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How do students use mathematical reasoning to solve PISA-type mathematics problems based on making kite contexts?

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Abstract

According to the PISA 2022 study, Indonesian students' mathematical literacy and mathematical reasoning skills are low. In fact, students need mathematical reasoning skills to face the complex challenges of life in the 21st century. Therefore, this study developed PISA-type math problems grounded in kite-making to support students' mathematical reasoning. Using real contexts that are familiar to students' daily lives can make it easier for them to understand and solve problems. This research uses a development study carried out in three stages: preliminary research, prototyping, and assessment. The data collection techniques used were tests, interviews, observations, and documentation. The data were analyzed using qualitative descriptive analysis to see the characteristics and potential effects of the questions developed. The results showed that PISA-type math problems based on the kite-making context supported students' mathematical reasoning. Students can connect mathematical concepts such as area, perimeter, and ratio to real-life situations, including the size of kite materials, the ability of kites to catch the wind, and the ability of kites to fly high. This research provides an alternative to PISA-type mathematics problems, with a familiar context, that can support students' mathematical reasoning. In addition, the results of this study can serve as a reference for educators and education policymakers in Indonesia in developing relevant, context-specific PISA-type questions to increase students' mathematical literacy scores at the national and international levels.

Keywords:
Design research, Making kite, Mathematical reasoning, PISA-type mathematics problem, Shape and space

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1. INTRODUCTION

In the 21st century, mathematical reasoning is one of the most important skills students need to solve mathematical problems in complex real-world challenges (Ernie et al., 2023). Mathematical reasoning involves thinking logically, making generalizations, testing truth, and relating various mathematical concepts to real-world situations (Jablonski, 2023). This ability supports a deep understanding of mathematical concepts and encourages students to communicate the reasons and strategies they use to solve problems (Marasabessy, 2021). However, the PISA study shows that many countries, including Indonesia, still have low scores in mathematical literacy skills, which include mathematical reasoning (OECD, 2023). This indicates the need to improve the development of students' mathematical reasoning skills to solve real-world problems.

Mathematical reasoning skills can be developed by familiarizing students with mathematical problems that require reasoning, such as PISA-type mathematics problem (Kamaliyah et al., 2013). However, schools have not developed and used PISA-type mathematics problem optimally to develop students' mathematical reasoning skills (Kholid et al., 2022). Mathematics education usually focuses on understanding concepts and using formulas to solve problems unrelated to the real world (Wijaya et al., 2024; Zulkardi & Kohar, 2018). Therefore, developing PISA-type mathematics problem to improve students' mathematical reasoning skills is crucial.

Developing PISA type problems use the context that are familiar to student can make them interested in practicing to solve problem because relevant to their lives (Hilmi et al., 2024). One context that can be used is the making kite (Isamer et al., 2024). Kite involves various complex mathematical problems, such as measuring the angle of the kite, the length of the rope, and calculating wind speed (Risnanosanti et al., 2024). In addition to providing experience solving interesting problems, students will gain valuable, meaningful learning experiences as they face life's challenges (Hsbollah & Hassan, 2022).

Previous research has shown that PISA-type math problem can improve students' mathematical reasoning skills. For example, Nurazizah and Zulkardi (2022) developed PISA-type math problem with a pandemic context. Oktiningrum et al. (2016) integrated the context of cultural heritage into PISA-type math problem. Kohar et al. (2019) developed PISA-type math problem with various everyday contexts, such as health, shopping, fish farming, and tourism. Ahyan et al. (2014) who developed mathematics problems based on PISA level of change and relationship content. Charmila et al. (2016) who developed PISA model mathematics problems using the Jambi Context. These studies demonstrate that using contexts close to students can encourage them to reason mathematically.

However, no study has specifically developed PISA-type mathematics problem based on the making kite context. The kite context closely relates to the daily lives and experiences of students in various parts of Indonesia and contains various mathematical concepts, such as measurement, geometry, and comparison (Hilmi et al., 2024). Additionally, project-based problem solving enables students to engage more deeply in the mathematical reasoning process, including designing strategies, constructing arguments, and reflectively evaluating solutions (Özaydin & Arslan, 2022).

