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HOW STUDENTS WORK WITH PISA-LIKE MATHEMATICAL TASKS USING COVID-19 CONTEXT

Abstract

Mathematical tasks using context can be used to stimulate students in learning mathematics. Covid-19 as a phenomenon is one context that can be exploited. This article describes how students learn with mathematical tasks that adapted PISA tasks and used the Covid-19 context. This study involved 29 secondary students, 15 years old, and their mathematical abilities were different. Design research was chosen as a research method. The data were collected through observation, interview, and documents and they were analyzed descriptively. The result showed there were 10 problems developed and students were asked to work with those problems. If the task included a picture then students looked at the picture, looked at the question, and started solving the problem; if the task provided a table with not too much data inside, then the students referred to all data in solving the problem; if the table consisted of much data, then some students calculated all data and the other only compared among them. Before students started solving problems, they tried to understand what the problem meant through reading or looking at pictures, tables, and questions.

Keywords: Students' Work; Mathematical Task; PISA Task; Covid-19 Context; Design Research

Abstrak

Soal matematika yang menggunakan konteks dapat digunakan untuk merangsang siswa dalam belajar matematika. Covid-19 sebagai suatu fenomena merupakan salah satu konteks yang dapat dimanfaatkan. Artikel ini mendeskripsikan bagaimana siswa belajar dengan soal yang telah diadaptasi dari soal PISA dengan menggunakan konteks Covid-19. Penelitian ini melibatkan 9 siswa sekolah menengah, usia 15 tahun, dan kemampuan matematika mereka berbeda. Penelitian desain dipilih sebagai metode penelitian. Pengumpulan data dilakukan melalui observasi, wawancara, dan dokumen serta dianalisis secara deskriptif. Hasil penelitian menunjukkan ada 10 soal yang dirancang dan siswa diminta untuk mengerjakan soal tersebut. Jika soal melibatkan gambar maka siswa melihat gambar tersebut, melihat soal, dan mulai menyelesaikan soal; Jika soal memuat tabel dengan data yang tidak terlalu banyak, maka siswa mengacu pada semua data dalam menyelesaikan masalah; Jika tabel berisi banyak data, maka sebagian siswa menghitung semua data dan yang lainnya hanya membandingkannya. Sebelum siswa mulai memecahkan masalah, mereka mencoba memahami apa yang dimaksud dengan masalah tersebut dengan membaca atau melihat gambar, tabel, dan pertanyaan.

Kata kunci: Pekerjaan Siswa; Soal Matematika; Soal PISA; Konteks Covid-19; Penelitian Desain

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Higher order thinking skills, as abilities that can support 21st century skills, are the abilities needed by students to face challenges in the future (Ahonen & Kinnunen, 2015; Hesse et al., 2015). These abilities include the ability to analyze, to evaluate, and to creative (Brookhart, 2010; Stacey et al., 2015). Meanwhile, 21st Century skills that need to be mastered by students include the ability to think critically, to be creative, to collaborate, and to communicate (Ahonen & Kinnunen, 2015; Hesse et al., 2015). Learning mathematics in schools has an important role in constructing these skills. Through mathematics learning, students have opportunities to construct abilities such as problem solving,

reasoning, and communicating mathematically (Ahonen, 2015).

In fact, the ability of Indonesian students is still dominant in lower order thinking skills (Stacey et al., 2015; OECD, 2015, OECD, 2018) This can be seen from the PISA results of Indonesian students (OECD, 2015, OECD, 2018). The students still have difficulty solving math problems that require higher order thinking skills. This is because Indonesian students are only accustomed to solving problems whose level of thinking is limited to knowledge and application (OECD, 2015, OECD, 2018, Putri & Zulkardi, 2018)

Efforts are needed to support students in developing their higher order thinking skills. One of the efforts that can be done by the teacher is designing mathematics learning using teaching materials that are oriented towards higher order thinking skills. Giving math problems that function as learning material is an alternative way that can be considered. Giving mathematical problems is believed to stimulate students in learning mathematics (Watson et al., 2015; Van Galen &Van Eerde, 2018). Furthermore, math problems, using context in students' daily lives, help students to start learning mathematics. By using the context in the given math problem, it will invite students to think through this context (Van Galen & Van Eerde, 2018; Rahayu et al., 2018; Meryansumayeka et al., 2019). Students' understanding of the context in the given math problems will lead students to think mathematically.

