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The Abilities of Junior High School Students in Solving PISA-Like Mathematical Problems on Uncertainty and Data Contents

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ABSTRAK

Partisipasi Indonesia di PISA kurang memuaskan, khususnya di bidang matematika. Ketidakpastian dan data adalah dua bidang konten PISA yang sedang dievaluasi. Oleh karena itu tujuan dari penelitian ini adalah menganalisis kemampuan siswa dalam memecahkan masalah matematika seperti PISA tentang ketidakpastian dan konten data untuk memetakan kesiapan siswa menghadapi PISA. Penelitian ini merupakan jenis penelitian kualitatif dengan menggunakan desain studi kasus. Sampel dalam penelitian ini adalah 84 siswa kelas IX SMP yang dipilih dengan teknik simple random sampling. Metode pengumpulan data menggunakan instrumen tes dan nontes. Teknik analisis data yang digunakan dalam penelitian ini terdiri dari reduksi data, penyajian data, dan penarikan kesimpulan dan verifikasi. Hasilnya menunjukkan bahwa 689 siswa mendapat nilai dari 1344, mewakili 51,41%. Hasil tersebut menunjukkan bahwa kemampuan siswa dalam menyelesaikan soal matematika seperti PISA pada materi ketidakpastian dan data berada pada kategori sedang. Sedangkan masing-masing materi yaitu statistik dan peluang berada pada kategori tinggi dan rendah. Kondisi ini didasari oleh pembelajaran yang belum mengarahkan siswa pada masalah kontekstual. Dengan hasil tersebut diharapkan ada upaya untuk memperbaiki proses pembelajaran dengan melibatkan permasalahan seperti PISA sebagai pembiasaan.

ABSTRACT

Indonesia's participation in PISA is less satisfactory, particularly in mathematics. Uncertainty and data are two of the PISA content areas being evaluated. Therefore the aim of this study is to analyze students' abilities to solve mathematical problems such as PISA on uncertainty and data content to map student readiness for PISA. This study is kind of qualitative study used a case study design. The sample in this study was 84 students of grade IX junior high school who were selected with a simple random sampling technique. The data collection method employs both test and non-test instruments. The data analysis technique used in this study consist of data reduction, data presentation, and conclusion and verification. The results showed that 689 students scored out of 1344, representing 51.41%. These results show that students' ability to solve math problems such as PISA on uncertainty and data content is in the moderate category. While each material, namely statistics and opportunities, is in the high and low categories. This condition is based on learning that has yet to lead students to contextual problems. With these results, it is hoped that there will be efforts to improve the learning process by involving problems such as PISA as habituation.

1. INTRODUCTION

The Program for International Student Assessment (PISA) is an international study organized by the Organization for Economic Cooperation and Development that aims to measure the abilities of 15-year-old students in reading literacy, mathematical literacy, and scientific literacy (Hewi & Shaleh, 2020; OECD, 2019; Saefurohman et al., 2021). The assessment focuses not only on students' abilities to restate their knowledge but also on analyzing and applying students' knowledge in real life. With the 2012 and 2015 PISA reference frameworks, PISA 2018 mainly concentrated on reading literacy as a significant