The context used in the PISA-type mathematics problems developed in this study is kite-making, as kite-flying is part of students' concrete experiences (Widodo et al., 2019). This context is believed to be able to motivate students to learn (Autin, 2007). So that students can understand and solve real problems in everyday life. Therefore, this research aims to develop PISA-type mathematics problemwith kite context to support students' mathematical reasoning ability. This research looks at the characteristics and potential effects of PISA-type math problem based on the kite context to support students' mathematical reasoning skills. It is expected that the development of this problem can be used by teachers and students to practice solving problems that measure mathematical reasoning with a context that is familiar to students. In addition, the results of this study also contribute to encouraging students' mathematical literacy in international studies such as PISA and can be used as a reference for educational institutions in designing mathematics learning evaluation questions that are more contextual, reflective, meaningful and according to international standards.

2. METHOD

This research uses design research with the type of development studies. This method was chosen because it aims to address educational problems through the development of learning design and evaluation based on relevant theoretical knowledge (Bakker, 2018). This type of design research includes three main stages: preliminary research, prototyping stage, and assessment stage (Plomp & Nieveen, 2013).

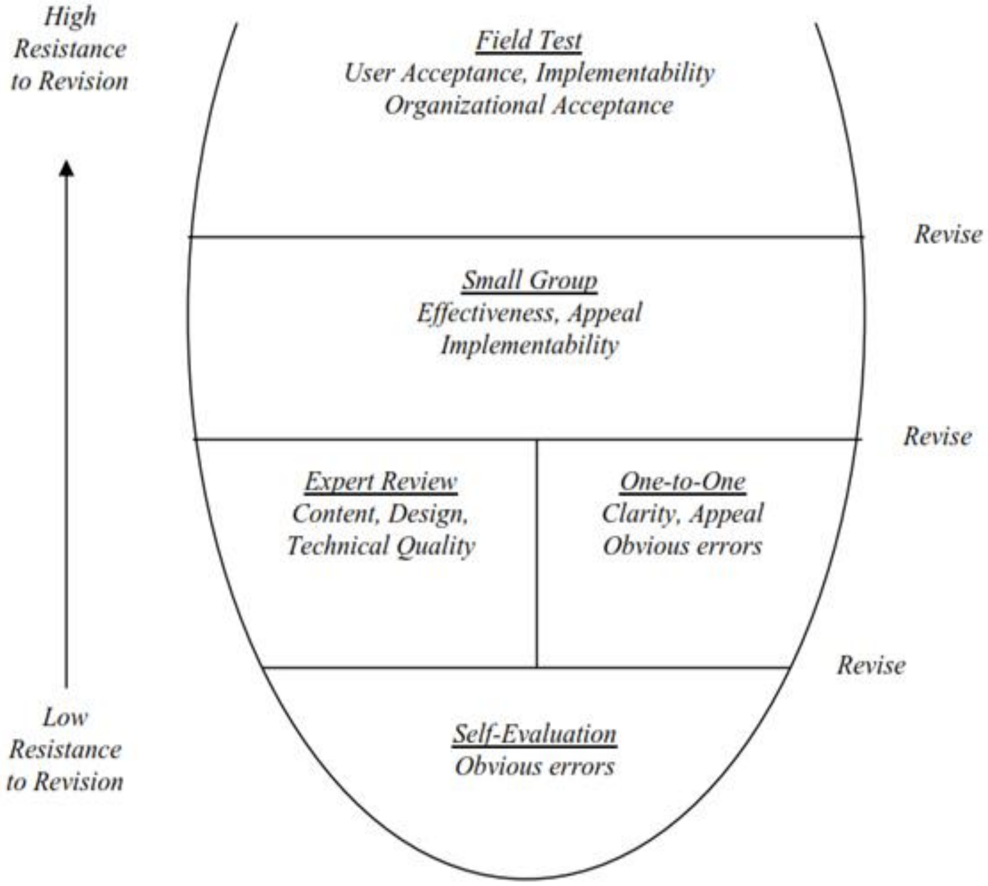

Figure 1. Formative evaluation (Tesmer, 1993; Zulkardi, 2002)

The development studies stage that is used as a guide is Formative Evaluation with stages consisting of self-evaluation, expert review, one to one, small group and field test (see Figure 1). In the self-evaluation sub-stage, the design of PISA-type mathematics problem based on the kite context was evaluated by the researchers themselves. Furthermore, at the expert review sub-stage, researchers conducted FGDs with experts to review the content, construction and validity aspects of the questions that had been designed (see Table 1).

