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The Development of PISA-based Numerical Problem Using the Context of Religious Day during the Pandemic

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Abstract

This study aims to produce valid and practical PISA-based numerical problems in the context of the pandemic period and to find out the role of the questions in the form of potential effects on the mathematical literacy skills of secondary school students. This research uses developmental research design, which has 2 stages, namely preliminary and formative evaluation (self-evaluation, expert review, one-to-one and small group validation, and field test). The participants in this study were students in Grade 8 who were under the age of 15 and different levels of skills. Data analysis was done descriptively by conducting observations, tests, interviews, and document analysis. The research was conducted face-to-face and via Zoom and WhatsApp Group (WAG) to produce valid and practical PISA-like arithmetic questions. Based on the students' responses, it can be stated that the questions presented are in the practical category because they can be completed quickly by students, they can be understood well by students, and they have the potential effect on students' mathematical literacy skills. In addition, there is a diversity of answers between one students and another according to the level of difficulty that is appropriate for Grade 8 students. This proves that a PISA-like numeration problem in the context of the religious day during a pandemic can help improve students' mathematical literacy.

Keywords: Development Research, PISA-based Numerical Tasks, Religious Day in Pandemic Contexts

Abstrak

Penelitian ini bertujuan untuk menghasilkan soal numerasi tipe PISA konteks hari raya dimasa pandemi yang valid dan praktis serta mengetahui peran soal dalam bentuk efek potensial terhadap kemampuan literasi matematis siswa SMP. Penelitian ini menggunakan penelitian pengembangan yang memiliki 2 tahap yaitu tahap preliminary dan formative evaluation (self-evaluation, expert review, one-to-one, small group serta field test). Subjek dalam penelitian ini adalah siswa kelas VIII yang berusia kurang dari 15 tahun dengan beragam kemampuan. Analisis data dilakukan secara deskriptif dengan mengumpulkan observasi, tes, wawancara, dan analisis dokumen. Penelitian dilakukan secara tatap muka dan zoom serta komunikasi melalui WhatsApp Group (WAG) dengan menghasilkan soal numerasi tipe PISA yang valid dan praktis. Berdasarkan respon siswa dapat dikatakan bahwa soal yang disajikan termasuk dalam kategori praktis karena dapat diselesaikan dengan cepat oleh siswa, dapat dipahami dengan baik oleh siswa, dan berpotensi berpengaruh terhadap kemampuan literasi matematika siswa. Selain itu, terdapat keragaman jawaban antara siswa satu dengan yang lain sesuai dengan tingkat kesulitan yang sesuai untuk siswa kelas VIII. Hal ini membuktikan bahwa soal tipe PISA konteks hari raya dimasa pandemic dapat membantu meningkatkan literasi matematis siswa.

Kata kunci: Penelitian Pengembangan, Soal Numerasi Tipe PISA, Konteks Hari Raya di Masa Pandemi

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INTRODUCTION

The draft of PISA 2022 Mathematics Framework defines that an individual's capacity to reason mathematically and to formulate, employ, and interpret mathematics to solve problems in a variety of real-world contexts is referred to as mathematical literacy. The draft of PISA 2022 Mathematics Framework also explained the general aim of PISA is to assess the extent to which 15-year-old students from various countries acquire appropriate proficiency in reading literacy, mathematical literacy and scientific literacy to make a significant contribution to their society. Wilkens (2011); OECD (2016, 2019) explained that Indonesia got very bad results in the mathematics category, Indonesia was ranked 7th from the bottom with an average score of 379, which decreased 7 points from the average score in 2015. This makes Indonesia far below the OECD average score of 489.

Several factors influence students' weak performance are lack of higher-order thinking skills (HOTS) or lack of the ability to address non-routine problems, lack of ability to design PISA-based mathematical tasks in terms of originality and language structure (Zulkardi & Kohar, 2018), and Most teachers who can only supply a limited amount of materials and allow students to practice regular low-level of questions. (Putri & Zulkardi, 2018). There are other factors that have been revealed by Hawa (2014), namely, being less trained in solving problems with characteristics such as the PISA questions and lack of readiness in working on questions.