Previous studies related to the development of PISA-like mathematical problems have been done a lot. Several studies have used the development of these questions to describe students' problem-solving abilities (Novita, 2012), mathematical literacy (Oktiningrum et al., 2016), creativity (Novita & Putra, 2016), and higher order thinking skills (Meryansumayeka et al., 2020). Some of them even developed questions using a local context (Kamaliyah et al., 2013; Charmila et al., 2016; Jannah et al., 2019). According to Freudenthal (Sembiring et al., 2008), a phenomenon in everyday life can be used to invite students to learn mathematics. One phenomenon that is currently happening is the Covid-19 pandemic. This pandemic is a problem and affects all aspects of human life including the student learning process (Bakker & Wagner, 2020). However, this phenomenon can also be used for the needs of students learning mathematics so that students are invited to think about solving problems related to this pandemic. To be able to help students in forming their higher order thinking skills, it is necessary to understand how students work on these math problems. Thus, this study was carried out with the aim of designing PISA-like mathematical problems using Covid -19 context and describing how students work with those problems

METHOD

This research used design research as a research method. This research consists of three stages, namely the preparation stage, the design stage and the evaluation stage which includes the self-evaluation, expert review, one-to-one, small group, and field test (Van den Akker, 2013).

Twenty-nine high school students in Palembang city were involved. The students are 15 years old

and have different mathematical abilities. Data were collected through tests, observations, interviews, and documents. The test used was in the form of 10 math questions using the context of Covid-19 which were adapted from PISA questions. Observation is used to determine students' behavior when they solve questions. Documents in the form of student work results are used to see how students think in solving questions. Meanwhile, interviews are used to clarify students 'answers and explore students' understanding. All data were analyzed descriptively.

RESULTS AND DISCUSSION

In the preparation stage, researchers analyzed the PISA framework, mathematical topics, and the context of Covid-19. In the next stage, 10 PISA math problems were developed using the Covid-19 context. In addition, researchers prepare observation and interview sheets to be used during trials.

After the design of the questions and research instruments have been designed, in the next stage, the researcher evaluates the mathematical problems designed. In the self-evaluation stage, after the researcher looked back at the mathematical problems designed, then they were validated through a Focus Group Discussion which was attended by several teachers as practitioners of learning mathematics in class and lecturers who were experienced in development research. After that, the mathematical problems were corrected based on the input obtained during the FGD. After being corrected, the mathematical problems were tried out to students in the one-to-one stage, small groups stage, and field test.

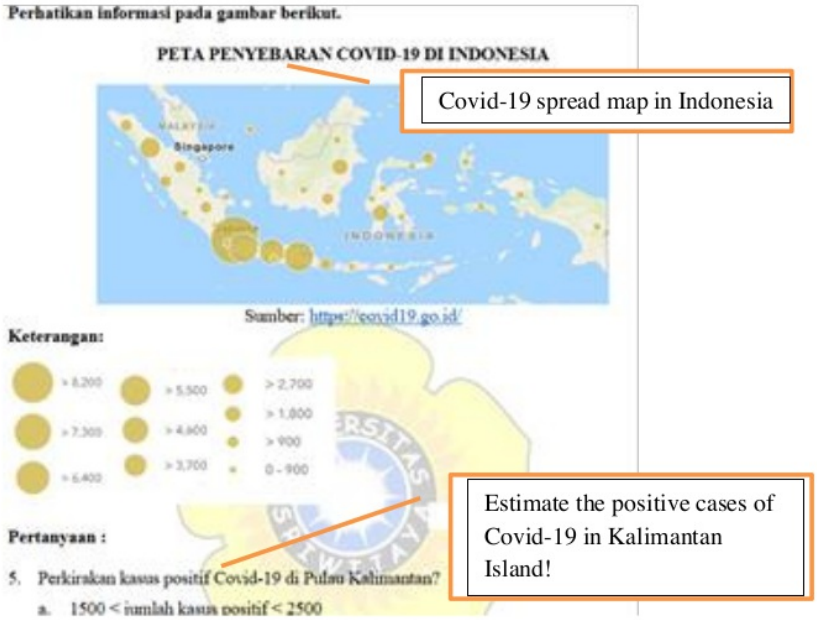


Figure 1. Change and relationship task using Covid – 19 contexts

Figure 1 shows one mathematical-like PISA task designed. This task used the spread of covid-19 context in Indonesia. The content was about space and shape asking students to estimate the number

of Covid-19 cases happened in Kalimantan. In solving the problem in figure 1, the students needed to find the less number as the result of division between the amount of each material with the amount needed in making a bottle of hand sanitizer. Since all materials are not in the same quantity, they need to analyze and realize the condition.