Table 1. Expert criteria

Name	Criteria
DSN (Lecturers)	Lecturer and Researcher, and some of his work focuses on PISA research and mathematical modeling
AKW(Lecturers)	The Writing Team for the Elementary School Literacy and Numeracy Learning Module, Distance Learning Program, Ministry of Education, Culture, Research, and Technology; The Writing Team for the Main Textbook, High School Mathematics, Ministry of Education, Culture, Research, and Technology;
AFF(Lecturers)	Writer of PKB Module for Teachers & Education Personnel in 3T regions at the Directorate General of Islamic Education, Ministry of Religious Affairs; National Instructor for training of 3T teachers & Regional Facilitators (Riau Province, Riau Islands Province, South Sumatra Province, NTT Province, South Papua Province) at the Directorate General of Islamic Education, Ministry of Religious Affairs; Online Instructor for Numeracy Training of Indonesian Madrasah Competency Assessment (AKMI) at the Directorate General of GTK, Ministry of Religious Affairs in 2023 - Present
DP, GA, and IP (Teachers)	Mathematics teacher and active in subject teacher discussion activities

Then, at the one-to-one sub-stage, the questions that have been validated by experts are then tested on one student to test the feasibility of the questions. The selection of students used for the one-to-one stage was based on the criteria of students' participation ability (actively participating in the one-to-one trial) and the criteria of students' academic ability, where students with high, medium, and low academic abilities were selected to obtain varied feedback related to students' understanding and difficulties that might arise during the implementation of the research. After that, in the small group sub-stage, the draft questions that have been validated by experts, tested on one student and have been revised according to the input then tested in two small groups of three students each to see the effectiveness of the questions that have been designed. The determination of the number of members in a group and the number of groups was considered with the assumption that three people in one group can place students with high, medium, and low academic abilities. Then choosing only two groups due to the reason of student representation in the class. Technically, researchers can interact maximally with students in an effort to maximize student readiness, student participation abilities, and feedback from students can be monitored maximally and comprehensively on the questions developed.

The PISA-type mathematics problem that have been validated through several sub-stages in the prototyping stage are then revised in accordance with the input and evaluation so that they become prototypes of PISA-type mathematics problem with the kite context (Gravemeijer & Cobb, 2006). The last stage is the assessment stage, at this stage the prototype of PISA-type mathematics problem is tested in one class to determine the potential effect of the problem on students' mathematical reasoning skills (Plomp & Nieveen, 2013; Zulkardi, 2002). The students who were the subjects of the research were 29 students in Class VII at a junior high school in Palembang City, and the research activities were carried out in the odd semester of the 2024/2025 academic year.

The data collection techniques in this study were tests, observations, interviews, and documentation (Bakker, 2018). Tests were used to measure students' mathematical reasoning skills. Then observations were made to observe students' behavior while solving problems, while documentation was used to analyze students' thought processes and problem-solving strategies. Furthermore, interviews were conducted in a semi-structured manner to clarify students' answers and dig deeper into their understanding of the problem. The entire learning process was also recorded through photo and video documentation as part of the visual documentation of activities. All data collection results were then written in the form of field notes which were then analyzed descriptively qualitatively to obtain a comprehensive picture of the characteristics and potential effects of PISA-type mathematics problem based on the kite context to support students' mathematical reasoning skills (Gravemeijer & Cobb, 2006).

3. RESULTS AND DISCUSSION

3.1. Results

Mathematical reasoning is an important skill for students to face the challenges of 21st century life. However, based on the results of the PISA study in 2022, mathematical literacy skills including mathematical reasoning skills are still very low. This indicates the need to improve the development of students' mathematical reasoning skills to solve real-world problems. To improve students' mathematical reasoning skills, this research seeks to develop a PISA type mathematics problem based to support students' mathematical reasoning.

In the preliminary research phase, researchers conducted a study of the curriculum used in Indonesian schools, the PISA 2022 framework, mathematical reasoning skills, and the context and content of mathematics. Based on the study results, researchers designed PISA-style mathematics problems, student activity sheets, question outlines, student cards and answer alternatives, assessment guidelines, and teacher and student guidebooks (see Figure 2).