This problem should not drag on, efforts are needed to overcome it by making the context more appropriate for Indonesian students (Zulkardi & Kohar, 2018). Students are directed to reason mathematically in a context and a situation in real life (Kohar, Wardani & Fachrudin, 2019). The COVID-19 pandemic is an example of a common condition that is continuous and has an impact on all parts of global life as well as student academic pursuits (Bakker & Wagner, 2020). It is necessary to use a context-based learning technique, such as the Indonesian Realistic Mathematics Education (PMRI) approach (Jannah, Putri & Zulkardi, 2019; Zulkardi, Putri & Wijaya, 2020).

Many have studied PISA in the context of COVID-19 in previous studies, for example, Zulkardi, Meryansumayeka, Putri, Alwi, Nusantara, Ambarita, Maharani & Puspitasari (2020), who discussed how students work with PISA-like mathematical tasks using a COVID-19 context, Nusantara, Zulkardi & Putri (2020), that applies physical distancing context, Nusantara, Zulkardi & Putri (2021a); designing PISA-like mathematics task using a COVID-19 context, and Nusantara, Zulkardi & Putri (2021b); using COVID-19 transmission map context. Other research looked at the degree of difficulty (Ahyan, Zulkardi & Darmawijoyo, 2014). Meanwhile, several prior studies looked into the effects of reasoning, mathematics, and communication on students' mathematical literacy (Dasaprawira, Zulkardi & Susanti, 2019) and representation (Efriani, Putri & Hapizah, 2019).

This is crucial to the usage of the inquiry-based learning model, which tries to improve students' communication abilities as one of its goals (Bayram, Oskay, Erdem, Ozgur, & Sen, 2013) and can help increase creativity students and improve thinking skills (Usman, Cahyati, Putri & Asrizal, 2019).

Furthermore, Azizah, Zulfiani & Muslim (2017) argue that students' scientific literacy skills after the implementation of IBL are better than before the implementation. However, until now no one has used PISA problems using the IBL model with the context of religious days during the (COVID-19) pandemic to see mathematical literacy skills.

METHODS

Due to the COVID-19 pandemic, online platforms such as WhatsApp and Zoom are assisting the study process. This developmental study is a research design with two stages: preliminary evaluation and formative evaluation (Bakker, 2018).

Furthermore, this study used the Inquiry-Based Learning (IBL) model in the development and implementation process. IBL helps students understand the material being studied through questioning and investigation. IBL allows students to ask questions and conduct investigations, experiments, and research independently. Students contribute actively to developing ideas and understanding throughout the learning process. At the preliminary assessment stage, researchers prepared, designed, and conducted a literature review, and created instruments such as grids, question cards, and rubrics, among other things. The researcher conducted a self -assessment, expert review, one-to-one interview, small group validation, and field test in the next stage, which was formative evaluation. At the small group validation and field test stages, IBL was used.

In the self-evaluation stage, the researcher analyzed the problems in the designed tasks and produced a better question called Prototype 1. Furthermore, the expert gave Prototype I a seal of approval for it to be conducted a FGD via Zoom meeting with two Sriwijaya University lecturers and several doctoral students and master's students, then sending a review to expert M. Noviarsyah Dasaprawira, M.Pd. who have conducted research related to the development of PISA tasks. This was done to examine the tasks in terms of content, construct, and language to apply PISA-based numerical questions in prototype II.

A one-to-one validation was conducted concurrently with the expert review. At this point, determining the validity of PISA-style numeracy challenges is beneficial. Three secondary school pupils of varying skills are used in this step (high, medium, low). Prototype II was created based on the validation results and was used in the small group stage. Six students with varied abilities were included in the small group validation stage to determine the practicality of the questions developed (high-, medium-, or low-difficulty questions). The prototype III of PISA tasks was the output of this stage. They are valid and practical PISA tasks. Prototype III was processed into the field to see its potential effect on students' mathematical literacy skills. Furthermore, prototype III was used for tests at the field test stage.

Walkthroughs, documentation, observation, and interviews were used to collect data. The data was then analyzed using a qualitative descriptive method to describe the steps' outcomes. Using the

context of a religious day during a pandemic that has the potential to affect mathematical literacy skills, this research creates valid and practical PISA-based numerical activities and problems. Comments and suggestions from expert reviews and one-to-one validation stage through document review demonstrated the tasks' validity. Observation, interviews, and document review in small groups were used to assess the viability of these tasks. As indicated by the students' test answers, observations, and interviews during the field test, the tasks had a potential effect on mathematics literacy. The material gathered was then descriptively analyzed.

