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Developing PISA-like math problems in the content of space and shape through the context of historical buildings

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Abstract

The essential purpose of developing PISA-like questions is to train students' reasoning abilities so that students' ability to solve PISA-like questions increases. Therefore, this research aims to produce PISA-like math problems in the context of historical buildings in the Karawang Regency that are valid, practical, and potentially affect mathematics learning. The subjects of this study were junior high school students at SMPN 2 Karawang Barat. This research uses design research with development studies, consisting of preliminary and prototyping phases. The preliminary stage consists of two stages: needs analysis and design, while the prototyping stage consists of 5 phases: self-evaluation, expert review, one-to-one, small group, and field tests. The data collection techniques in this study were in the form of PISA-like math problems in the context of shape and space with the context of Historic Buildings in Karawang, observations, questionnaires, and interviews. All data obtained were analyzed descriptively. The results show that this study resulted in nine PISA-like math problems in the context of shape and space with the context of Historic Buildings in Karawang that are valid, practical, and potentially affect learning mathematics. The potential effect is related to students' interest in PISA-like questions and students' ability to understand and answer PISA-like questions. Finally, the results of this study have an impact on students who are getting trained in solving PISA-like math problems.

Keywords: Design Research, Historical Buildings' Context, PISA-like Math Problems, Space and Shape

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The poor quality of education in Indonesia directly affects the quality of human resources (Beatty et al., 2021). It can be seen through several students' international assessment results, such as PISA and TIMSS. For instance, in PISA, Indonesia was consistently ranked bottom ten in mathematics (OECD, 2014, 2016, 2018, 2019). In PISA, the domain of mathematics is arranged to assess students' mathematical literacy. OECD (2014) explains that mathematical literacy is an individual's ability to formulate, apply, and interpret mathematics in various contexts. Mathematical literacy includes mathematical reasoning and using mathematical concepts, procedures, facts, and mathematical tools to describe, explain and predict phenomena or events (OECD, 2018; Rieu et al., 2022). It is what connects the mathematics learned in the classroom with a variety of real-world situations.

One program that assesses mathematical literacy initiated by the OECD is the Program for International Student Assessment (PISA). PISA is an international assessment held every three years to

determine the skills and abilities of 15-year-old students (OECD, 2016). Skills and abilities in PISA assessed include math, reading, and science (OECD, 2019).

PISA introduces mathematical literacy as the capacity of the individual to identify and understand mathematics' role in real life and to make constructive judgments that meet the needs of the individual's life. It is in line with what was said by Csapó (2022) to support evidence-based education; more effective, more extensive worldwide assessment programs were created using the knowledge gained from earlier comparative studies.

The Ministry of Education and Culture (2014) states that questions are needed based on the development of the 2013 curriculum that adapts learning in Indonesia to the questions tested by PISA. In this case, teachers must be able to design questions using contexts close to their students' lives (Zulkardi & Putri, 2019; Putri & Zulkardi, 2020). On the other hand, Indonesian students need to learn to solve contextual and high-level PISA-based math problems. It is in line with the opinion of Pulkkinen et al. (2022), which states that PISA proficiency scores correlated not only with the corresponding grades but also with the grades of other theoretical subjects, indicating that the PISA test assesses a wide range of school achievement.

Another effort to prepare Indonesian students for PISA is to develop questions (Nusantara et al., 2021; Arifin et al., 2017). In this case, the PISA model questions in the context of historical buildings in the Karawang Regency will be developed. The development of PISA-like questions must start now because it can make it easier for students to understand the questions in the classroom (Oktiningrum et al., 2016). One way to develop PISA-like questions can be done by making these questions related to the cultural life of the students in their environment.

In Karawang, a well-known building is called the monument of determination and the home of Soekarno's exile. Figure 1 shows the monument of determination which presents the visual of the building containing several shapes. Therefore, the monument of determination and the home of Soekarno's exile uses as the context for developing the PISA-like questions.

Figure 1. The monument of determination

On the other hand, one of the solutions to overcome the low Indonesian PISA scores is to introduce PISA questions close to students so that students are more interested in doing them because they know the context of the questions (Aini & Putri, 2018; Aini, Putri, & Yaniawati, 2019). In this regard, this research

aims to develop PISA-like questions in the context of historical buildings in Karawang as the context that is valid, practical, and has potential effects.

METHODS

The research method used is design research with development studies (Bakker, 2018). This study aims to produce valid, practical, and potentially effective PISA-like questions. The stages carried out in this study were the preliminary stage and the prototyping stage (formative evaluation), which included self-evaluation, expert review, one-to-one, small group, and field tests (Tessmer, 1993; Zulkardi, 2002).

Preliminary Stage

In this stage, the researchers determine the research place and subject and examine some literature related to historical buildings in Karawang and the 2013 Curriculum.

Formative Evaluation

To develop a valid and practical PISA-like question, the researchers conducted a formative study in the form of self-evaluation, expert and one-to-one reviews, small groups, and field tests (Zulkardi, 2002; Nusantara et al., 2021).

