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# Student's Mathematical Reasoning Ability in Solving PISA-Like Mathematics Problem COVID-19 Context

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**Abstract**

The goal of this study is to use the PMRI approach to measure the mathematical reasoning ability of grade VII students in answering PISA-like mathematics problems on number content in the context of COVID-19. This study employs descriptive research with a total of 34 participants from SMP Srijaya Negara Palembang's class VII.B. Tests, interviews, and observations were utilized to collect data. The method of analysis adopted is descriptive. Google Meet is used to facilitate learning. Learning the PMRI technique was accomplished in this study by assigning sharing and jumping task, followed by two exam questions. In the context of COVID-19, the test questions are PISA-like maths problems. The results show that students' average mathematical reasoning skill is 67.5, with mathematical manipulation being a common indicator among them. Most students have exhibited indications for presenting conjectures, but only a few students have been able to put down indicators for drawing logical conclusions, so drawing logical conclusions is an indicator that students rarely see. Overall, grade VII students' mathematical reasoning skills in answering PISA-like mathematics questions on number material in the context of COVID-19 utilizing the PMRI approach is good since students are used to modeling contextual problems such that mathematical manipulation indicators occur.

**Keywords:** COVID-19; mathematical reasoning ability; PISA; PMRI; number

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## Introduction

Reasoning is a crucial skill that may be used to learn, understand, and solve issues, both in math and in real life (Sofyana & Kusuma, 2018). Students' reasoning ability is defined as their ability to think in terms of connecting statements or premises whose truth has been established in order to reach a conclusion (Akuba et al., 2020; Asdarina & Ridha, 2020). The mathematical literacy ability tested in PISA includes the capacity to reason mathematically (OECD, 2019). One of the materials that involves mathematical reasoning abilities in studying is number material (NCTM, 2000). Additionally, pupils should master the number material because it is a vital component of life.

However, as seen by the results of the 2018 PISA, Indonesian students' mathematical reasoning ability is still quite low, the mathematics score of Indonesian students is 379. This

is a lower result than in 2015, when Indonesia received a 386 in maths (OECD, 2019). Because teachers frequently ask low-level routine questions, students are not used to addressing contextual problems such as PISA (Nusantara et al., 2020a). Students' low thinking ability is also caused by a lack of ability to comprehend or study topics thoroughly, as well as errors in computations (Amalia & Hadi, 2020; Sofyana & Kusuma, 2018).

PISA-style maths questions must be familiar to students (Nusantara et al., 2020b). Giving pupils a PISA-style arithmetic problem will acquaint them with working on PISA questions, which will help them enhance their reasoning skills (Azizah et al., 2017). Students' mathematical literacy, which in this case means their reasoning, can be improved by asking questions with valid and practical PISA-like maths problems (Zulkardi & Kohar, 2018).

The backdrop of COVID-19 is one that students are familiar with and is currently a hot topic of discussion (Saputri et al., 2020). Situations like the number of deaths and incidents of spread that are frequently reported in the media. This environment is ideal for learning mathematics (Nusantara et al., 2021). There are already a plethora of materials relating to COVID-19, such as the proliferation of cases across Indonesia (Prabowo & Dahlan, 2020). As a result, the teacher can use that background to present PISA-like maths problems during the learning process.

The applied learning method or strategy has an impact on students' thinking abilities (Zulkardi, 2002). PMRI is a teaching method based on real-life situations that pupils have encountered (Zulkardi & Putri, 2010). In this instance, PMRI may be a viable option for improving the learning process and outcomes since students will be able to expand their knowledge and gain a deeper understanding of the concepts in the content (Manik, 2021).

This study is linked to a previous study that looked at the relationship between using the PMRI approach to improve students' mathematical reasoning abilities in number patterns (Octriana, 2019) and students' reasoning abilities in solving PISA equivalent questions with geometric content (Octriana, 2019). (Asdarina & Ridha, 2020). In the context of COVID-19, however, no one has used the PISA-like mathematics problem. In this regard, the researchers are interested in conducting research to gain an overview of students' mathematical reasoning abilities in solving PISA-like mathematics problems in the COVID-19 context using PMRI on class VII number material.

## Methods

This is a descriptive study that uses the PMRI approach to determine students' mathematical reasoning abilities in solving PISA-like mathematics problems on the COVID-19 context number material. The participants in this study were 34 students from SMP Srijaya Negara Palembang's class VII.B in the odd semester of the 2021/2022 academic year. Data was gathered using test questions in the form of a two-item description, observations, and interviews.