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assessment domain and math and science literacy as minor domains. Furthermore, in 2018, the assessment included the financial literacy domain and global competence for the first time while still emphasizing students' abilities to apply knowledge and skills in solving context-based problems, as is typical of PISA questions (Kismiantini et al., 2021; OECD, 2019; Saefurohman et al., 2021). Indonesia took part in the triennial event from 2000 to 2018. PISA results for Indonesia show fluctuations in reading literacy skills, mathematical literacy, and scientific literacy (Ekawati et al., 2020; Purwanti et al., 2020; Saefurohman et al., 2021). Over the course of 18 years, Indonesia's coverage of the PISA population has increased from 39% in PISA 2000 to 68% in PISA 2015 and 85% in PISA 2018. This indicates that Indonesia's educational participation in PISA has increased. Regarding PISA achievement, Indonesia's PISA trend shows an increase from 2000 to 2018 in reading, science, and mathematics. Although the trend was upward throughout the period, Indonesia's score in these three areas fell in PISA 2018 (Hidayah et al., 2021; Purwanti et al., 2020). The results of the 2018 PISA, which show a decrease in Indonesia's PISA scores in reading, science, and mathematics (mathematical literacy). The reading score in PISA 2015 was over 390, but only around 370 in PISA 2018. The science PISA score in 2015 was above 400, but it fell below 400 in PISA 2018. Similar circumstances exist in mathematical literacy, where PISA PISA 2015 yielded a score of 386, but PISA 2018 yielded a score of 379 (Dewantara et al., 2015; Saefurohman et al., 2021). One unsatisfactory outcome is in the area of mathematical literacy. Mathematical literacy refers to students' abilities to formulate, apply, and interpret mathematics in a variety of contexts, including mathematical reasoning and the use of concepts, procedures, facts, and tools to describe, explain, and predict a phenomenon (Lange, 2006; Nurgiyantoro et al., 2020; Zua, 2021). In terms of mathematical knowledge content, PISA questions in the domain of mathematical literacy are designed to contain four contents: quantity, space and shape, change and relationship, and uncertainty and data (data and uncertainty). The 2018 PISA results place Indonesia seventh from the bottom in the domain of mathematical literacy, with an average score of 379 (OECD average of 489). This score is lower than the 2015 result of seven points (Saefurohman et al., 2021; Siswono et al., 2018).

According to the OECD, level 1 competence level demonstrates the lowest level of competence, where students are only able to respond to questions in the context of everyday situations using readily available information. In contrast, level 4 shows the highest level of competence, where students can generalize, conceptualize, and use information from complex situations (Murtiyasa & Perwita, 2020; Sujadi et al., 2022). Indonesian students can only use mathematical formulas based on direct instructions on questions, but they need to improve at problem-solving and contextual problems. In addition to the data presented above, several other research findings show similar conditions, namely, students' low achievement in solving mathematical literacy questions similar to PISA (Novita & Putra, 2016; Yansen et al., 2019). Nonetheless, PISA achievements in 2018 should be widely praised, as the proportion of students achieving competencies above the minimum level has risen to 8%.

Due to the PISA results showing low student achievement, more academics must pay attention to the issues that arise. Numerous research studies have shown that students' poor performance on the PISA results from their unfamiliarity with answering questions of the problem-solving variety, including context-based questions (Murtiyasa & Perwita, 2020). It is evident from the methods and strategies adopted by students to answer PISA questions. Furthermore, the low achievement is due to students only memorizing formulas, which include being used to solve the same problems as conveyed by the teacher (Novita & Putra, 2016; Yansen et al., 2019). As a result, the learning process becomes routine.

Uncertainty and data are two PISA questions tested (Uncertainty and Data). Uncertainty and data content are phenomena that arise in the mathematical analysis of many problem situations involving opportunities and statistics as data representation techniques. Uncertainty and data content as a domain of mathematical literacy will be widely used in various aspects of life, including sports, business, industry, politics, forecasting, population, and so on (Hanah et al., 2016; Yanti et al., 2016). Previous study argue that students must have a strong understanding of uncertainty and data contents and mathematical literacy skills to solve various problems (Pratiwi et al., 2019). Recognition of the place of variation in a process, the meaning of quantification of variation, knowledge of uncertainty and measurement error, and knowledge of opportunity are all categories of uncertainty and data content. Moore also stated that data presentation and interpretation are vital concepts in data content and uncertainty. Data and uncertainty are widely applied in many areas of life, including climatology, politics, and economics. In addition, data content and uncertainty require mathematical knowledge of numbers and algebra. This content is related to statistics and probability in the Indonesian mathematics curriculum. Data collection, presentation, analysis, probability, and inference are the main concepts in statistics and probability closely related to real-world contexts (Budiono, 2014; Kaye Stacey, 2011). Therefore, it is expected that students' abilities in the field of uncertainty and data will lead to the development of mathematical abilities such as reasoning, representation, and communication, which are part of the seven fundamental abilities of mathematics.