Self-Evaluation

In the self-evaluation phase, the researchers designed a grid question containing PISA-like question indicators, scoring rubrics, and walk-through sheets. Then the researchers reviewed the devices that had been designed to be developed. The first prototype is the result of the draft designed during the self-evaluation phase. The characteristics that focus on designing the developed draft or device consist of content, construct, and language.

Expert Review

During the expert review phase or expert test, the product that has been made is validated by the expert using observation, assessment, and evaluation. Expert validation uses a study of content, construct, and language. In this study, the referred experts are mathematics education and language experts. The validation process of the first prototype at the expert review phase was carried out in three ways: face-to-face review, letters/emails (email review), and panel review (Tessmer, 1993). The results of the expert review will be used to revise the product.

One-to-One Review

The researchers conducted tests on students individually (one-to-one) and an expert review. The results from the one-to-one are used to revise the product, and it will produce a second prototype.

Small Group

The small group phase was carried out after an expert review and one-to-one with the results of the second prototype. There were 12 students involved in this phase who differed from the research subjects. Students involved in this phase have diverse mathematical abilities based on math scores below, equal to, and above the Minimum Completeness Criteria set by the school. This phase is carried out to determine the effectiveness and validity of the designed prototype. The result of this phase is the third prototype.

Field Test

The last phase is the field test, which is the third prototype field test. This phase was carried out at SMPN 2 Karawang Barat, involving 7th-grade students. The products produced in the field test are expected to fulfill the quality criteria.

RESULTS AND DISCUSSION

This research develops a set of PISA-like mathematics problems with space and shapes content in the context of historical buildings in Karawang. There are nine questions with four contexts to improve students' understanding of solving space and shape problems. The study results are described in two major phases: preliminary design and formative evaluation, consisting of five phases: self-evaluation, one-to-one, expert review, small group, and field test. The following sections will be discussed in more detail for every phase.

The Preliminary Stage

At this stage, the researchers review and analyze several works of literature to develop several problems. In addition, discussions and interviews were conducted with the vice principal, mathematics teachers, and students at SMPN 2 Karawang Barat, which aims to explore the knowledge of students and teachers about PISA questions at the school and to determine students' ability in mathematics learning. Based on the interview results, their knowledge of PISA questions still needs to be improved, and student's ability to solve PISA questions still needs to improve because preparing PISA-like questions constrains it, and students' abilities in learning mathematics are heterogeneous.

Data collection was carried out by field study and interviews with several informants, such as the guardian of historical buildings and cultural practitioners in Karawang, exploring and clarifying the mathematical ideas in the historical buildings in Karawang. These buildings contain several parts related to 7th-grade students' mathematics material based on the 2013 Curriculum. Therefore, the researchers developed PISA-like mathematics problems with space and shape content in the context of historical buildings in Karawang.

The Prototyping Stage

In the prototyping stage, the formative evaluation of the prototype contains five phases: self-evaluation, expert review, one-to-one, small group, and field tests.

Self-Evaluation

The prototype compiled by the researcher is re-evaluated to correct errors that appear in the self-evaluation phase before carrying out the next step. Evaluation of the prototype focused on content, construct, and language.

The descriptions for each question follow the PISA framework. There are ten questions developed in this research divided into four problems. The first problem, namely *Pesawahan*, consists of three questions, such as general context used to identify the 3rd-level PISA question with the indicator of finding the formula for the area of a square, the 4th-level PISA question with the indicator of calculating the area of the square, and the 4th-level PISA question with the indicator of problem-solving related to rectangular.

The second problem, *Monumen Kebulatan Tekad*, consists of a general context with the question indicator determining the circle element for the 1st-level PISA question. The next problem, namely *Rumah Pengasingan Soekarno*, has three questions. The first question includes the 4th-level PISA question and

contains a general context with indicators for solving problems related to rectangular. The second question consists of the 5th-level PISA question in a general context with indicators about determining the equations that apply to triangles using the Pythagorean theorem. The last question has the 5th-level PISA question under a general context with an indicator determining the length of one side of a right triangle if the other two sides are known. Lastly, the final problem, *Bendungan Walahar*, holds three questions containing a general context with the 3rd-level PISA question. All questions discuss how to solve several kinds of circle problems.

Expert Review and One-to-One

The prototype, and the self-evaluation process's results, were tested simultaneously at the expert review and one-to-one phases. The expert review and one-to-one phases were carried out to produce products validated by experts and tested on three students.

Expert review or expert test is a qualitative validation stage of the prototype, namely device validation in content, construct, and language. In this study, the expert review was validated in three ways: face-to-face, electronic mail/email, and focus group discussions. Table 1 presents the result of the expert review phase.

Table 1. Comments of expert review

Expert	Institution	Suggestions
Dr. Dori Lukman Hakim	Lecturer at Universitas Singaperbangsa Karawang	Even better if it presents questions that are interesting and in accordance with the context you want to appear.
Hetty Patmawati, M.Pd.	Lecturer at Universitas Siliwangi	The sentence in the problem must be clarified
Ngatimah, S.Pd.	Mathematics Teacher at SMPN 1 Karawang Barat	For question number 10, the level of difficulty is too high, and it is better if the language of the question is clarified
Meti Faroka, S.Pd.	Mathematics Teacher at MTs N Tasikmalaya	All the questions developed when examined in terms of content and construct to follow the form of PISA questions. Everything leads to shape and space content and the general context, in this case, the Karawang context. Likewise, the questions presented follow the junior high school level. Furthermore, regarding the essential competencies presented in this instrument, they are following the material studied at the junior high school level. It is regardless of its suitability with the current government-imposed curriculum.