RESULTS AND DISCUSSION

This study resulted in PISA-based numerical problems consisting of 2 question units, namely the clothing context (1 unit) and the diamond context (1 unit), which is focused on quantity content.

Preliminary Stage

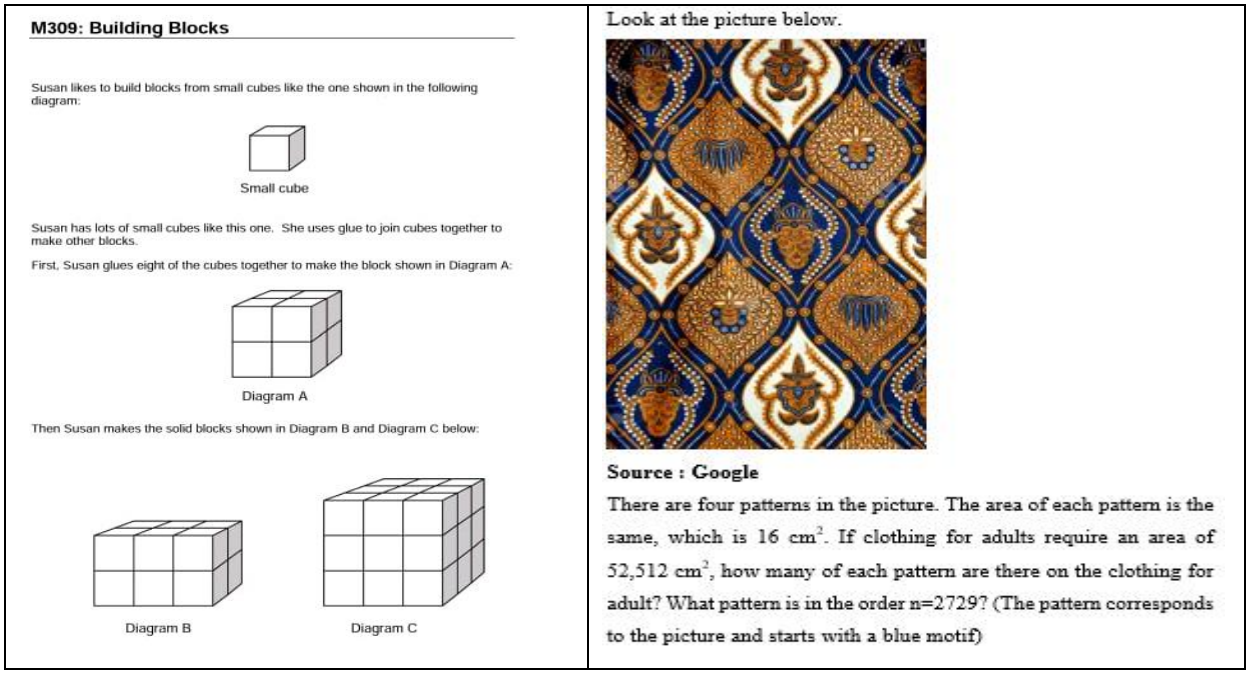
In the preliminary stage, the researcher and the mathematics teacher chose students as research subjects by determining the level of students' abilities. So, the researchers got the subjects of three 8th grade students with various levels of abilities (high-, medium-, and low-level of abilities) for the one-to-one stage and six 8th grade students with various abilities for the small group stage.

In addition, the researcher conducted curriculum analysis by assessing the indicators of competency achievement related to quantitative material and the tactics employed by students in demonstrating their mathematical literacy abilities. Then, the issue of PISA, which was used as the basis for development in the context of the religious day during the pandemic. Next, PISA questions related to the cube context, which were developed into a religious day context, were examined.

Formative Evaluation

Self-Evaluations

The researcher produced the PISA-based numerical tasks, which are then evaluated, and analyzed during the self-evaluation stage. The results of the improvements at this stage are called Prototype 1. Then prototype 1 is used in the next stage. The original 2006 PISA problem with a cube context which was developed into PISA-based numerical problems using the context of religious day during the pandemic, is shown in Figure 1.



