets to the class and then instruct them to discuss and resolve the issue as indicated in (a) and (b). As seen in figure (c), the teacher will ask several student representatives to present and respond before concluding with a statement from one of the students. The crew was requested to assist the researchers by acting as observers in each group. Observations were made to ensure learning using the PMRI

Figure 2. Field Test on PISA-like mathematics problems

Figure 2 shows that students were given creative thinking skills test questions. After the students' test results were obtained, the researchers interviewed three students based on the low, medium and high categories.

The final stage

The researchers then compile a research report by analyzing the data from the interviews, the test results for creative thinking skills, and the data from the observations. The researchers conclude at the end. The value or score of the students' answers is used to gauge the analysis of test data.

Results

The researchers examined each student's responses to the written test afterward. According to the scoring rubric, three students were identified as being very high categories (11.1%), six as being high categories (22.2%), 12 as being moderate categories (44.4%), five as being low categories (18.5%), and two as having very low categories (7.4%). Then, DR was chosen as a stand-in for students with high categories. SN was chosen as an example of students with moderate categories, and one student, WS, was chosen as a representative of students with extremely low categories. The findings of the examination of student responses are as follows in Figure 3.
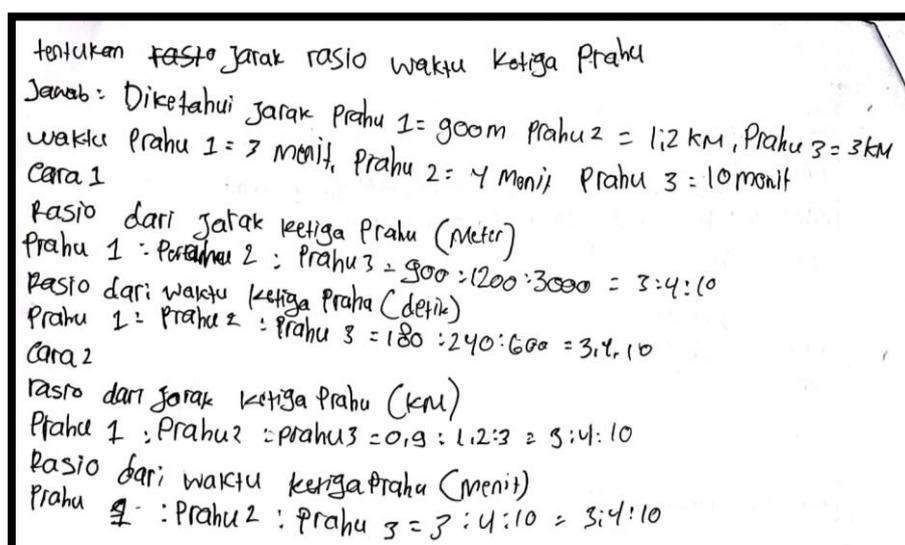
Translation:
Determine the ratio of the distance and the ratio of the time of the three boats
Answer : it is known that the distance of boat 1 = 900 m, boat 2 = 1.2 km, boat 3 = 3 km
boat time 1 = 3 minutes, boat 2 = 4 minutes, boat 3 = 10 minutes
method 1
ratio of the distance of the three boats (meters)
boat 1 : boat 2 : boat 3 = 900 : 1200 : 3000 = 3 : 4 : 10
ratio of the time of the three boats (second)
boat 1 : boat 2 : boat 3 = 180 : 240 : 600 = 3 : 4 : 10
method 2
ratio of the distance of the three boats (kilometers)
boat 1 : boat 2 : boat 3 = 0,9 : 1,2 : 3 = 3 : 4 : 10
ratio of the time of the three boats (second)
boat 1 : boat 2 : boat 3 = 3 : 4 : 10

Figure 3. Answers to test question students DR

Figure 3 shows that DR students have entirely and clearly explained how to calculate the distance and time ratios, getting them a score of 4. DR students also write in two different methods, and the calculations are accurate, getting them a score of 4. Furthermore, since the response utilized a basic formula and got a score of 1, DR students answered with only some original and distinctive thoughts. Finally, DR students developed the scenario and contributed information, scoring 4. So, students got a score of 13 on the question

Interviews were conducted to support the student's test analysis findings. The first is DR as an example of a student with very high and high skills. The findings of the interview are as follows:

R : What information did you get? What is known about this matter?
DR : Distance
R : How far is it?
DR : 600 meters
R : What is asked in this question?
DR : How long will it take
R : So, is there anything else to know?
DR : Speed
R : So, what is the speed of the ship?
R : Apart from the method you used, can you find another method?
DR : Maybe use a speed of 0.3 km/min
R : When solving the problem, did you have any questions to ask your friends? What do you ask?
DR : No, I didn't
R : Explain in detail the steps of the solution
DR : we first find the distance and speed, then we find using the formula distance, speed and time that is distance = time x speed. so later time = distance/speed