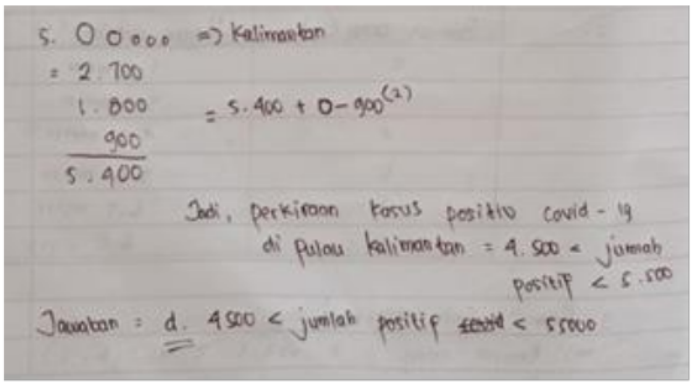


Figure 2. Student's answer in solving a mathematical problem using Covid-19 spread context in Kalimantan

Student's answer in figure 2 shows that there were some circles drawing by the student as representation of Covid-19 spread area in Kalimantan. The student also tried to calculate the number of Covid-29 cases in Kalimantan through multiplying 3 same little circles that have range between 0 and 900. It looks like the student used the biggest number that is 900 and multiply it with 3 that means 3 circles. Then, the student predicted the number of the biggest circle that was 1800 and the number of medium one was 900. All numbers were added up together and the results was 5400. Then, the student referred to the option where 5400 is included in the range, that is between 4500 and 5500. The way students answered also was supported in transcript below.

R: "How did you answer this problem?"

S :" At first, I saw the question. Nah, the question is asking about the number of Covid-19 spread cases in Kalimantan."

R: "Then?"

S : "Then I saw Kalimantan and I looked at there were 5 circles. They were 3 little circles, 1 medium, and 1 the biggest one. "

R: "Ok"

S : "Then I predict the little one is about 900, the biggest one is 1800, and the medium is more than 900."

R: "So, you looked at the number of the little one as the littlest circle, and the number of the biggest one was about the third last circle, and the medium one was the second last circle."

S : "Yes"

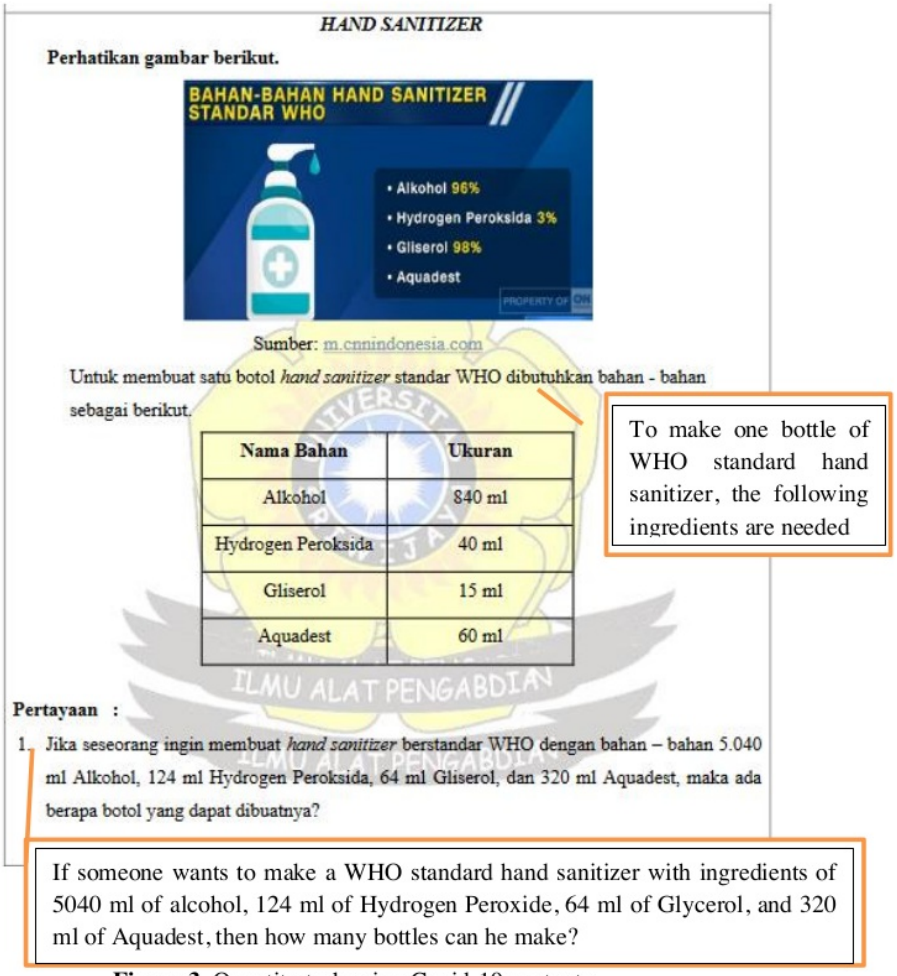
R: "And then?"