(a) (b)

Figure 1. PISA-based task before being revised

Figure 1(a) is the original 2006 problem of PISA using the context of the cube, which was developed into Figure 1(b). Figure 1(b) is a pattern that will be used to make clothes. Figure 1 explains that during a pandemic, they prefer making clothes and buy materials online to reduce their exposure to the COVID-19 virus to buying clothes at the market and meeting lots of people.

Expert Reviews and One-to-One Validation

Expert review and one-on-one interviews were conducted simultaneously to ensure that the questions are valid. Three students with high, medium, and low talents were chosen as subjects at the one-to-one stage. When the students were reading and answering the problem, students were given questions about the religious day during the epidemic and were required to provide answers. The observed responses focused on the clarity of the reading and the problems in the questions. At this stage students provide several responses when viewing and working on questions.

(Note: R: Researcher; S1: Student A)

S1 : Where should I start calculating the pattern, ma'am?

R : From the blue one.

S1 : Should I count it vertically or horizontally?

R : Sideways

S1 : If it is counted sideways, the image below does not count.

Students asked the questions above during the one to one process and as a reference to improve the question. Table 1 describes the results of the validation at the one-to-one stage.

Table 1. Comments from experts and students

Validation	Comments	Revision
Expert Review	- Learning objectives must be adjusted to the questions that have been made. - It is recommended to use a smaller number (two-digit number).	- Improving learning objectives. - The problem, which was initially n=2729 to n=15, changed.
Students	- Why are the pictures different? If you count horizontally, the result will be different from the result if you count vertically.	- Replace the image with the same pattern.

The researcher resolved the issue based on the results of the expert evaluation and the one-to-one stage. So, it can be concluded that the question is valid. This stage, in theory, generates valid inquiries in terms of content, construct, and language. According to expert comments and suggestions and students' knowledge of the problem, the initial prototype was certified qualitatively valid (Zulkardi, 2002).

Content validity in terms of the compatibility of the constructs with the characteristics of 8th grade students was assessed according to the PISA mathematics framework. In terms of language, the writing of the sentence in the question must follow the Indonesian Spelling System General Guidelines (PUEBI) and the sentence must not be ambiguous (Zulkardi, 2002). Prototype II was the product of the question's improvement and was used in the small group stage. Figure 2 depicts the issues with prototype II.

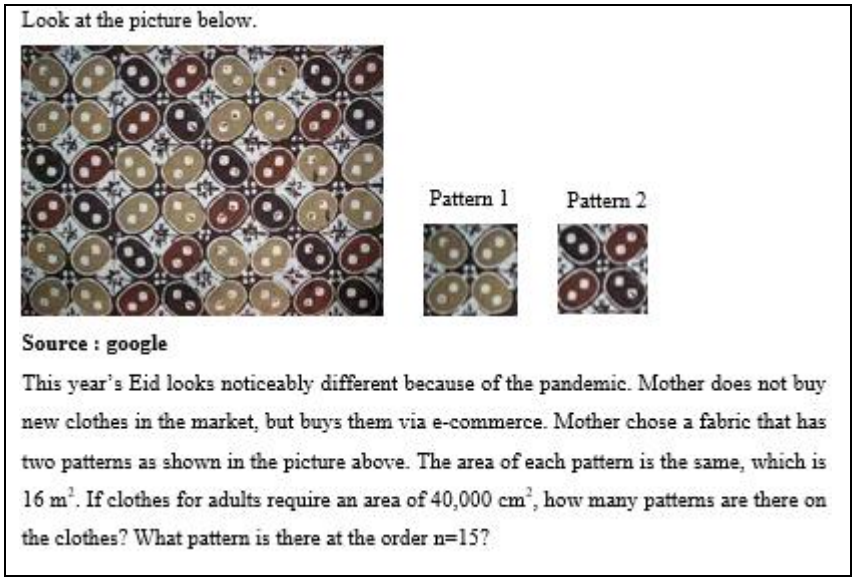


Figure 2. PISA-based task after being revised

Figure 2 is the result of the Prototype I to Prototype II revision. The graphic was modified since it confused students when they were looking for patterns, and an explanation was given for each pattern so that students were not confused when they were answering, and then the numbers in questions that were deemed too large were changed to smaller ones.