However, the results obtained still need to be improved. In line with the overall PISA results stated that students could only achieve level 2 of 6 PISA levels regarding uncertainty content and data (Yansen et al., 2019). In addition, the evaluation system, which continues to use low-level questions, contributes to the low results, as students are only accustomed to acquiring and applying formal mathematical knowledge in the classroom (OECD, 2014; K. Stacey, 2010). Given these findings, the process of accustoming students to answer PISA-type questions during learning is required so that they can provide abilities and skills in solving PISA math problems. The focus of attention is also on mapping students' abilities and weaknesses, particularly in problem-solving math questions, including number content, space and shape, change and relationships, and uncertainty and data, in the hope that student achievement in the next PISA round will be even higher. Thus, this study aimed to analyze students' abilities in solving PISA-type math problems with uncertainty and data contents.

2. METHOD

This qualitative case study describes students' abilities to solve PISA-type math problems with uncertain content and data. This study's sample comprised 84 students from class IX at State Middle School in Surakarta, who were chosen using a simple random sampling technique. The data collection method employs both test and non-test instruments. The test instrument consisted of PISA-type math questions with uncertainty content and 16 data questions adapted from AKSI Puspendik Ministry of Education and Culture questions, intending to gather information on students' abilities to solve PISA-like questions (PISA-like). These are questions designed in the PISA-like questions that involve contextual problems relevant to life. The non-test instrument is a questionnaire designed to collect information about students' obstacles or difficulties in solving problems and the causes of these obstacles. The percentages of correct answers from students were calculated and categorized (Kurniawan et al., 2019), as depicted in Table 1.

Table 1. Students' abilities categories

Percentage (P)	Categories
$0\% \leq P < 20\%$	Very low
$20\% \leq P < 40\%$	low
$40\% \leq P < 60\%$	average
$60\% \leq P < 80\%$	high
$80\% \leq P \leq 100\%$	very high

The P value in Table 1 shows the percentage of Number of Students' Correct Scores to Number of Total Correct Score. The data analysis technique used in this study consist of data reduction, data presentation, and conclusion and verification. The data reduction stage is carried out by summarizing and focusing on the data required for the next step, making the data collected simpler than expected. The data presentation stage is the presentation of data obtained as a graph or table to facilitate the next stage, drawing conclusions and verifying students' abilities to solve PISA-type math problems with uncertainty and data content. While the data's validity is based on triangulation techniques

3. RESULT AND DISCUSSION

Result

The research phase began by distributing PISA-type math problems with uncertainty and data content to 84 selected junior high school students in Surakarta. The questions used were 16 multiple-choice and short-answer questions with test material in the form of statistics and probability questions. Students are given PISA-like mathematics questions. They include fundamental competencies related to the mathematics subject curriculum, such as analyzing data to draw conclusions based on data distribution, average value, median, mode, and data distribution. They also make statistical decisions and predictions and solve problems relating to an event's empirical and theoretical probability ranging from an experiment to material opportunities. Table 2 summarizes students' correct answers to PISA-like math questions with uncertainty and data content.

Table 2. Students' Score Recapitulation

Content	Number of Total Correct Score	Number of Students' Correct Scores	Percentage	Categories
Uncertainty and Data	1344	689	51.41	Average

Students were asked 16 questions, 12 of which were about statistics and four about opportunities. Table 3 shows the results of the correct scores obtained by students in both materials.

Table 3. Recapitulation of Students' Scores Based on Materials

Materials	Number of Total Correct Score	Number of Students' Correct Scores	Percentage	Categories
Statistics	1008	618	61.31	High
Opportunity	336	71	21.13	Low

The data in Table 2 and Table 3 show that students' correct scores on uncertainty content and data reached 51.41%, with 61.31% accurate on questions about statistics material and 21.13% correct on questions about opportunities. As a result, students' abilities to solve PISA-like questions on uncertainty content and data are in the medium range. However, low scores were found in some questions related to uncertainty and data, both in statistics and opportunity materials. It indicates that students' abilities in solving problem-solving-based questions related to real-life contexts still needed to be as expected. Based on several factors in students' abilities to solve problems similar to PISA still need to be optimal regarding uncertainty and data contents. 68% of students' problems or difficulties with problem-solving stem from their inability to comprehend PISA-type questions, 21% from their lack of understanding of mathematical concepts, and 11% from excessively long questions