SOAL MATEMATIKA TIPE PISA
KONTEKS: LAYANG-LAYANG

PROGRAM DOKTOR PENDIDIKAN MATEMATIKA
FAKULTAS KEGURUAN DAN ILMU PENDIDIKAN
UNIVERSITAS SRIWIJAYA TAHUN 2024

Tema 1 : Proyek Membuat Layang-layang

Ibu Ella merupakan guru matematika yang akan mengembangkan proyek pembelajaran matematika dengan tema membuat layang-layang. Proyek ini tidak hanya mengembangkan kreativitas siswa tetapi juga perlu penghitungan matematika. Bu Ella terkenal dengan cara mengajarnya yang selalu menghubungkan pelajaran matematika dengan kehidupan sehari-hari.

"Anak-anak, hari ini kita akan membuat layang-layang, tapi kita juga akan menghitung panjang, luas, dan kelilingnya. Siap?" Bu Ella membuka pelajaran dengan semangat.

Semuanya bersorak gembira. Salah satu murid, Akbar, sangat antusias. Ia menyukai matematika dan juga layang-layang. Bersama teman-temannya, ia mulai memilih bahan-bahan, seperti bambu, kertas, dan tali layangan. Bu Ella membagikan lembar kerja yang berisi langkah-langkah pembuatan dan beberapa soal matematika.

Langkah pertama adalah menentukan bentuk layang-layang. Berikut ragam bentuk layang-layang beserta ukurannya yang akan dibuat oleh murid-murid.

No	Bentuk Layang-layang	Ukuran	
1.	Persegi Panjang	Panjang = 50 cm	Lebar = 30 cm
2.	Persegi	Panjang = 60 cm	Lebar = 60 cm
3.	Belah ketupat	Diagonal 1 = 60 cm	Diagonal 2 = 60 cm
4.	Layang-layang	Diagonal 1 = 80 cm	Diagonal 2 = 60 cm

Kemudian murid-murid pun asyik membuat layang-layang sesuai dengan ukurannya.

Pertanyaan 1:
Bentuk Layang-layang manakah yang paling banyak menghabiskan bahan untuk bingkai layang-layang?

a. Persegi
b. Persegi Panjang
c. Layang-layang
d. Belah ketupat

Pertanyaan 2 :
Bentuk Layang-layang manakah yang paling banyak menangkap angin?

a. Persegi
b. Persegi Panjang
c. Layang-layang
d. Belah ketupat

Translate:

PISA-TYPE MATHEMATICS QUESTIONS
CONTEXT: KITE

DOCTORAL PROGRAM IN MATHEMATICS EDUCATION
FACULTY OF TEACHER TRAINING AND EDUCATION
SRIWIJAYA UNIVERSITY 2024

Theme 1: Kite-Making Project

Ms. Ella is a math teacher who will develop a math learning project with the theme of kite-making. This project not only develops students' creativity but also requires mathematical calculations. Ms. Ella is known for her teaching style, which always connects math lessons to everyday life

"Children, today we are going to make kites, but we will also calculate their length, width, and circumference. Ready?" Ms. Ella began the lesson enthusiastically.

Everyone cheered happily. One of the students, Akbar, was very enthusiastic. He loved mathematics and kites. Together with his friends, he began to select materials, such as bamboo, paper, and kite string. Ms. Ella distributed worksheets containing the steps for making kites and several math problems.

The first step was to decide on the shape of the kite. Here are the various shapes of kites and their sizes that the students would make

No	Kite Shape	Size	
1.	Rectangle	Length = 50 cm	Width = 30 cm
2.	Square	Length = 60 cm	Width = 60 cm
3.	Rhombus	Diagonal 1 = 60 cm	Diagonal 2 = 60 cm
4.	Kite	Diagonal 1 = 80 cm	Diagonal 2 = 60 cm

Then the students enjoyed making kites according to their sizes.