As seen in the interview up top, DR is capable of communicating answers clearly and can also elaborate on queries and suggest alternative approaches. However, DR still needs to develop a new and original solution.

| Translation: |
| Determine the ratio of the distance and the ratio of the time of the three boats |
| Answer : |
| boat 1 : boat 2 : boat 3 |
| 900 : 1200 : 3000 |

Figure 4. Answers to test question students SN

Figure 4 shows that SN students have completed their writing. However, it needs to be clarified how to calculate the time ratio, specifically by only writing numbers without receiving a prior explanation, going to result in a score of 3. SN students write only in one direction, and the calculations' outcomes are accurate. Hence, they got two scores. Additionally, SN students got a score of 1 since their response, which employed a general formula, lacked originality and differentiation. Finally, SN students got a score of 1 because they needed to elaborate on the situation in detail. Students thus got a score of 9 on the question.

Translation:
Determine the ratio of the distance and the ratio of the time of the three boats
Answer :
The first boat is 900 m and the time is 3 minutes
The second boat is 3 km away and the time is 10 minutes

Figure 5. Answers to test question students SN

Figure 5 shows that WS students also only write in one way. However, there is an error, and it needs to be evident how to calculate the ratio, particularly just by writing numbers and doing the computation incorrectly so that they get a score of 1. Hence, you will get one score. Furthermore, because the response utilized a standard formula and got a score of 1, WS students did not respond with original and distinctive thoughts. Last but not least, we only elaborated on the topic by providing specifics to get a score of 1. Students thus got a score of 4 on the question.

Discussion

Fluency, flexibility, originality, and elaboration are the four marks of creative thinking used in PISA problems. The following analyzes most students' answers and then explains the indications.

Fluency

It was found that students on the "fluency" indicator on creative thinking skills often appeared. It was because students could see the problems presented. Students can see the problems presented because the problems presented use content and contexts that students often experience in real life. It is in line with the opinion of Masfufah and Afriansyah (2021). In practice, students need to be accustomed to being given questions with the PISA type in everyday life so that students can open their minds widely. Some students can use arithmetic techniques to solve the problem, even if their solution is inaccurate, even when they cannot write down what is known and asked. Students are accustomed to turning everyday circumstances into mathematical issues (Nurazizah & Zulkardi, 2022). However, due to the online learning caused by COVID-19, several students who were hesitant to speak referred to previously learned material.

Flexibility

It was found that students on the "flexibility" indicator on creative thinking skills often appeared. Although they cannot develop new answers, they make more than one way out of the existing ones (Subur, 2013). They have studied these methods before in learning using the *Pendidikan Matematika Realistik Indonesia (PMRI)* approach. Students can determine the intended pattern of the test questions. It relates to the flexibility of students in developing existing problems (Anggraini & Zulkardi, 2020).

Originality

It was found that the students' ability on the originality indicator rarely appeared. Most of the students' answers were the same because they were based on formulas. However, the indicators of fluency, flexibility, and elaboration distinguished students' answers from one another. It is caused by students who are only fixated on the formula. It is in line, according to Subur (2013); namely, the student's point of view in solving the problem still needs to be improved because of the habit of students who are always fixated on standard solutions or formulas that are commonly studied in class.

Elaboration

It was found that some students answered by writing down the details presented in the questions. It shows that the "elaboration" indicator is on creative thinking skills. Moreover, some students need to show these indicators. The factor is that most students need to remember to write down these details (Andiyana et al., 2018).

Conclusion

According to the study, class VII students have good creative thinking skills when using the *Pendidikan Matematika Realistik Indonesia (PMRI)* approach to solve math problems similar to those from the PISA-like mathematics problems. However, they are specific to the Palembang tourism industry. Students can fully and clearly explain the requirements of the problem and have multiple options even though there is no new or original way to solve the problem. Students are taught using the *Pendidikan Matematika Realistik Indonesia (PMRI)* method and have access to various content materials during visits around Palembang.

However, this study has several drawbacks, including the need for more student knowledge because previously, students did ineffective online learning. Some students need help with the lessons they should learn. In online learning, students only get the maximum lesson due to personal or network reasons.

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Conflicts of Interest

The authors declare no conflict of interest regarding the publication of this manuscript. In addition, the authors have comprehensively addressed the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies.

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Author Contributions

Shalshabilla Shafa: Conceptualization, writing - original draft, editing, and visualization; **Zulkardi:** Writing - review & editing, formal analysis, and methodology; **Ratu Ilma Indra Putri:** Validation and supervision.

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