Table 1 consists of several suggestions from validators. They suggest developing several questions and improving the lesson plans, including clarity in the questions' language, so they do not contain double meanings, improving the picture quality, and the editorial questions. Furthermore, the validation process is carried out using content and construct validity. Content validity is seen from three

aspects: content, construct, and language. The following are the results of content validity from the content element.

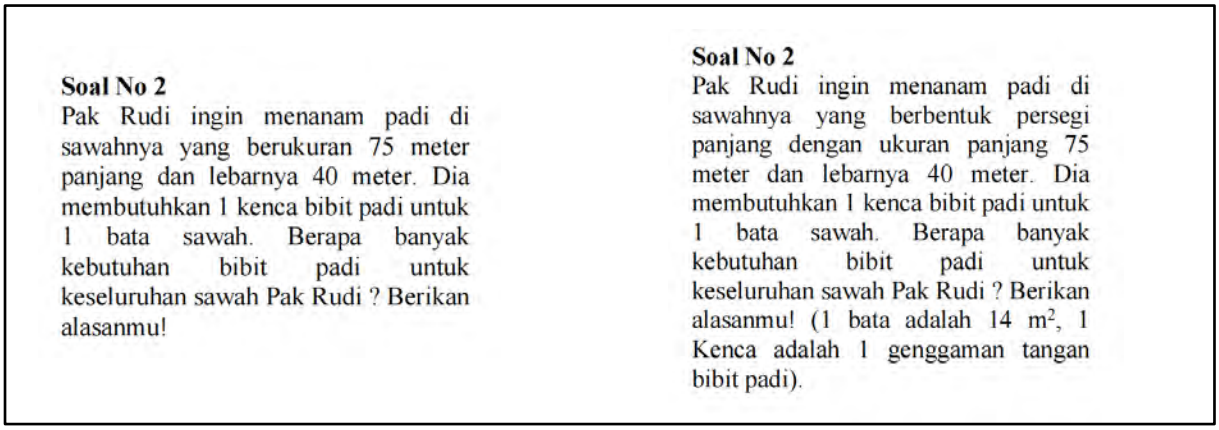
Based on the validators' comments and the results of the validation questionnaire about the developed questions, it was concluded that the questions were categorized as valid, reasonable, and worthy to be tested on students. Furthermore, in the one-to-one stage, three students were selected according to the formative evaluation instructions to produce substantial changes to the PISA-like mathematics problems in the Karawang historical building context that had been made (Tesmer, 1993). The three students were Syifa Nadira, Ikhsan Nur Hidayat, and Dira Siti Hubiah T. The purpose of this trial was to determine the responses and difficulties faced by students when reading and answering questions. Reactions and practical challenges focused on the readability and clarity of the question. The questions in this study consisted of three materials taught in 7th and 8th grades, namely Quadrilateral, Circle, and Pythagorean Theorem. The followings are their comments or suggestions on the PISA-like mathematics problems in the Karawang historical building context, as shown in Table 2.

Table 2. Comments on one-to-one stage

No	Name	Comment
1.	Ikhsan Nur Hidayat	I need help understanding and am never used to working on questions like this, so completing them takes a long time. Furthermore, some words or terms need to be explained in the problem.
2.	Syifa Nadira	My comments for questions 4 and 5 are questions and pictures that need to be more appropriate (less transparent). There are too many words in question number 4, so I must read it repeatedly even though it is unrelated to what is being asked. To be clarified so that the questions and pictures are connected.
3.	Dira Siti Hubiah T.	I became more aware of the history of relics in Karawang.

From the two stages described, the researchers revised the editorial of several questions following the general guidelines for Indonesian spelling, removed irrelevant information about questions and images, and fixed the layout and appearance of the questions. During the one-to-one phase, it is known that the student's ability to read the questions and interpret the meaning into mathematical problems is good enough. Still, it takes a long time for low-ability students to understand them. The difficulties experienced, on average, were on the *Bendungan Walahar* questions, which are questions 8, 9, and 10. In these questions, there were no students who were able to identify the problems given and connect the solutions to the material. All students try to solve this problem by guessing and trying to find a pattern so that it becomes the input for researchers to clarify the question text further so that students more easily understand the meaning of the question. It shows that students in the one-to-one phase generally understand the PISA-like mathematics problems, although some 5th-level questions still need to be solved.

The researchers revised the first prototype to produce a second one from the one-to-one and expert review results. Here are some pictures showing the change from the prototype to the second prototype. The modification for question number 2 is shown in Figure 2.