Question 1:
Which kite shape uses the most material for the kite frame?

a. Square
b. Rectangle
c. Kite
d. Diamond

Question 2:
Which kite shape catches the most wind?

a. Square
b. Rectangle
c. Kite
d. Diamond

Figure 2. PISA type mathematics question display

This research resulted in the development of PISA questions that support student reasoning. This research focuses on student reasoning in the Space and Shape content. The kite-making project used was a kite-making context. PISA questions were developed based on the PISA 2022 framework, where the content focus is Space and Shape with a kite context. In the process of developing PISA-based questions, the stages of self-evaluation, expert assessment, one-to-one assessment, small group testing, and large group testing were carried out. The expert process was packaged in a Focus Group Discussion (FGD) model and one-to-one activities. Thus, the results of these activities were refined to produce valid products, regarding content, construction, and language (see Table 2).

Table 2. Validator suggestions (lecturers and teachers) and on-to-one activities on PISA-based questions with the context of kites

Context	Suggestions	Revision
The Context of Making Kites	In PISA questions, the questions that appear do not use the word "how many".	The questions that arise are "explain" then the words "which form" so as to construct students' reasoning in solving mathematical problems.
	The interpretation of the word "frame" refers to the kite frame, not the kite plane	Bringing up the word "frame" as a guide for students in doing mathematical calculations
	To bring up reasoning that leads to interpretation, additional questions are needed, so you can add which kite can fly higher.	It appears in the questions as an effort to get a variety of answers and provide confidence in students' understanding of the shape and aerodynamic properties of kites.
The Context of Flying a Kite	It is necessary to raise questions that direct students to reason "why the kite does not fly stably"	Raising open questions, regarding what causes kites to not fly stably
	In an effort to emphasize students' reasoning in constructing mathematical arguments, provocative questions must be raised about the rules for installing the goci rope/bucket rope.	Raising questions that lead to opinions on how to attach the goci string/bucket string so that the kite can fly stably

The next stage of developing PISA-Based Questions is a small group trial, at this stage the questions are tested on students, students concentrate on solving mathematical problems that arise from PISA questions. The results of this small group trial found that students experienced different interpretations regarding the Kite Frame and the Area of the Kite. Then when faced with the problem of the kite context, students had difficulty in expressing answers. For example, what causes the kite to not fly stably, students interpreted that this was caused by the shape, but when logically in the situation of flying a kite "why can't the kite rise" the cause is because the frame is not good, it can be tilted or not symmetrical and also the role of the Goci rope / bucket rope on the kite.

The study also finds that students are unable to write answers to open-ended or non-routine questions. With a design like this, when students can answer and use effective wording when providing explanations for open-ended/non-routine questions, it will add to the treasure trove of findings in the research. The following is the result of student work using the kite context.

Making Kite Project

Figure 3. Student activity for making kite project

Mrs. Ella is a mathematics teacher who developed a math learning project on kite-making. This project not only develops students' creativity but also requires mathematical calculations. Students are very enthusiastic to make kites. Together with their friends, students begin to choose materials such as bamboo, paper, and kite string. Mrs. Ella distributed worksheets with step-by-step instructions for making kites with various geometric shapes, then asked students to measure the length and width of the shapes they chose (see Figure 3). The results of students' measurements of the kite geometry shapes are shown in Table 3.

Table 3. Student measurement results of geometric shapes on kites

No	Kite Shape	Size	
1	Rectangle	Length = 50 cm	Width = 30 cm
2	Square	Length = 60 cm	Width = 60 cm
3	Rhombus	Diagonal 1 = 60 cm	Diagonal 2 = 60 cm
4	Kite	Diagonal 1 = 80 cm	Diagonal 2 = 60 cm

After measure various shapes of kite, students then try to make it based on these measurements (see Figure 3). The teacher then asked the students to answer the following PISA-type question:

Take a look at the following images of various kite shapes!