The purpose of the test was to determine which category of students' mathematical reasoning abilities in problem solving fell into. Using the PMRI approach, observations were made to see what indicators emerged and what students did while learning (Anggraini & Zulkardi, 2020). While interviews were conducted to confirm answers to student test results and to provide data to support test results, they were also conducted to confirm the answers to student test results (Saputri et al., 2017; Anggraini & Zulkardi, 2020). The type of data analysis that was used was descriptive. In this study, the following are indicators and descriptors of mathematical reasoning abilities.

**Table 1.** Mathematical reasoning ability indicator

| Indicator | Descriptor |
|---|---|
| Submit a conjecture | • Able to write what is known and asked from pictures and questions |
| Mathematical Manipulation | • Able to translate problems in sentence form into mathematical form<br>• Able to solve problems based on assumptions |
| Drawing Logical Conclusion | • Able to write logical conclusion in accordance with the problem |

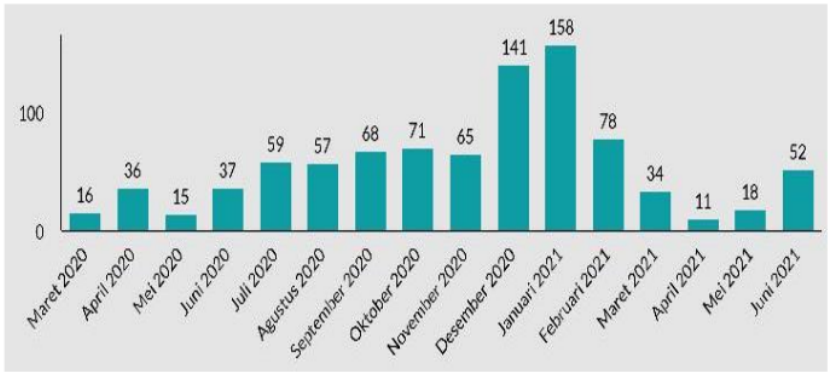
Table 1 contains indicators and descriptors of mathematical reasoning ability used in this study and has been adapted to the number material.

## Results

The lecturer, Mrs. Elika Kurniadi, S.Pd., M.Sc., the doctoral student, Mr. Duano Sapta Nusantara, S.Pd., and the teacher, Mrs. Lipa Meisinta, S.Pd., all validated the research instrument. Validation results for the three validators The images chosen must be real data, problem solving must include at least two strategies, and the question sentence editor must be adjusted to the level of difficulty, among other things. Following that, the researcher conducted a one-on-one and small group trial, with the results for question number two being changed from "amount" to "total."

Starting with the problem of sharing tasks and jumping tasks (see attachments 1 and 2), the learning is carried out using the PMRI approach, and the test questions are as follows.

Take a look at the illustration below.




(source of image www.data.tempo.co)

From March 2020 to June 2021, determine the number of health workers who died as a result of COVID-19.

**Figure 1.** Test question number 1

Figure 1 depicts the number one test question, which has a difficulty level of level three, which is equal to C3. As of June 28, 2021, the data in the image represents death data for Indonesian health workers as a result of COVID-19. Between March 2020 and June 2021,

students must calculate the number of deaths caused by COVID-19 among health practitioners.

**INDONESIA IS A CORONA EMERGENCY**

6 Areas With The Largest Cases

| No | 8 June 2020 | 5 June 2021 |
|---|---|---|
| 1 | **DKI Jakarta** Case: 8.121, Healed: 3.206, Die: 529 | **DKI Jakarta** Case: 434.116, Healed: 415.246, Die: 7.273 |
| 2 | **Jawa Barat** Case: 2.424, Healed: 952, Die: 161 | **Jawa Tengah** Case: 204.342, Healed: 181.994, Die: 9.348 |
| 3 | **Sulawesi Selatan** Case: 2.014, Healed: 673, Die: 94 | **Kalimantan Timur** Case: 72.039, Healed: 69.236, Die: 1.731 |
| 4 | **Jawa Timur** Case: 6.313, Healed: 1.499, Die: 502 | **Jawa Barat** Case: 318.892, Helaed: 294.870, Die: 4.297 |
| 5 | **Jawa Tengah** Case: 1.642, Healed: 428, Die: 98 | **Jawa Timur** Case: 156.050, Healed: 142.713, Die: 11.458 |
| 6 | **Kalimantan Selatan** Case: 1.347, Healed: 117, Die: 100 | **Sulawesi Selatan** Case: 62.321, Healed: 60.964, Die: 948 |