Question Number 2
Mr. Rudi wants to plant rice in his rice field which is a rectangle with a length of 75 meters and a width of 40 meters. He needs 1 *kenca* of rice seed for 1 *bata* of rice field. How many rice seeds are needed for the entire Mr. Rudi's rice field? Give your opinion! (1 *bata* is 14 m^2 and 1 *kenca* is 1 handful of rice seeds).

Figure 2. Before revision (left) and after revision (right)

Figure 2 shows the changes based on the validator's comments on words that are felt to be ambiguous, so the sentence structure of the question is changed. Then the question is given additional information that 1 *bata* = 14 m^2 to avoid differences in perception. Furthermore, the revision for question number 10 is shown in Figure 3.

***Bendungan Walahar* Unit**
Question Number 10

Soal No 10

Jika Agnia membutuhkan waktu

diketahui panjang jembatan adalah 500 meter, berapa menit waktu yang ditempuh Agnia untuk menyebrangi bendungan walahar tersebut?

If Agnia takes time
It is known that the length of the bridge is 500 meters, how many minutes that Agnia takes to cross the *Bendungan Walahar*?

Revision

Jika Agnia akan menyebrangi bendungan dengan panjang jembatan 500 meter, berapa menit waktu yang dibutuhkan Agnia untuk menyebrangi Bendungan Walahar tersebut ?

If Agnia wants to cross the dam with a bridge length of 500 meters, how many minutes that Agnia takes to cross the *Bendungan Walahar*?

Figure 3. The revision for question number 10

Figure 3 shows changes based on the validator's comments about writing unclear questions. These phases conclude that the questions need improvement with several revisions. After modification, all questions are stated in the booklet. Finally, after the revisions were made according to comments and suggestions from experts and one-to-one, it was decided that there were ten questions in the second prototype, which would be tested later.

Small Group

After revising the one-to-one and expert review results, the second prototype was obtained, and then a small group phase was carried out. In the small group stage, the number of subjects is 12 students with various abilities, as seen in Figure 4.

Figure 4. Small group stage

Next, students have distributed 10 PISA questions from the 2nd level until the 5th level to be worked on individually. After 15 minutes of working individually, the students were formed into three groups of 4 in 1. In groups, students discuss the results of their work separately and then determine a conclusion to answer that will be written on the group's question paper. After the discussion process took place, it continued with the presentation. The presentation is done when the three groups have different results. Initially, the teacher asked the results of each group's answers, then from the three groups with different results, one presented forward. After that, the other groups responded correctly or not to the results of the group's answers. Furthermore, the teacher determines which answer is correct.

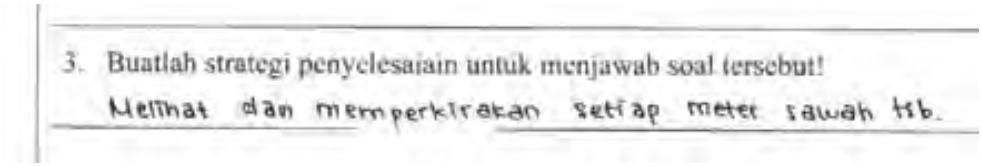
From the result of a small group, there is 1 question has been revised, namely question number 9, which was deleted because there was no one student who answered correctly. The result of this stage is called the third prototype, which will be continued at the field test.

Field Test

After the small group test result was revised, the third prototype was obtained, then a field test was carried out. It was carried out to see the potential effects of the developed questions (Mutia, Effendi, & Sutirna, 2021; Nurazizah & Zulkardi, 2022). In the field test, the learning process is carried out using PISA questions that have been developed.

The learning process begins with an apperception telling the objectives and benefits of learning about PISA questions. The next step is to show a video of historic buildings in Karawang. Then students are asked to work on six PISA questions for 30 minutes individually. Then the students were formed into five groups with four members each. From the results of individual work, each group discusses to produce

one best answer to be written on the group answer sheet. Next, the teacher monitors the solutions from each group. If there are different answers, the teacher asks them to present the solutions in front of the class. Then, the students and the teacher discuss and agree on the right solution. The following explains the various responses from this stage of the field test. Furthermore, for question number 1, when students were asked what strategy was used, there was a group answer stating that the first step was finding the price per square meter, as shown in Figure 5.



3. Create a solution strategy to answer the question!
Look and estimate every meter of the rice field.

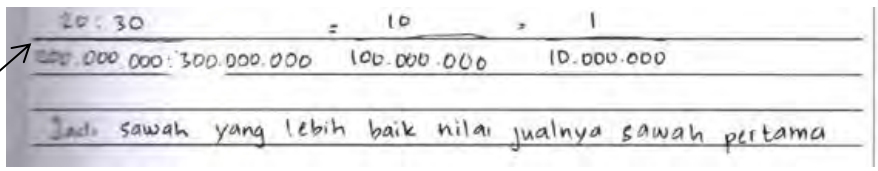
Figure 5. Student's answer

Figure 5 shows that students have understood the question's meaning to find out which selling point is better. Furthermore, the researcher interviewed the student to ask about the results of the group's work. The interview results between the researcher and the student are as follows.