Discussion

The percentage of student scores and shows that students' abilities in solving PISA-like questions (PISA-like) on uncertainty content and data are in the medium range. The achievement categories of students' abilities in each test material, namely students' abilities in statistics material and opportunity material. The statistics material categorizes students' abilities as high. Still, the opportunity material shows that the acquisition of student scores compared to the total score is in a low category, at only 21.13%. These findings are consistent with several research findings indicating that student achievement in answering PISA questions is uncertain, and data still needs to be higher (Damayanti & Yunianta, 2018; Oktaviana & Rosyidi, 2019). This low ability indicates that students can only solve problems using simple mathematical formulas when the information or instructions provided are clear. When students are presented with issues in which data or instructions are not explicitly contained in the questions, they experience confusion or obstacles, contributing to low student achievement. Because PISA questions are complex by involving contextual problems that require students to think critically in solving problems, the condition of lack of information or unclear instructions on questions is frequently found. Uncertainty and data are two mathematical literacy topics covered by the PISA test. One aspect of mathematics analysis in various problems is the domain or content of uncertainty and data in mathematics (Lara-Porras et al., 2019; OECD, 2019). The questions presented in the form of mathematical problems that involve context from daily life demonstrate that students' abilities to solve contextual problems using statistical concepts and opportunities still need to be improved. The students' abilities to solve questions in real-life contexts could be better at best, particularly regarding uncertainty and data content, indicating that students are still unfamiliar with real-world problem-based questions during the learning process (Khasanah et al., 2021; Wijaya et al., 2014).

The conditions listed above can occur as a result of a variety of factors. One of these factors is that students need to become more accustomed to solving PISA-like problems as part of their learning process. Students' learning experiences have yet to fully utilize contextual issues such as PISA, including evaluation activities (Ahyan et al., 2014; Dewantara et al., 2015). In addition, because students are not used to answering PISA-like questions, there may be a need for students to connect information on questions with mathematical concepts such as statistics and opportunities, resulting in less hypothesis construction, development, and implementation of strategies (D. Kurniati & Annizar, 2017; Nusantara et al., 2021). One of the questions related to uncertainty content and data that students were tested on was in the form of a personal context regarding a survey of junior and senior high school students' study habits in less than 60 minutes and more than or equal to 60 minutes. In sub-sample 1, junior high school students, and sub-

sample 2, junior high school students, the question posed to students was to determine which category had the opportunity to carry out individual study habits. The students' responses revealed that 72.62% of the 84 students correctly answered the questions in sub-sample 1, and 78.57% of the 84 students correctly answered the questions in sub-sample 2. Therefore, for each sub-sample, students must determine which category has the most significant opportunity value for individual learning, both in sub-sample 1 and sub-sample 2. The most important opportunity value begins with choosing the number of students for each category of study time. This means that students carry out the process of identifying mathematical aspects of the problem, namely determining the number of students based on their group. Furthermore, students can represent problems from various perspectives, which can be seen as part of the concept of opportunity or statistical concepts in determining solutions. This activity corresponds to the stage of mathematical literacy, which is an activity in the background of mathematically formulating situations (Ambarita et al., 2018; OECD, 2019). The action of mathematically acquiring conditions is essential because it is the key for students to solve these problems, especially in understanding the problem. Knowing information and representation from a different perspective of a problem is an important step that students must master because the information obtained will be used in the subsequent stage of forming a model or mathematical formulation.