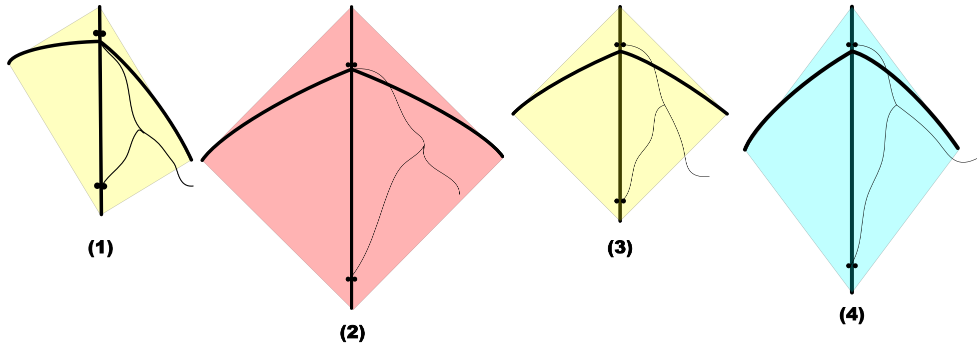

Figure 4. Various kite shapes

Problem 1: Kite Material

Which kite shape need the most kite material for the kite frame?

a. Square

b. Rectangle

c. Kite

d. Rhombus

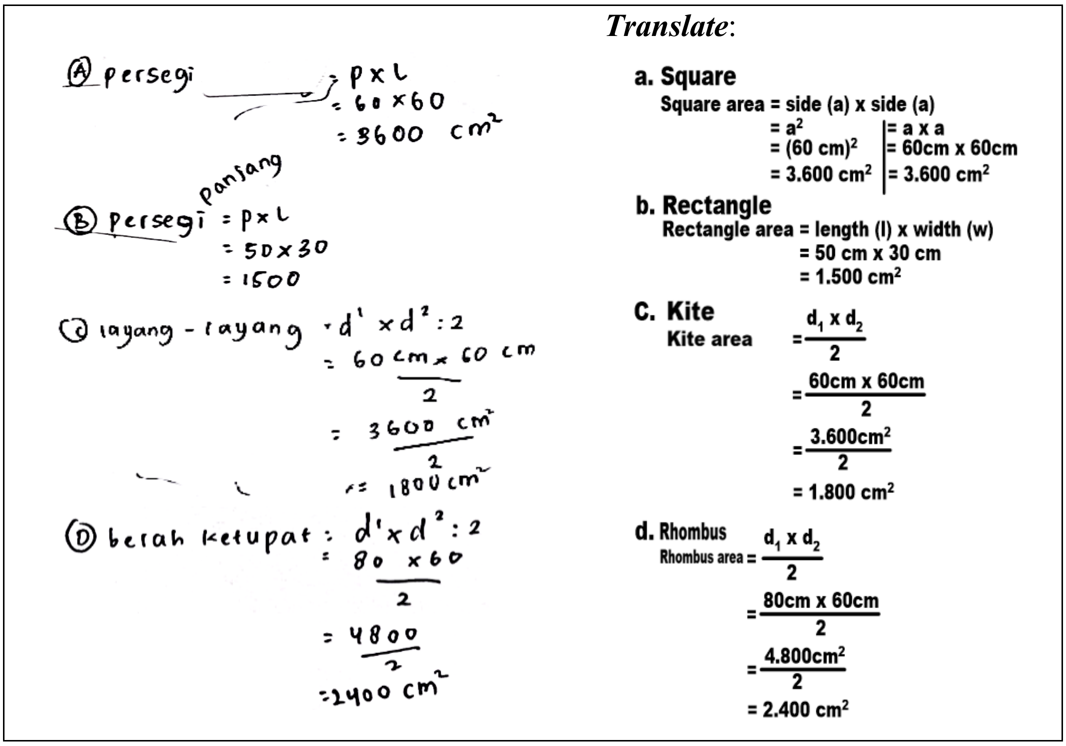

Figure 5. Student's answer to problem 1

Based on the problem shown in Figure 4, students can use their mathematical reasoning skills to solve the problem. In addition, students answered that the square kite shape uses the most material for the kite frame (see Figure 5). When asked about the kite material, the students considered the area, so they calculated the area of all the kite shapes in the problem using the measurements they had obtained earlier. Based on the answers to the questions, it can be seen that, through the kite-making project, students can more easily imagine and understand the problem, and thus solve it with good mathematical reasoning.

Problem 2: Catch the Wind

Which kite shape catches the most wind?

a. Square

b. Rectangular

c. Kite

d. Rhombus

In the question, most students answered that a square is the shape that catches the most wind. This indicates good mathematical reasoning, namely linking contextual information with the mathematical concept of area. Based on the calculations, students can see that the square has the most significant area, so it will catch the most wind compared to other shapes.