Q : Are you sure about your strategy for finding the correct answer?
S: Sure, Miss.
Q: Can you explain how?
S : So, Miss, to determine the best selling price, you must first know the selling value per square meter for each rice field. Now that it is known, then it is determined which one is better.
Q: Then which one do you think is better?
S: The first rice field is better because it is more expensive, about five hundred thousand per square meter

From the interview footage, it appears that students understand the meaning of the given question and can solve it well. Alfian et al. (2017) explain that asking students to describe their strategy can lead them to solve the problem well. Then there are different answers. The student FT-2.1 answered the question incorrectly, but the conclusion needs to be corrected. In this case, there is a misunderstanding, as shown in Figure 6.

interpreting and using representations based on sources of information



So, the rice field with better selling value is the first rice field.

Figure 6. The answer of student FT-2.1

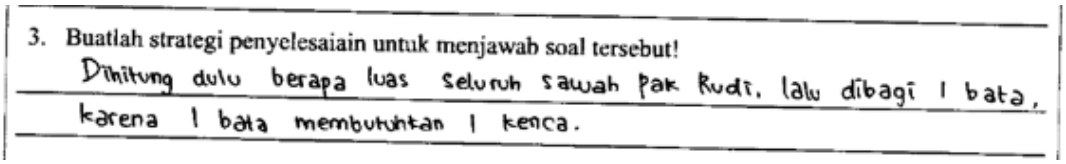
Figure 6 shows that students do not understand the question's meaning. He compared the two fields to find out which selling point was better. So, this is where the error lies. Furthermore, the researcher

interviewed the student to ask about the results of the group's work. The interview results between the researcher and the student are as follows.

Q : Are you sure about your answer?
S : I am sure, Miss, because I made the comparison. The ratio between the two is the same, which is 1: 10,000,000. So, I think it is a yes, and the first rice field has a better selling price.
Q : Why immediately do the comparison?
S : Oh yes, Miss, the sizes are different, so the area will also differ. Then, first, I must know the price per meter, is it right, Miss?
Q : Yes, then how?
S : So, you will find the area first, then divide it, right, Miss? See you later

From the interview results, it is known that the students understood the questions well. He found out where the mistake had been made, so he rewrote the correct answer. Judging from the activities carried out in the 3rd level: students can develop simple communication through their results, interpretation, and reasoning; in this case, students can do their interpretation and reasoning to solve the problem, so it is predicted that this question will influence students' abilities (Meryansumayeka et al., 2020; Putri & Zulkardi, 2020; Zulkardi et al., 2020).

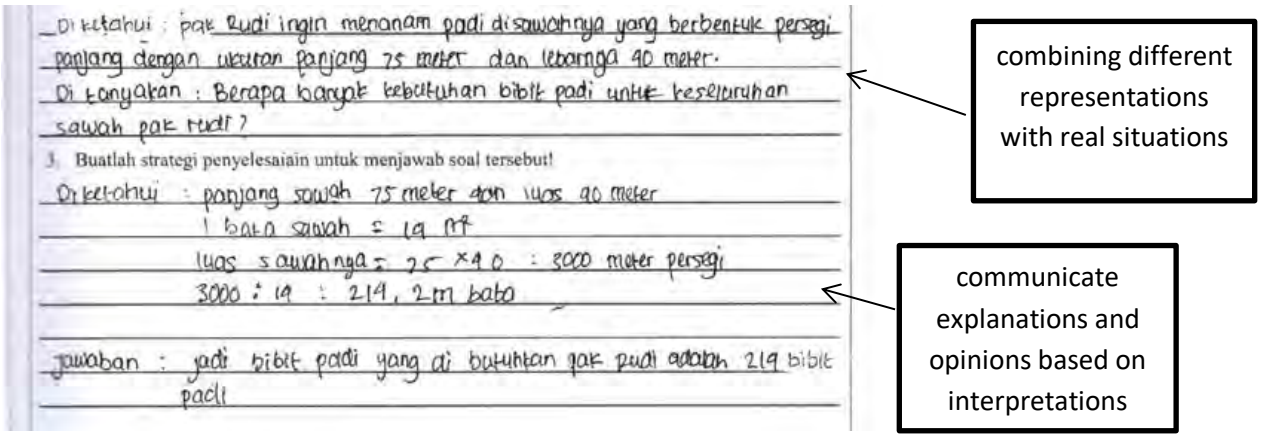
Problem number 2 deals with the area of a square. In this problem, students are expected to be able to choose and combine different representations, including symbolizing and relating them to real situations. Figure 7 shows the strategies used by students in answering questions as follows.


3. Buatlah strategi penyelesaiain untuk menjawab soal tersebut!
Dititung dulu berapa luas seluruh sawah Pak Rudi, lalu dibagi 1 bata, karena 1 bata membutuhkan 1 kenca.

3. Create a solution strategy to answer the question!
First, calculate the area of Mr. Rudi's entire rice field, then divided by 1 *bata*, because 1 *bata* requires 1 *kenca*.

Figure 7 The answer of student FT-3.2

Figure 7 shows that students can make a solution plan. Furthermore, students' answers can be seen in Figure 8.