The following activity that students engage in as part of the mathematical literacy process is the application of mathematical concepts, facts, procedures, and reasoning. During this process, students perform activities such as applying facts, rules, or mathematical algorithms to solve problems (Murtiyasa & Perwita, 2020; Risnanosanti & Ristontowi, 2019; Sumirattana et al., 2017). From the perspective of opportunity, the probability value of a student from the junior high school sub-sample who chooses to study with individual habits is 0.583 for the category with at least 60 minutes of study time, while the student is equal to 0.417 for the category with less than 60 minutes of study time. Based on this, the category with at least 60 minutes of study time has the highest opportunity value. As a result, students who study for at least 60 minutes are more likely to learn independently. Activities carried out by students when comparing opportunity values so that the most significant opportunity value is obtained as a solution to solving problems are part of the interpretation of the results. This activity is part of interpreting, applying, and evaluating mathematical outcomes as part of mathematical literacy, where data interpretation is an essential component of uncertainty and data (Muzaki & Masjudin, 2019; Wang, 2021). Thus, when students compare opportunity values, they must engage in all algebraic results activities and present existing data to obtain a correct interpretation. Students' scores on statistical material can be classified as high. For example, this condition can be seen in some of the student answers related to data analysis based on the distribution of data presented in the graphical form regarding the average height of adult males in European and Asian countries, with only 41.67% of students answering correctly. In this problem, 58.33% of students needed help identifying mathematical aspects, including the inability to estimate the data contained in the graph. As a result, achieving mathematical literacy skills necessitates fundamental mathematical abilities such as mathematizing, representation, reasoning and arguments, problem-solving strategies, and the use of operations, including students' self-confidence (Cooke et al., 2011; Ojose, 2011).

Base on result not optimal student achievement in solving PISA-type questions based on the inability to understand the problem. This condition is based on a learning process in which contextual problems such as PISA or similar PISA questions need to be fully presented. This is consistent with previous study that state one of the difficulties students face is due to the contextual problems presented in the PISA questions (Sari & Valentino, 2016). Under these conditions, students become limited, resulting in incorrect data interpretation. As a result, the achievement still needs improvement. As a result, student achievement in solving PISA-type math problems still needs to improve. It will provide an accurate picture of students' learning processes by examining their abilities to solve PISA-type math problems with uncertain content and data. Several factors contribute to students' inability to answer PISA-like questions. These factors include students' need for experience answering PISA-like questions and non-contextual learning. This condition is consistent with several research findings that show that the learning process, the selection of teaching materials, the presence of misconceptions, and the weak ability of students to solve non-routine questions all contribute to students' low abilities to solve PISA-type questions (Fuadi et al., 2020; Harahap & Surya, 2017; Humaira et al., 2019). The habit of solving problem-solving questions based on real-world contexts must be developed during the schooling process. PISA-like questions can be communicated to students via worksheets. According to providing students with worksheets with PISA-like questions can improve their abilities to solve PISA problems (I. Kurniati et al., 2018). Contextual learning is accomplished not only by transferring material from the teacher to the students, but it can also help students gain proficiency in what they learn (Arini & Agustika, 2021; Suastika & Rahmawati, 2019). Such circumstances enable students to comprehend mathematics, including statistics, and to grasp

abstract concepts using concrete objects. Despite this, previous study state some teachers struggle to create context-based questions (Siswono et al., 2018). This, however, does not impede continuing to work on presenting real context-based problem-solving questions in the learning process as a form of student preparation for the upcoming PISA round. The implication of this research is to increase the understanding of junior high school students' ability to solve mathematical problems related to uncertainty and data content. Then this research also provides information to teachers and education stakeholders about areas that need to be improved in learning mathematics. In addition, this research shows the need to put more emphasis on learning mathematics that focuses on students' ability to solve problems involving uncertainty and data content. However, this research also has limitations. The research sample may not be representative of the entire population of junior high school students, because it is only limited to certain schools or certain areas. In addition, in this study the measurement of students' abilities was only based on one type of test, so the results of the study may not fully reflect students' abilities in solving mathematical problems related to uncertainty and data content. Therefore, it is hoped that future research will be able to deepen and expand research on similar topics.

4. CONCLUSION

Based on the results, students' achievement in solving mathematical problems similar to PISA with uncertainty content and data still needs to be suboptimal. These findings indicate that students' abilities to answer PISA-like questions on uncertainty and data contents are moderate. This achievement provides an overview of students' abilities to solve mathematical problems similar to PISA with uncertainty and data content. It becomes an evaluation of the educational process, particularly in mathematics learning. Thus, the answer to the research objectives has been obtained. One of the efforts to prepare students for future PISA rounds is the process of habituation in learning through the presentation of real context-based problem-solving questions such as PISA questions and contextual-based learning activities.

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