Problem 3: Fly High

With the same wind strength and kite material, which kite shape do you think will fly higher? Explain your answer.

layang² terbentuk persegi panjang karena layang² tersebut memiliki permukaan yg kecil /lebih ringan semakin kecil layang² maka akan tinggi layang² tersebut terbang.	***Translate***: *The rectangular shape kite because it has a small surface area. The smaller the kite, the higher the kite will fly*
bentuk layangan yang akan terbang lebih tinggi yaitu yang ukurannya keci dan juga ringan . jadi layangannya yang berbentuk persegi panjang , karena memiliki permukaan yang kecil dan ringan.	***Translate***: *The shape of the kite that will fly high is the small and light kite, so the kite that can flying higher is rectangular kte because it has small surface and is light*

Figure 6. Student answers for problem 3

Figure 6 shows the student's mathematical reasoning in determining which kite will fly higher based on its size. Students can connect the problem to the mathematics concept of the kite surface area. Students thought that kites with smaller or narrower surface areas would fly higher because they are considered lighter and have less wind resistance. This reasoning reflects the ability to see the relationship between the quantities involved in the concrete context of kites and geometric quantities. To support this statement, interviews were conducted, resulting in the following results.

Researchers : Which kite do you think catches the most wind?

Student : The biggest kite.

Researchers : what is meant by the biggest

Student : The kite that has the largest surface area, a square kite has an area of 3,600 cm^2, a rectangular kite has an area of 1,500 cm^2, a rhombus kite has an area of 1,800 cm^2, and a kite-shaped kite has an area of 2,400 cm^2, so the one that catches the most wind is the square kite.

Researchers : How can you tell that the biggest kite can catch more wind.

Student : I interpret from the keyword "catching a lot of wind" then my logic is the biggest kite or the kite that has the largest area.

Researchers : Next, from the follow-up question, which kite can fly higher?

Student : the one that can fly higher is the one that is the smallest or has a smaller area, namely a rectangular kite, which only has an area of 1,500 cm^2

Researchers : How do you know that a small kite can fly higher?

Student : from my experience when flying kites, where "smaller" kites can fly higher and "big" kites can't fly too high.

3.2. Discussion

Based on the results of students' answer to the PISA-type mathematic problems developed in this study, it can be seen that the contextualized problems of making kite effectively support students' mathematical reasoning skills. These problems not only measure students' understanding of mathematical concepts such as area, perimeter, and comparison, but also involve students in an applied process that connects these concepts in a real-world context. The making kite context provides a concrete experience that allows students to develop mathematical understanding relevant to everyday situations. This context provides a space for students to interact directly with mathematical concepts in real life, increasing their motivation to learn and strengthening their ability to solve problems critically. In addition, the concrete context of the kite, such as the relationship between size and the ability to catch the wind or fly high, helps students see the connection between physical and mathematical aspects, which in turn facilitates deeper thinking. Overall, this context-based making kite project not only facilitated students' understanding of mathematical concepts, but also improved their critical and applied thinking skills, which are essential for solving PISA-type problems.

In the PISA 2022 framework (OECD, 2023), there are three stages in solving mathematical problems: Formulate, where students attempt to recognize aspects of contextual problems that can be abstracted and presented in mathematical form for solution. Students reason and understand the limitations and assumptions in the problem, then work (Employ). After formulating the problem in mathematical form, students apply mathematical concepts, facts, procedures, and reasoning to solve the problem to obtain results and find mathematical solutions. Finally, interpret and evaluate: students are allowed to reflect on mathematical solutions, results, or conclusions and reinterpret them in the context of real-life problems that begin the problem-solving process. Krulik and Rudnick (1995) divide the reasoning process experienced by students, which is part of the thinking process, into four stages: recall, basic thinking, critical thinking, and creative thinking.

This context of the kite-flying activity not only brings students closer to the material, but also provides space for them to engage in deeper mathematical reasoning, such as making the connection between geometric measurements and the concept of wind affecting kite flight. As stated by de Lange (2006), problems that require higher-level reasoning provide opportunities for students to not only solve problems mechanically, but also to think creatively and critically and develop more complex mathematical skills. This is in line with the findings of Berisha et al. (2020) that reasoning tasks can assess broader learning outcomes, not just correct or incorrect answers, but students' thought processes in constructing solutions.