Translated in English:
Known: Mr. Rudi wants to plant rice in his rice field which is rectangle with the length of 75 meters and the width of 40 meters.
Asked: How many rice seeds are needed for Mr. Rudi's entire rice field?
3. Create a solution strategy to answer the question!
Known: the length of rice field is 75 meters and the area is 40 meters
1 *bata* of rice field = 14 m^2
The rice field area = 25 × 40 = 3000 sq. meters
3000 : 14 = 214.2 m *bata*

Answer: So, the rice seeds needed by Mr. Rudi are 214 rice seeds

Figure 8 Student's answer

Figure 8 shows that students understand the questions well. Students can work effectively with the model implied in the problem to get the correct conclusion. The activities carried out by students in expressing flexible reasons and views according to the context can be seen in the answers. So, it is assumed that this question has the potential to have effectiveness in the learning process (Meryansumayeka et al., 2022).

For question number 3, there is no difference in the answers. All groups finished well. There is one unique group answer in the solution, as shown in Figure 9.

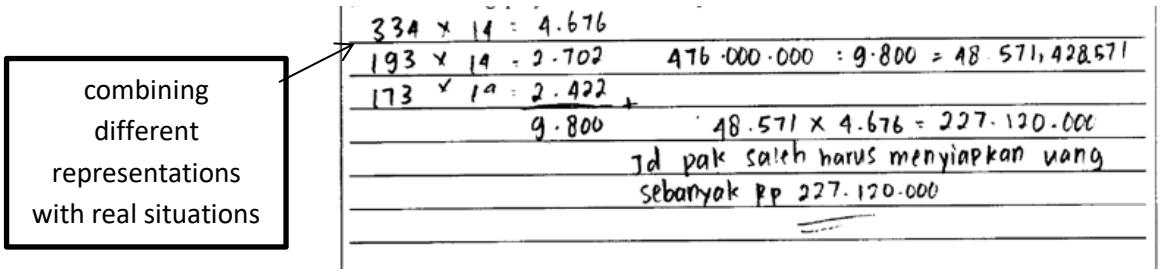


Figure 9 Student's answer

Figure 9 shows that this student converted the area of the rice fields to meters and then added them all together. Furthermore, after obtaining the sum, the total price of the rice fields is divided by the area. The results are then multiplied by the area of the largest rice field. It is in line with the interview results as follows.

Q : Why do you convert to square meters?
S: To make it easier, Miss, I understand better this way
Q: Then, after the conversion, what do you do?
S : I divided the total selling price by the area of the rice fields, so I know, Miss, how much the price is per square meter.

This dialog shows that the student can use good skill development and present flexible reasons and views according to the context. It means that student activities are under the characteristics of student activities in solving the 4th-level PISA questions.

Like question number 3, question number 4 has no different answers. This question is predicted to fall into the category of 1st level question, where all students can take actions easily according to the given stimulus. Problems are presented in the pictures. Students are asked to visualize the picture if it is seen from above. Most of the students answered correctly, and they were very enthusiastic. Furthermore, the researcher interviewed the student. Herewith is the following interview.

Q: How about question number 4?
S: I am interested, Miss. From the words in the question, I know the history of Indonesian independence
Q: How do you answer the questions?
S: Yes, just imagine, Miss, hehe

From the interview, students enjoy working on this question so that similar questions can be reproduced for further development. It follows Stacey's (2011) research that shows Indonesian students can solve low-level questions.

The development of PISA-like questions is critical because PISA questions are included in the HOTS question category (Zulkardi & Putri, 2019; Rawani, Putri, & Hapizah, 2019). Along with the development of the curriculum, all teachers in assessing learning outcomes are expected to be able to make HOTS questions. Furthermore, the development of relevant questions is reflected in the suitability and consistency of the material taught. The questions must follow the indicators and learning objectives to be addressed. Therefore, the PISA-like questions developed in this study emphasized content validity, construct validity, and language. It is so that the questions developed are under the curriculum used.

The questions developed have been categorized as valid. Even though from the results of the validation, the expert concluded that it was classified as valid, it needed a little revision to the editorial question. It is because, in writing queries, the researchers pay less attention to perfected spelling and punctuation and less attention to sentence structure, causing the written language to be interpreted differently by students (Zulkardi & Kohar, 2018). Because the written question needs to be clarified, it will have a double meaning.

This research has produced PISA-like mathematics problems in the context of historical buildings that are valid and practical and have potential effects on students. In the preliminary stage, the researcher analyzed the curriculum and students' abilities in mathematics subjects and examined the mathematical elements in historical buildings in Karawang.

The first prototype, revised from the expert review phase and one-to-one, is called the second prototype. Then, a trial will be carried out at the small group stage of 12 students from 7th grade of one of the junior high schools in Karawang whose research subjects are not. This phase aims to determine the practicality of the product that has been made. In addition to documentation and interviews, the researchers used a questionnaire to see the practicality of the reading text of the school literacy movement in learning mathematics in junior high school. Akker (1999) mentions that practically refers to the extent to which users (or other experts) consider the intervention appealing and usable in normal conditions. The results of the questionnaire analysis showed that the PISA-like mathematics problem in the context of the historical building in Karawang has a practical category for students. It is because

students need to experience problems in solving problems. Furthermore, the revised results from the small group phase are called the third prototype.