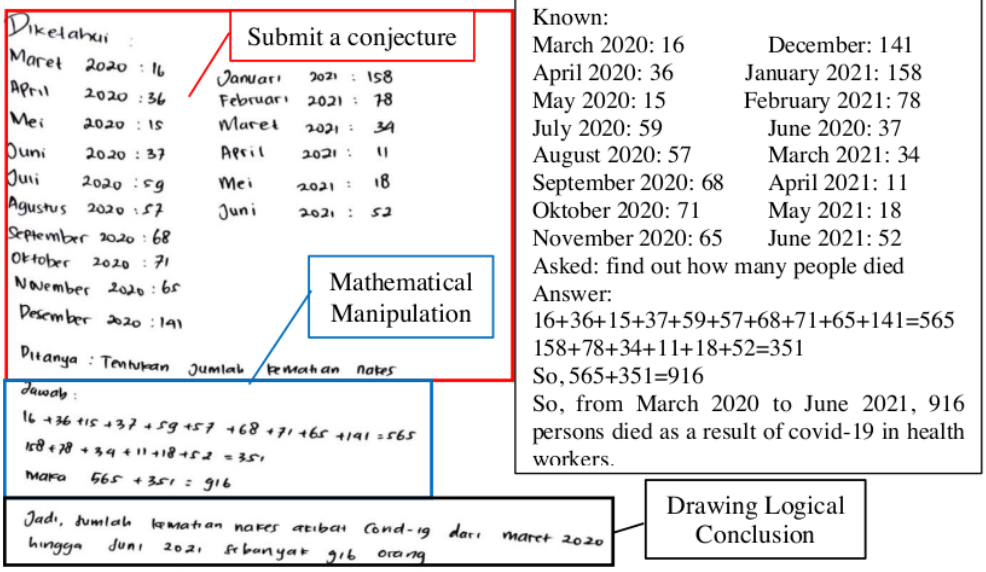
(source of image www.cnbcindonesia.com)

Check whether the total rise in death cases in the DKI Jakarta and West Java provinces from June 2020 to June 2021 was 10.000 instances?

**Figure 2.** Test question number 2

Figure 2 depicts the number two test question, which has a difficulty level of level three, which is equivalent to C4. In June 2020 and June 2021, the information in the picture of Indonesia's corona emergency indicates six regions with the most incidents. Students must verify whether the cumulative rise in mortality cases in DKI Jakarta and West Java Provinces from June 2020 to June 2021 reached 10,000. Here are some of the pupils' responses.

a. AA's Answers (High Ability Student)




**Translated**

Known:

| | |
|---|---|
| March 2020: 16 | December: 141 |
| April 2020: 36 | January 2021: 158 |
| May 2020: 15 | February 2021: 78 |
| July 2020: 59 | June 2020: 37 |
| August 2020: 57 | March 2021: 34 |
| September 2020: 68 | April 2021: 11 |
| Oktober 2020: 71 | May 2021: 18 |
| November 2020: 65 | June 2021: 52 |

Asked: find out how many people died

Answer:

16+36+15+37+59+57+68+71+65+141=565

158+78+34+11+18+52=351

So, 565+351=916

So, from March 2020 to June 2021, 916 persons died as a result of covid-19 in health workers.

**Figure 3**. AA's answer for the question number 1

Figure 3 shows that students comprehend the information in the image and the meaning of the problem, resulting in indicators making assumptions, manipulating mathematics, and drawing logical conclusions. Students receive a score of 12 on question number 1. AA is one of the students who pays attention and isn't afraid to ask questions even during the learning process.