Small-Group

The goal of the small group stage is to determine how realistic the questions are. This stage took 6 students of Grade 8 as subjects. These students include TA and RA (high ability), NO and UA (medium ability), and AS and RO (low ability). They were divided into two groups: one high-ability student, two medium-ability students, and one low-ability student. Face-to-face sessions were used to perform the learning process utilizing the RME technique, IBL model.

Students were first asked to solve the problems independently, and then they were asked to have discussion with their classmates. It can be seen that almost all students can understand the question and solve the problem well. It can be seen that students have different ways of solving the problem (see Figure 3 and Figure 4).

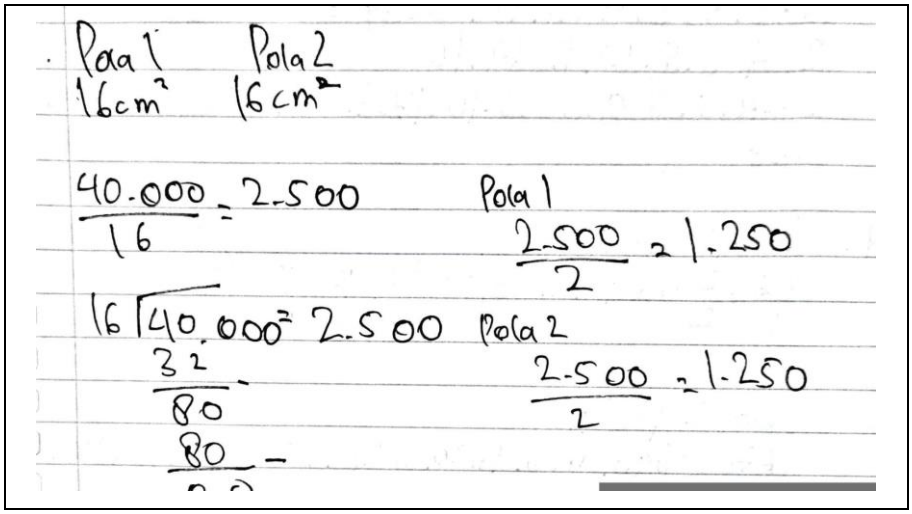
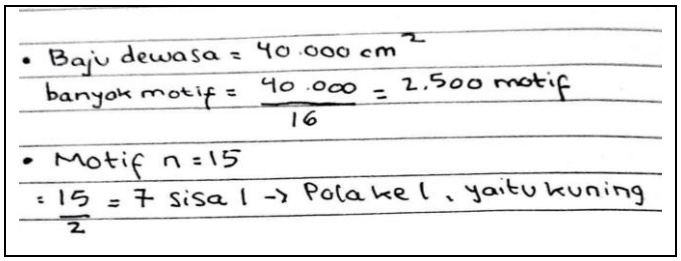


Figure 3. Answer by student with the initials TA to question that uses the context of religious day

Figure 3 shows that students have done well on the questions. However, students only answer one question in the math word problem given to them. At the same time, the other 2 questions were not answered by the student.



Translated into English:

Adult clothes = 40.000 cm^2

Many pattern ÷ 40.000/16 = 2.500 pattern

Pattern n = 15

15 ÷ 2 = 7 remaining 1 → 1st pattern is yellow

Figure 4. Answer by student with the initials US to question that uses the context of religious day

Meanwhile, in Figure 4, it can be seen that students were very careful working on the questions. The student answered each question, and the student's answers were all as expected by the researcher.

The results of the student worksheets revealed that most students can solve problems utilizing the religious day context effectively; it is only a matter students' accuracy that prevents them from answering these questions. Each student used a different way of answering questions. According to Dasaprawira, Zulkardi & Susanti (2019); Nusantara, Zulkardi & Putri (2021b), each student can utilize different ways to solve arithmetic problems such as PISA test question. At this small group stage, students were also active in terms of communication, representation, and reasoning and expressing their respective opinions to compare the results obtained from one student to another in solving problems in the questions.