The results of the PISA-type mathematics problem developed in this study also show that the making kite project-based approach is highly relevant to developing students' critical thinking skills. Through this project, students not only gain knowledge of mathematical concepts, but also connect them to real-world contexts, enriching their learning experiences and preparing them to face the challenges of 21st century life, as outlined by Niss (2015). Thus, this approach can improve students' mathematical reasoning skills, which are essential for solving more complex problems, such as those found in PISA questions.

PISA-type mathematics problems based on the kite making context provide opportunities for students to think more critically, develop deeper mathematical reasoning, and prepare them to face the challenges of an increasingly complex life. In this case, teachers play an important role in guiding students to complete tasks that not only test knowledge but also facilitate students' creative and reflective thinking processes (Wijaya et al., 2024). As explained by Szabo et al. (2020) and Hasanah et al. (2023), reasoning-based tasks can help students develop higher-order thinking skills, a much-needed skill in the 21st century. This research contributes as an alternative to PISA-type mathematics problems with a familiar context that can be used to support students' mathematical reasoning. In addition, the results of this study can be a reference for educators and education policy makers in Indonesia in developing relevant and contextualized PISA-type questions to promote an increase in students' mathematical literacy scores at the national and international levels.

Even fartherThe PISA-based questions were designed in the context of kites. They presented two contexts: making a kite and flying a kite. In the initial questions, students were asked to make a decision regarding the problem presented, namely making a kite.The levels of understanding in mathematics are divided into three levels (de Lange, 1995), namely lower level (reproduction), middle level, and higher level (reasoning). In his explanation, higher level (reasoning) relates to complex matters such as mathematical thinking and reasoning, communication, critical thinking, creativity, interpretation, reflection, generalization, and mathematization. Students' construction of problem-solving skills is a key component of the reasoning level (Verhage & de Lange, 1997). From this perspective, it is crucial for teachers to change their approach to designing students' mathematical tasks. Tasks with a reasoning format have the potential to assess broader learning outcomes (Berisha et al., 2020). Students also need to know that what teachers assess is not just the right and wrong answers, but also the students' reasoning in constructing solutions to the problems presented (de Lange, 1995;

Zulkardi, 2002). This article provides an overview that teachers need to accustom students to solving mathematical problems in everyday life (Harisman et al., 2023) with the aim of preparing students to have 21st-century skills and also have a higher level of understanding (reasoning) (Gravemeijer et al., 2017). Furthermore, a teacher is naturally more interested in the process that enables students to find multiple solutions to mathematical problems. This is truly what constitutes true learning (de Lange, 1995).

4. CONCLUSION

This study shows that PISA-type math problems based on the context of kite making are effective in improving students' mathematical reasoning skills. This context allows students to connect mathematical concepts to real-life situations, thereby improving their understanding of concepts such as area, perimeter, and comparison. By engaging in familiar and meaningful tasks, students are encouraged to reason, justify, and reflect mathematically, key skills needed to meet the challenges of the 21st century.

However, there are several limitations to this study. The small sample size may affect the generalizability of the findings, and the focus on only one content domain, space and form, limits the applicability of the findings to other mathematical topics. Therefore, future research could broaden the scope by including different mathematical domains, such as quantity, change and relationships, and uncertainty and data, as defined in the PISA mathematics framework. Furthermore, it would be valuable to investigate the effectiveness of contextualized PISA-type problems in different classroom settings and student demographics.

In addition, this study opens avenues for exploring other factors that influence students' mathematical reasoning skills, such as learning styles, motivation, prior knowledge, and classroom interactions. Understanding these aspects could lead to more targeted instructional strategies. This research highlights the potential project problem as a context for supporting students' mathematics reasoning, which is essential for improving the quality of mathematics education in Indonesia and for improving students' ability in international assessments such as PISA.

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Declarations

Author Contribution : D: Conceptualization, Formal analysis, Methodology, Visualization, Writing - original draft, and Writing - review & editing; Z: Supervision, Validation, and Writing - review & editing; RIIP: Supervision, Validation, and Writing - review & editing; H: Supervision, Validation, and Writing - review & editing; S: Supervision, Validation, and Writing - review & editing.

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