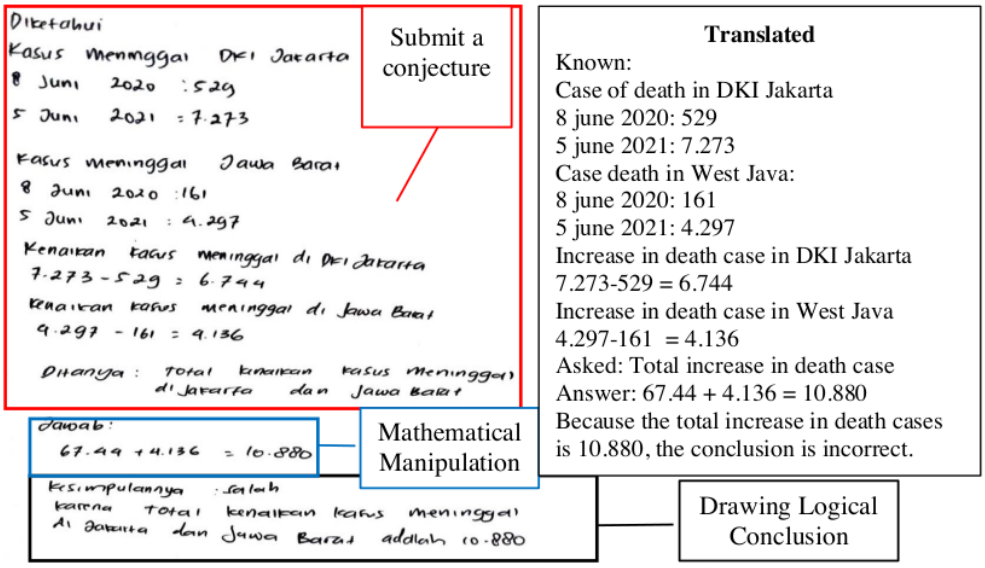



**Figure 4**. AA's Answer for the question number 2

Figure 4 shows that students comprehend the question's content and are able to write down everything that is known and asked in its entirety. As a result, he receives a score of 4. The final step, checking for increases in the two provinces, adding them together, and receiving a score of 4, is likewise right. The conclusion is also correct, earning a score of four. As a result, the overall score is 12.

b. ST's Answer (Medium Ability Student)

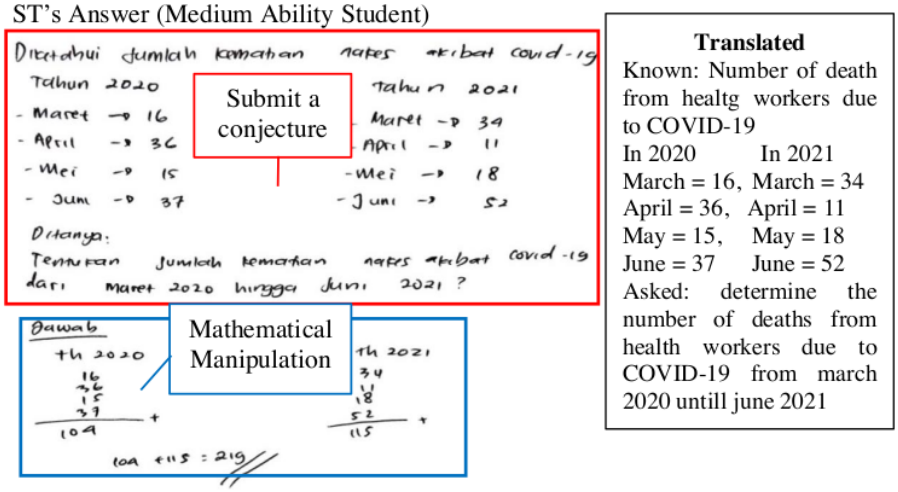
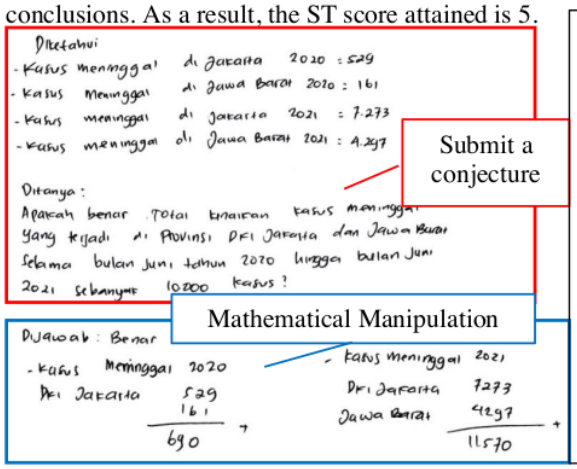



**Figure 5**. ST's answer from the question number 1

Based on the responses of students and interviews, it appears that ST is misinterpreting the questions, resulting in incorrect solutions at the end. The question covers the period from March 2020 to June 2021, yet ST only writes from March 2020 to June 2020, then from March 2021 to June 2021 in the second part. Meanwhile, the period from July 2020 to February 2021 has not been written. The researcher came to the conclusion that ST did not read the questions carefully or could not properly analyze them. Her mathematical manipulation abilities are already strong, it's only that the outputs are incorrect due to the inadequate data. ST does not include a conclusion in the results section, only line two. Based on the foregoing analysis, the researcher assigns a 2 to the indicator of making claims, a 3 to the indicator of mathematical manipulation, and a 0 to the indicator of drawing logical conclusions. As a result, the ST score attained is 5.