Students with solid reasoning abilities can correctly analyze, formulate, and solve problems (Ahyan et al., 2014). The problem employing the religious day setting that has been constructed fulfills the legitimate and practical criteria, according to the results obtained at the one-to-one and small group phases.

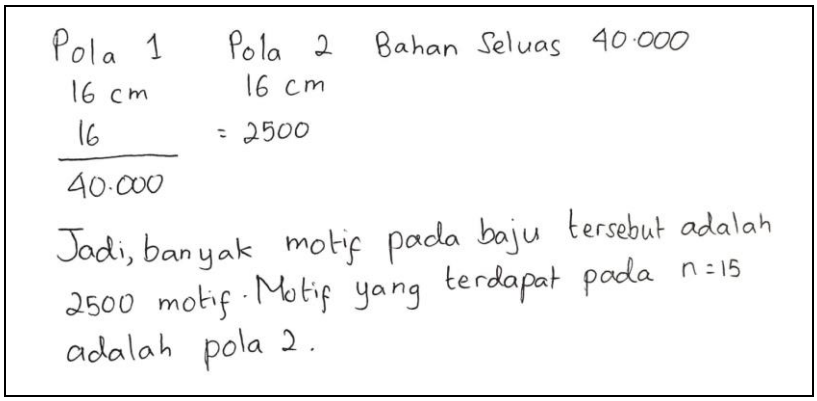
Furthermore, it can be determined from the findings during student worksheet interviews that

PISA-based numerical problems set in a religious day environment can strengthen students' mathematical literacy skills such as communication, representation, reasoning, and argument skills. In addition, it can be seen that students feel challenged when given the question, and they were excited to be able to solve the problem.

Field Test

This stage involved 22 students of SMP 13 Palembang. This stage investigated the potential effects of math problems such as PISA test questions on students' mathematical literacy skills. This research produces PISA-based numerical with the following characteristics. The content discussed is a quantity that focuses on number patterns. Furthermore, the context to be explored is the context of religious day during the pandemic, which includes social context.

The field exam revealed that only 8 students received full credit, 11 students received half credit, and three students did not receive credit. We can also record 22 students' mathematics literacy skills.



Translated into English:

Pattern 1 = 16 cm

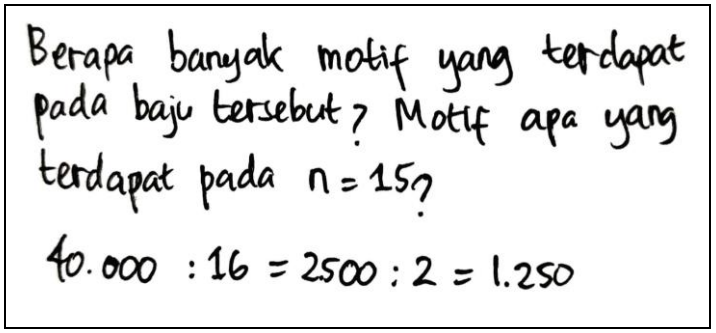
Pattern 2 = 16 cm

Material area = 40.000

So, the number of patterns on the clothes is 2500. The pattern at n = 15 is pattern 2.

Figure 5. Answer by Student 1 to a PISA-based numerical problem using the context of clothing

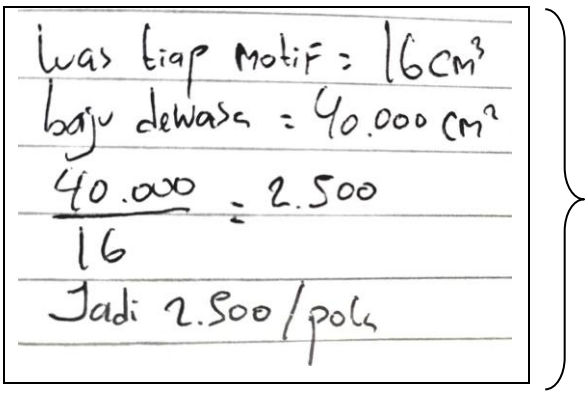
Students at the field test stage, as shown in Figure 5, can be seen as students who have worked in their way, and the results obtained were as expected by the researcher. It is just that there was an error when they were answering the 15th pattern. The correct answer is pattern 1, but students' answer was pattern 2, and another mistake was that students only answered the question on the total pattern and did not answer the question on the number of each pattern.