From the study results, students do not experience problems in solving problems. Students could follow the directions of the questions, and it was also seen that they wrote according to what was asked or asked. Based on the findings of this study, the teaching materials developed are considered practical. It is in line with the practical opinion if the research results show that students, as users of teaching materials, assume that these materials meet their needs, expectations, and desired boundaries (Zulkardi & Putri, 2019; Putri & Zulkardi, 2020).

The last phase in the formative evaluation is the field test. In the field test, the research subject is 7th-grade students in one of the Karawang Junior High Schools, totaling 20 students. At this stage, students are asked to answer questions, discuss them with group friends, and present them in class. In the answers and discussion process, it is seen that students understand the questions developed.

The results of a questionnaire to see the potential effect of reading texts on the school literacy movement show that the text has a potential effect on students. Furthermore, judging the students' answers to each question shows that the PISA-like mathematics problem with shape and space content potentially affects learning mathematics. Reigeluth (1999) explains that an essential aspect of the effectiveness (potential effect) of an instrument, theory, or model is knowing the level/degree of application of the theory or model in a particular situation. Furthermore, Akker (1999) states that effectiveness refers to the experience and results of the intervention consistent with the intended goal and is indicated by the relationship between the results and the goals to be achieved. In this case, the potential effect of using PISA-like mathematics problems in the context of historical buildings in Karawang can be seen from the results obtained in its application, both from the answers to questions in the text of habituation development and mathematics learning.

CONCLUSION

This research produces a set of PISA-like mathematics problems with space and shapes content in the context of historical buildings in Karawang. The set of questions was developed based on two stages of the design research approach with the development studies: the preliminary stage and the prototyping stage with a formative evaluation. The prototyping stage produces nine questions in four units declared qualitatively valid. It means the validity of the questions can be seen from the expert reviews results and one-to-one, which states that the questions are good in terms of content, construct, and language. Furthermore, the prototyping stage results were also declared practical based on the small group stage test results, which showed that students could understand the questions well.

A set of questions declared valid and practical are tested at the field test phase, which involves twenty 7th-grade students at SMPN 2 Karawang Barat. This stage is carried out to determine the potential effect of a set of questions that have been developed. The field test results show that these questions can enhance students' understanding of two-dimensional shapes.

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Declarations

Author Contribution : INA: Conceptualization, Investigations, Analysis, Writing-Original Draft, and Editing.
Z: Resources, Methodology, and Supervision.
RIIP: Validation and Supervision
PY: Supervision and Formal Analysis

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REFERENCES

Aini, I. N., & Putri, R. I. I. (2018.). Designing PISA-like mathematics problems using the context of Karawang. *Journal of Physics: Conference Series*, *1088*(1), 012117. https://doi.org/10.1088/1742-6596/1088/1/012117

Aini, I. N., Putri, R. I. I., & Yaniawati, P. (2019). PISA-like mathematics problems using rice fields context in Karawang. *Journal of Physics: Conference Series*, *1188*(1), 012073 https://doi.org/10.1088/1742-6596/1188/1/012073

Akker, J. (1999). Principles and Methods of Development Research. In: van den Akker, J., Branch, R.M., Gustafson, K., Nieveen, N., Plomp, T. (eds) Design Approaches and Tools in Education and Training. Springer, Dordrecht. https://doi.org/10.1007/978-94-011-4255-7_1

Alfian, M., Dwijanto, D., & Sunarmi, S. (2017). Effectiveness of probing-prompting learning models with scaffolding strategy to mathematic creative thinking ability and enthusiasm. *Unnes Journal of Mathematics Education, 6*(2), 249-257. https://doi.org/10.15294/ujme.v6i2.17172

Arifin, S., Putri, R. I. I., Hartono, Y., & Susanti, E. (2017). Developing Ill-defined problem-solving for the context of "South Sumatera". *Journal of Physics: Conference Series*, *943*(1), 012038. https://doi.org/10.1088/1742-6596/943/1/012038

Bakker, A. (2018). What is design research in education?. In *Design research in education* (pp. 3-22). Routledge.

Beatty, A., Berkhout, E., Bima, L., Pradhan, M., & Suryadarma, D. (2021). Schooling progress, learning reversal: Indonesia's learning profiles between 2000 and 2014. *International Journal of Educational Development*, *85*, 102436. https://doi.org/10.1016/j.ijedudev.2021.102436

Csapó, B. (2022). Social determinants of mathematics and science achievement in historical context. *Current Opinion in Behavioral Sciences*, *46*, 101182. https://doi.org/10.1016/j.cobeha.2022.101182

Meryansumayeka, Putri, R. I. I., Zulkardi, & Hiltrimartin, C. (2020). Secondary students' higher-order thinking skills in solving PISA-like mathematical tasks. *Journal of Physics: Conference Series*, *1480*(1), 012034). https://doi.org/10.1088/1742-6596/1480/1/012034