S : "And I added all numbers, and they were 5400"

R : "So, at what range it was?"

S : "D, between 4500 and 5500"

Based on the transcription, student started solving the problem by reading the question directly. Then she looked at the picture. She predicted the values of all circles by referring to information about each circle given. She added up all predicted numbers and chose an option where the range including the number that she got.



HAND SANITIZER

Perhatikan gambar berikut.

Sumber: m.cnnindonesia.com

Untuk membuat satu botol *hand sanitizer* standar WHO dibutuhkan bahan - bahan sebagai berikut.

Nama Bahan	Ukuran
Alkohol	840 ml
Hydrogen Peroksida	40 ml
Gliserol	15 ml
Aquadest	60 ml

To make one bottle of WHO standard hand sanitizer, the following ingredients are needed

Pertayaan :

1. Jika seseorang ingin membuat *hand sanitizer* berstandar WHO dengan bahan – bahan 5.040 ml Alkohol, 124 ml Hydrogen Peroksida, 64 ml Gliserol, dan 320 ml Aquadest, maka ada berapa botol yang dapat dibuatnya?

If someone wants to make a WHO standard hand sanitizer with ingredients of 5040 ml of alcohol, 124 ml of Hydrogen Peroxide, 64 ml of Glycerol, and 320 ml of Aquadest, then how many bottles can he make?

Figure 3. Quantity task using Covid-19 contexts

The mathematical task in figure 3 was about quantity. The context is about making hand sanitizer based on WHO standard. The ingredient information serving through table is given. The task asks students to predict the number of hand sanitizer bottles that can be made from the number of materials given.

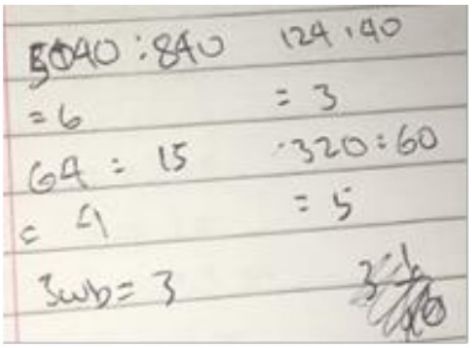


Figure 4. Student's answer in whole numbers

Based on figure 4, the student used all information seen from there are 4 parts of his calculation. The information given are about 4 different ingredient of hand sanitizer. The student tried to determine the number of bottles that can be made based on each ingredient. He used division between the number of each ingredient provided with the amount of each ingredient needed to make 1 bottle of hand sanitizer. He did not really count the precise number, but he only estimated the closed number in a whole number.

R : *How did you find the answer?*

S : *I divide the amount of ingredients by the number of ingredients needed.*

R : *How did you get 3?*

S : *124 divided by 40 is 3 comma something*

R : *Do you think the answer is 3? Why not 6?*

S : *if we make 6 bottles then we cannot use Hydrogen Peroxide. That's not enough. It is just enough for 3 bottles.*

From transcription, the student use estimation in determining the result of division of the number. In answering the question, he had to find the smallest number of the results gotten from his calculation. He had a reason in finding the answer. He argued that the other ingredient was not enough when he made more than 3 bottles of hand sanitizer based on the amount or ingredients provided.