Translated into English:
How many patterns are there in the clothes? What pattern is there at n=15?
40.000 ÷ 16 = 2500 ÷ 2 = 1250

Figure 6. Answer by Student 2 to a PISA-based numerical problem using the context of clothing

In Figure 6, it can be seen that the student answered very correctly, but the student missed the question about n=15.



Translated into English:
Area of each pattern = 16 cm^2
Adult clothes = 40.000 cm^2
40.000 ÷ 16 = 2500
So, 2500/pack

Figure 7. Answer by Student 3 to a PISA-based numerical problem using the context of clothing

Figure 7 is almost the same as Figure 6. Students did not answer questions about n=15. At the field test stage, the findings were collected. Some students can work according to the researcher's expectations, while others were merely interested in supporting the questions.

(Note: R = Researcher; S1 = Student 1; S2= Student 2; S3= Student 3)

R : Try to explain why you answered like that? start from s1 please.

S1 : With a material area of 40,000 with 2 types of patterns, each covering an area of 16 cm2, then to find the number of patterns, 40,000 divided by: 16. Next, the 15th pattern can be calculated from the picture because the first pattern is pattern 1, then the 15th pattern is pattern 2.

R : Ok, good answer. How about s2?

S2 : To find the number of patterns found on the clothes, 40,000 is divided by 16, then the result is divided by 2 to find out the number of patterns 1 and pattern 2. Pattern 1 and pattern 2 are 1250 patterns each.

R : Then the question asking for the 15th pattern was not answered?

S2 : No, I was too focused on the number of patterns so I did nott notice the question.

R : But you know how to answer correctly?

S2 : Yes, I know.

R : How about S3?

S3 : My answer is the same as S1, only I was too focused on working on the number of patterns, so I forgot to do the 15th pattern question.

Based on the interview, it can be seen that students have their answers and can understand the topic in their way. According to Bayram, *et al*. (2013), the IBL model affects students' understanding of knowledge development on a topic, scientific process skills, attitudes toward science learning, motivation in education, and communication skills, and according to Usman, *et al*. (2019), it helps develop students' practical skills.

It is just that there are still students' answers that are wrong and cursory; this is also corroborated by Usman, *et al.* (2019) who argued that students who have high thinking skills can monopolize this learning model. Students with slow thinking skills will be confused in thinking broadly, making abstractions, finding relationships between concepts in a subject, or constructing what they have learned in writing or orally.

They concluded that incorporating the setting of the religious day during the pandemic helped students think numerically and subconsciously, engaged them actively in learning based on the findings. According to Kohar, *et al*. (2019) and Zulkardi, *et al.* (2020), context guides students to think mathematically because the provided scenario activates their capability for mathematical thinking processes.

Three students wrote perfectly and accurately, while five students wrote incorrectly, according to communication skills signs of the writing process in achieving solutions. Meanwhile, there were no students who have completed the indicators of completing mathematical outcomes. These errors occur when students are not cautious about reading the data from the information provided in the questions, resulting in errors in converting the data into calculations and a lack of experience in providing conclusions for each answer. On contrary, Nusantara, Zulkardi & Putri (2021a); explain that if students are too focused on finding information on the problem and it takes a long time, it will affect students' calculations.

As measured by indicators of using and connecting multiple representations in problem solving, the ability of representation reveals that eight pupils can totally and accurately use representations, whereas eleven others were not. When students focus too much on pictures and read information while focusing on one question, they make mistakes such as not paying attention to other questions. It is in line with Efriani and Putri (2019), who explained that if students focus too much on the picture, the student will be wrong in doing calculations.

CONCLUSION

The questions produced are valid and practical based on the characteristics of the PISA items developed, namely the exploration of quantity content that focuses on number pattern material, the situation given is religious days during a pandemic which includes social context. When problems are used to improve mathematical literacy abilities, they can impact. The skill of representation is the dominant skill in students since they grasp it well enough to relate the facts. Meanwhile communication skills are still low because students only focused on pictures so they were less thorough in working on questions and the IBL learning model is used so that students can be motivated in learning and practicing communication skills.

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