**Translated**

Known:
-Death case in Jakarta 2020 = 529
-Death case in West Java 2020 = 161
-Death case in Jakarta 2021 = 7.273
-Death case in West Java 2021 = 4.297
Asked:
Check whether the total rise in death cases in the DKI Jakarta and West Java provinces from June 2020 to June 2021 was 10.000 instances?
Answer: True
Kasus meninggal 2020
529+161 = 690
Kasus meninggal 2021
7.273+4297 =1.1570

**Figure 6**. ST's answer from the question number 2

The photos and results of student interviews show that ST know what they know and are asked about the questions. She meets the indicator of submitting an assumption with a score of four. However, when it came to math, he was inaccurate because, rather than looking for an increase in death cases in each province, she added death cases to the two provinces every year. She got a one for it. She determined that it was accurate even if the result he received was not 10,000 examples to draw a reasonable conclusion. She then receives a score of zero. She is awarded a total of 5 points.

c. RR's Answer (Low Ability Student)

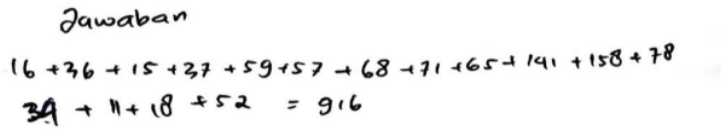



**Figure 7**. RR's Answer from the question number 1

It indicates that students comprehend the meaning of the questions based on the images and the findings of interviews with students. It's only that he didn't write down everything that was known and requested; instead, he answered the problem right away by writing down the facts in an addition operation. As a result, the student does not appear to be submitting his conjecture; rather, the student appears to be manipulating numbers. Because the signs for generating logical conclusions are also absent, they receive a score of 4 out of a possible 5.

Then, in response to question 2, RR simply wrote the word "yes" in the response. The signal in this example reveals that RR draws judgments, but she does so without supporting

evidence. She seemed to be oblivious to the meaning of the inquiry. Indicators aren't used to make conjectures, and mathematical manipulations aren't used. Because the response is incorrect and is not supported by evidence, the score is 0, and she receives a score of 0 in question 2.

Only 14 of the 34 pupils collected responses to the tests. This is due to the fact that many kids do not own cell phones and rely on their parents' property to complete their assignments, making it difficult to complete them. The indications' appearance can be seen in the accompanying table, which is based on the responses of 14 students.

**Table 2.** The origin of mathematical reasoning ability indicators

| Indicator | Total student who meet | |
|---|---|---|
| | Question test number 1 | Question test number 2 |
| Submit a Conjecture | 9 | 9 |
| Mathematical Manipulation | 13 | 11 |
| Drawing Logical Conclusion | 6 | 8 |

According to table 2, the indicator that emerges the most frequently from the two test questions is mathematical manipulation, which received responses from 13 people for question one and 11 people for question two. The scores of all students' replies were then calculated and arranged into the table below.

**Table 3.** The qualitative value of mathematical reasoning ability

| Nilai | $f_1$ | $f_2$ | $f_{tot}$ |
|---|---|---|---|
| 81-100 | 5 | 7 | 12 |
| 61-80 | 3 | - | 3 |
| 41-60 | 3 | 2 | 5 |
| 21-40 | 4 | 1 | 5 |
| 0-20 | 2 | 20 | 22 |

Information:

f1: Number of students in question number 1

f2: Number of students in question number 2

ftot: f1 + f2

According to table 3, the top five students on question one have the highest score, while the top seven students have the highest score on question two. The most people are in question two, which has the lowest score, which is 20 people.