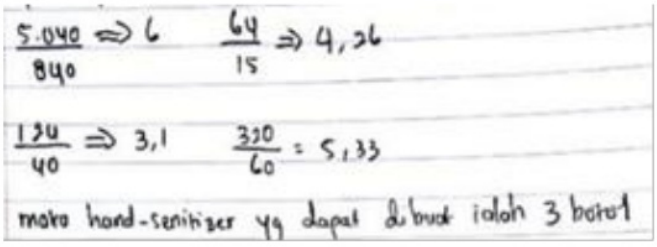


Figure 5. Student's answer in decimal numbers

Different with figure 4, the result of student's calculation in figure 5 was more precise. She used division and found the result in decimal numbers. However, both student's answer in figure 4 and figure

5 concluded that the number of hand sanitizer bottles was 3 bottles.

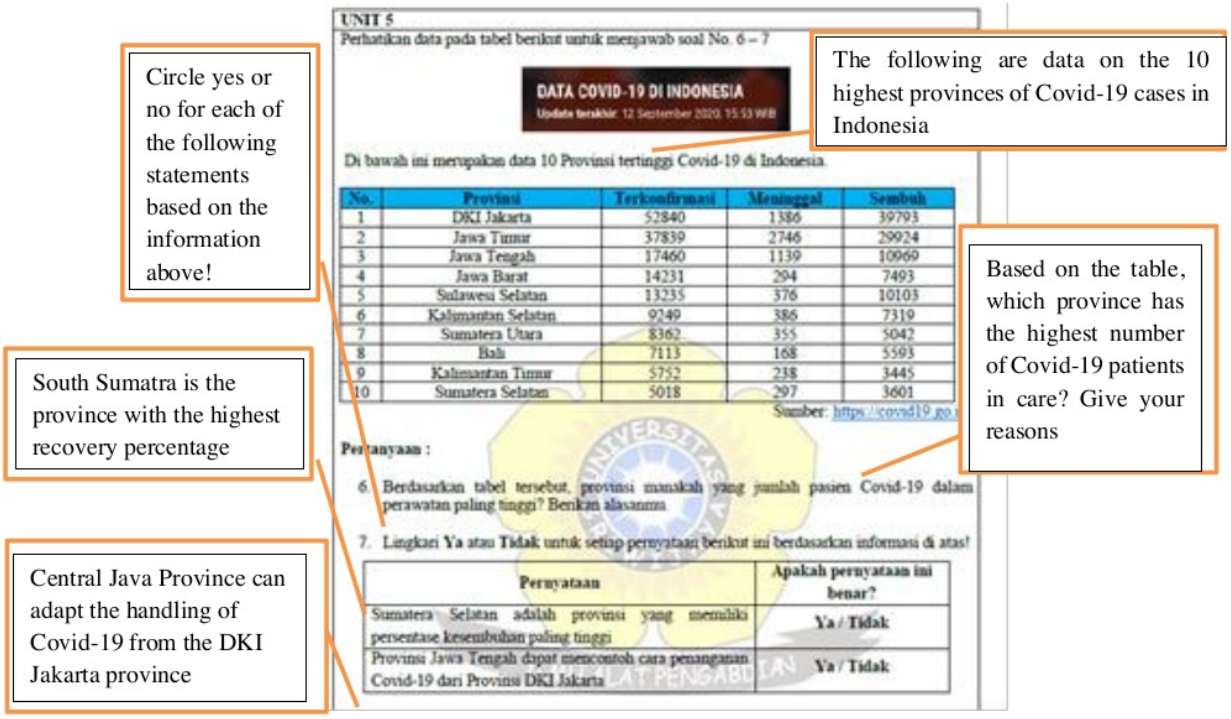


Figure 6. Uncertainty and data task using Covid-19 context

Figure 6 shows a mathematical task with much data displaying in a table. One problem was about analyzing which province has the biggest recovery percentage. The other problems were checking the truth of statements given.