Meryansumayeka, Zulkardi, Putri, R. I. I., & Hiltrimartin, C. (2022). Designing geometrical learning activities assisted with ICT media for supporting students' higher order thinking skills. *Journal on Mathematics Education*, *13*(1), 135-148. https://doi.org/10.22342/jme.v13i1.pp135-148

Mutia, M., Effendi, K. N. S., & Sutirna. (2021). PISA-LIKE: Uncertainty and data content in Statistics subject with futsal context. *Journal of Physics: Conference Series*, *1778*(1), 012028. https://doi.org/10.1088/1742-6596/1778/1/012028

Nurazizah, I., & Zulkardi. (2022). Students' mathematical reasoning ability in solving PISA-like mathematics problem COVID-19 context. *Jurnal Elemen*, *8*(1), 250-262. https:/doi.org/10.29408/jel.v8i1.4599

Nusantara, D. S., & Putri, R. I. I. (2021). Designing PISA-like mathematics task using a COVID-19 context (PISAComat). *Journal on Mathematics Education*, *12*(2), 349-364. http://doi.org/10.22342/jme.12.2.13181.349-364

OECD. (2014). *PISA 2012 Results: What Students Know and Can Do (Volume I, Revised edition, February 2014): Student Performance in Mathematics, Reading, and Science.* Paris: OECD Publishing. https://doi.org/10.1787/9789264208780-en

OECD. (2016). *PISA 2015 Result (Volume I): Excellence and Equity in Education*. Paris: OECD Publishing. https://doi.org/10.1787/9789264266490-en

OECD. (2018). *PISA 2018 Assessment and Analytical Framework*. Paris: OECDiLibrary. https://doi.org/10.1787/b25efab8-en

OECD. (2019). *Indonesia – Country Note – PISA 2018 results*. Retrieved from https://www.oecd.org/pisa/publications/PISA2018_CN_IDN.pdf

Oktiningrum, W., Zulkardi, & Hartono, Y. (2016). Developing PISA-like mathematics task with Indonesia natural and cultural heritage as context to assess students mathematical literacy. *Journal on Mathematics Education*, *7*(1), 1-8. DOI: http://dx.doi.org/10.22342/jme.7.1.2812.1-8

Pulkkinen, J., & Rautopuro, J. (2022). The correspondence between PISA performance and school achievement in Finland. *International Journal of Educational Research*, *114*, 102000. https://doi.org/10.1016/j.ijer.2022.102000

Putri, R. I. I., & Zulkardi. (2020). Designing PISA-like mathematics task using asian games context. *Journal on Mathematics Education*, *11*(1), 135-144. https://doi.org/10.22342/jme.11.1.9786.135-144

Rawani, D., Putri, R. I. I., & Hapizah. (2019). PISA-Like Mathematics Problems: Using Taekwondo Context of Asian Games. *Journal on Mathematics Education*, *10*(2), 277-288. https://doi.org/10.22342/jme.10.2.5243.277-288

Reigeluth, C. M. (1999). What is instructional-design theory and how is it changing. In *Instructional-design theories and models: A new paradigm of instructional theory* (pp. 5-29). Routledge. https://www.researchgate.net/profile/Charles-Reigeluth/publication/292733090_What_is_Instructional_Design_Theory_and_How_Is_it_Changing_93/links/00b495318c0cd8aa42000000/What-is-Instructional-Design-Theory-and-How-Is-it-Changing-93.pdf

Rieu, A., Leuders, T., & Loibl, K. (2022). Teachers' diagnostic judgments on tasks as information processing–The role of pedagogical content knowledge for task diagnosis. *Teaching and Teacher Education, 111*, 103621. https://doi.org/10.1016/j.tate.2021.103621

Stacey, K. (2011). The PISA view of mathematical literacy in Indonesia. *Journal on Mathematics Education*, *2*(2), 95-126. http://dx.doi.org/10.22342/jme.2.2.746.95-126.

Tessmer, M. (1993). *Planning and conducting formative evaluations*. Routledge. https://doi.org/10.4324/9780203061978

The Ministry of Education and Culture. (2014). *Mathematics for Junior High School*. Jakarta: Kementerian Pendidikan dan Kebudayaan.

Zulkardi & Kohar, A. W. (2018). Designing PISA-like mathematics tasks in Indonesia: Experiences and challenges. *Journal of Physics: Conference Series*, *947*(1), 012015. https://doi.org/10.1088/1742-6596/947/1/012015

Zulkardi & Putri, R. I. I. (2019). New school mathematics curricula, PISA and PMRI in Indonesia. In *School Mathematics Curricula* (pp. 39-49). Springer, Singapore. https://doi.org/10.1007/978-981-13-6312-2_3

Zulkardi, Meryansumayeka, Putri, R. I. I., Alwi, Z., Nusantara, D. S., Ambarita, S. M., Maharani, Y., & Puspitasari, L. (2020). How students work with PISA-like mathematical tasks using COVID-19 context. *Journal on Mathematics Education*, *11*(3), 405-416. https://doi.org/10.22342/jme.11.3.12915.405-416

Zulkardi. (2002). Developing a learning environment on realistic mathematics education for Indonesian student teacher. *Doctoral Dissertatio*n. Enschede: University of Twente.