**Table 4.** Students' average mathematical reasoning abilities

| Score | $f_{tot}$ | $x_i$ | $f_{tot}. x_i$ | Rata-Rata |
|---|---|---|---|---|
| 81-100 | 12 | 90,5 | 1086 | 67,5 |
| 61-80 | 3 | 70,5 | 211,5 | |
| 41-60 | 5 | 50,5 | 252,5 | |
| 21-40 | 5 | 30,5 | 152,5 | |
| 0-20 | 12 | 10 | 120 | |
| Total | 27 | | 1822,5 | |

According to table 4, the average mathematical reasoning ability of Srijaya Negara Palembang Junior High School grade VII.B students in solving PISA-like mathematics problems on the COVID-19 context number material after implementing the PMRI approach learning indicates that the students' mathematical reasoning abilities are classified as good.

## Discussion

The analysis of students' mathematical reasoning abilities that emerged after learning with PISA-like mathematics problems was applied to the COVID-19 context number material using the PMRI approach, according to the study's findings. The following is a more detailed explanation of the indications identified in this research.

1. Submit a Conjecture
   The indication that submit a conjecture can be described as one that appears in the second order. This is due to the fact that the majority of pupils displayed the indicator, with only a few students failing to write it down. When the indication presenting conjectures appears, it means that pupils understand the question by putting down what they know and asking questions based on illustrations and questions. After that, the learner makes an educated assumption about the problem's solution, which leads to mathematical manipulation. Students' responses to problems are also influenced by the usage of real data or graphics. Some students, according to Zulkardi et al (2020), read the questions first, then look at illustrations, tables, or count all the data, and so on.
2. Mathematical Manipulation
   The indicator that occurs the most in this investigation is mathematical manipulation. Students can convert phrases into mathematical forms and then answer problems using assumptions or what is known and asked from the questions. Even if some pupils are unable to write down what is known and asked, they can solve the problem using arithmetic procedures, even if the solution is not entirely correct. This means that pupils are used to transforming real-world situations into mathematical problems.
3. Drawing Logical Conclusion
   Many students fail to write conclusions from the issues they have solved in this indicator. Line two in the answer section on mathematical manipulation is frequently used by students. As a result, after receiving an answer, students line up the two responses as if to signify that they have reached a conclusion. There are also pupils that perform their calculations accurately but come to the incorrect conclusion, which contradicts the data and the questions asked.

Because they were directed by the teacher, the pupils appeared to understand the context of COVID-19 when they were studying. Fauziah et al., (2017) discovered that using the PMRI approach to learning made it easier for students to understand and learn new things. Students can expand their knowledge and have a deeper understanding of the principles in the content they are studying (Manik, 2021). PMRI, according to Octriana et al. (2019), can help students grow and improve their mathematical reasoning in an indirect way.

However, due to online learning, some students are less engaged in the learning process. Due to quotas, networks, parents using cellphones, low batteries, and other factors, many children are passive and do not respond during learning and group discussions. Only 14 pupils collect test answers as a result of this. Sholichin et al., (2021) found that many students were unable to participate in learning because of unstable networks, low cellphone batteries during class, and a lack of internet capacity.

Aside from the online learning issue, students still require a significant amount of time. This is due to the constraints of researchers who only teach one meeting and immediately deliver test questions for the second meeting, causing students to be unfamiliar with learning to answer problems in the context of COVID-19. As a result, learning that leads to mathematical thinking abilities requires a significant amount of time.

Despite the challenges, the findings of this study demonstrate that students' average mathematical reasoning ability is 67.5, which is considered good, with mathematical manipulation as an indicator that frequently arises. Students' reasoning abilities were likewise

classified as good when using the PMRI technique, according to Nisa et al., (2019). In junior high schools, PMRI could be an alternative learning model (Kusumaningrum, 2016).

## Conclusion

The mathematical reasoning ability of grade VII students in solving PISA-like mathematics problems on the COVID-19 context number material using the PMRI approach is good, according to the results of the research, because students are used to modeling contextual problems so that indicators of mathematical manipulation appear. Students' understanding of cases of spread and the current situation of Indonesia can be increased by asking questions based on COVID-19 and taught utilizing the PMRI approach. However, there are some drawbacks to this study, including a lack of lesson hours owing to online learning, and the questions used are of a pretty high difficulty level. As a result, additional researchers are likely to expand the frequency of meetings in the learning model used in junior high schools, the PMRI online approachlearning model (Kusumaningrum, 2016)..

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## Conflicts of Interest

The authors state that the publication of this work does not include any conflicts of interest. Furthermore, the writers have comprehensively addressed ethical issues such as plagiarism, misconduct, data fabrication and/or falsification, multiple publishing and/or submission, and redundancy.

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