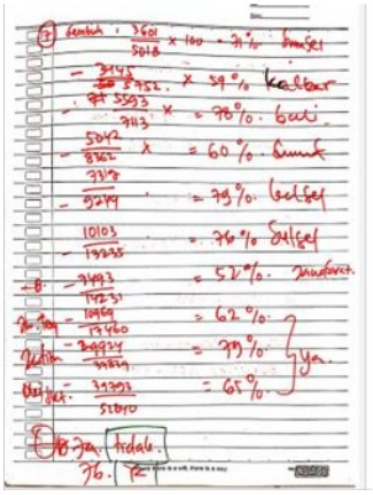


Figure 7. The student calculated all data

In solving the problems in figure 6, a student tried to calculate the recovery percentage of all

provinces. The student did not calculate in accurate way, but she just estimated the results in whole numbers. Then, she looked at the biggest number of the percentage and found that the highest percentage were in East java and South Kalimantan. For the next two problems, based on the calculation of all data, she concluded that the recovery percentage of South Sumatra was not the highest one. Therefore, she concluded that the statement was wrong. For the next statement, she concluded that the statement was true since the recovery percentage in Jakarta was higher than in Central Java. However, there were also students did not calculate all data, but they only did calculation for some data. It was described in the following transcription.

S : I thought the statement (the first statement of problem no. 7) was false

R : Why?

S : Because Bali was higher than South Sumatra

R : How did you find that?

S : At first, I divided the number of recoveries with the number of confirmed cases in South Sumatra. Then, the result is multiplied by 100%. I looked at data in Bali. I also did the same way in determining the recovery percentage in Bali. Evidently, the recovery percentage in Bali is higher than the South Sumatra one.

The transcription shows that after the student found the recovery percentage in South Sumatra, she looked at data of the other province and calculated the recovery percentage of the province. When the number of the other province was higher than South Sumatra, the student concluded that the recovery percentage in South Sumatra was not the highest one. Then, she remarked the statement as a wrong statement.

Based on the results, designing mathematical problems can provoke students thinking mathematically. Van Galen (2018) stated that mathematical problem can stimulate student in learning mathematics. Using context in mathematical problems was also a good way in inviting students to learn mathematics since they know about the context and can explore mathematics behind it through problems given (Sembiring et al., 2008; Van den Akker et al., 2013; Meryansumayeka et al., 2019).

Students are encouraged to use their analytical skills in solving PISA-like mathematical problems developed using Covid-19 context, like displaying in figure 1, 3, and 6. Brookhart (2010) stated that analytical skill is one of higher-order thinking skills. In using this skill, students need to see the relation among information and find out the possible strategies that satisfy the condition.

In solving a PISA - like mathematical problem developed, students tried to understand it starting from reading the question. This is the first step of students in solving problems (Nurkaeti, 2018). By reading the question, student get the meaning of the problem that want to be solved. However, not all of sentences in the task are read by students. Most of students refer to what the question about. This happened because the students feel lazy in reading all sentences. This is in line with what Hoogland (2018) stated that a “word” problem, where the task is described in many words, gives negative effect to students’ performance. In understanding the problem, students also looked at the picture or the table

given and refer some information in the picture or table. Hoogland (2018 (a); 2018 (b)) also stated that using pictures in mathematical problems may help students in understanding the problems. A picture invites student to know the problem and can give information visually (Hoogland et al., 2018 (a); Hoogland et al, 2018 (b))

In solving the problem with a table serving not too much data, most of students used all information di finding the answer. Since the number of data were different and they found that the results of division among data were also different from the first row until the last row, they referred to all data and found the answer based on the question. It also happened when the problem displaying much data, the students calculated all data and compared among them to find the highest percentage like described in figure 7. What the students did were their strategy in finding the answer, finding the highest percentage, by calculating and comparing among data. After students understood the problem, they used a strategy or a procedure that they know (Nurkaeti, 2018).

Some students used estimation in finding the result of division, they did not really count the result in the precise number, like what students did in figure 4 and figure 7. This happened because the students used multiplication in determining the result of division. They tried to find out what numbers, if they multiplied those two numbers then the result approached to the divided number. This is in line with Dubé et al. (2018) that in determining the result of division of two numbers, students look at the relation to the multiplication that appropriated with those numbers.

CONCLUSION

This study has developed 10 PISA-like mathematical problems using Covid-19 context. In solving those problems, most of student read the question directly, looked at the picture or the table and referred information on the picture or the table. For the problems serving not too much data, students looked at all data and used all data in answering the problems. It also happened for the problem displaying much data. Some students also used estimation in solving mathematical problems related to division of numbers

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