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# Problem Solving Ability Of Perspective Pre Teacher: A Pisa On Uncertainty And Data Content

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## Abstract

International standard evaluation, PISA, one of which tests problem solving and literacy skills in the Uncertainty and data content on the topic of statistics, until now Indonesia is still below the OECD average. This study is here to describe how the ability of prospective teachers in problem solving is based on the Polya stages. This research needs to be done, where students who will become teachers should have national and international standardized abilities so that Indonesian education can compete globally. The method used in this study is descriptive qualitative which describes the problem solving of the research subjects based on the Polya steps, namely understanding the problem, making a plan, implementing the plan and looking back. The work data from the PISA question instrument that has been adapted, modified according to the surrounding culture and has been validated by experts. In addition, the interview technique was carried out based on interview guidelines developed from the indicators of each Polya step. The research subjects were semester VII students who were selected because most of them had completed the core courses of the study program, which reflected their readiness as future educators. The results of the study showed that from the 4 Polya steps of the 4 questions analyzed, it was found that high group students had very good problem solving. Meanwhile, the students in the medium group are divided into two categories, one is almost at low ability and the other is in the medium group. One sample of the medium group has moderate obstacles in step 2 for questions 2 and 4 and the other is only constrained by number 2. For the low group, it is almost similar to the medium group, the difference lies in the implementation of steps 2,3 and 4 on polya which are incomplete except for number 4.

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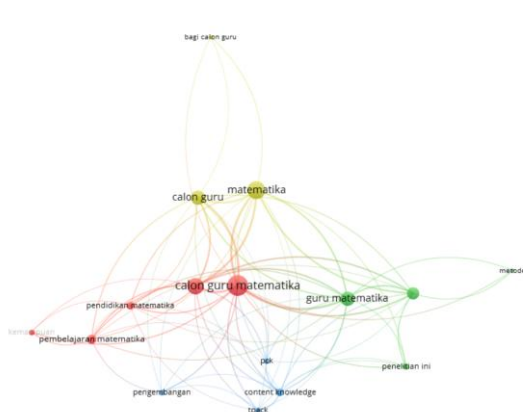
## **INTRODUCTION**

Program for International Student Assessment (PISA) is a global education evaluation program on knowledge and skills in reading, mathematics and science. Students who are in the assessment category are 15 years old and are randomly selected from different schools with the aim of being the basis for evaluating and following up on educational outcomes to become better.(OECD, 2023). For mathematics, PISA measures students' abilities in the realm of mathematical thinking and formulating, using and interpreting mathematics that is useful in the real world in solving problems.(OECD, 2023).

Some of the content tested includes change and relationship, quantity, space & shape and uncertainty & data.(Organization for Economic Co-operation and Development, 2023)which is presented in the form of a two-hour assessment test for each participant. Among all the content available, the content that plays an important role as a provision for improving 21st century skills is directed at data literacy in the content of uncertainty and data. Thus, this content is important for each individual to have the ability and skills to assess, collect and analyze information related to data(Sudarti, 2021). The Uncertainty and Data category is a study of Probability and Statistics theory. Probability and Statistics theory is a study studied in High School and in the Mathematics Education study program.

Indonesia's PISA results in the last few cycles show consistency in achieving average scores that are still below the average for OECD countries. Indonesia's PISA results obtained a score of 363 with a difference of 216 from Singapore which is ranked first in terms of overall study content.(Organization for Economic Co-operation and Development, 2023). This achievement reflects that various efforts made by stakeholders in overcoming the problem of problem-solving abilities have not shown maximum results based on international assessments and national education reports.(Ministry of Education and Culture, 2021). One of the fundamental factors that can be traced is the less than optimal mastery of problem solving using the Polya framework, especially in terms of the completeness of the problem solving stages.(Fazzilah et al., 2020). Strengthening the above conditions, the status quo regarding students' ability to solve PISA questions with uncertainty and data content is apparently not yet optimal.(Sujadi et al., 2023;Sumarni, Nuranita Adiastuty, Mohamad Riyadi, Dania Khairun Nisa, Alfin Muhammad Restu, 2023;(Sutrisno, U., & Adirakasiwi, 2019).

It is questionable whether this happens at the level of prospective teachers. Given that prospective teachers are at the forefront in shaping students' problem-solving abilities.(Anam et al., 2021). Of course, a prospective teacher or graduate of Education should have met the competency standards to become an educator.(Viktory & Damianus, 2022). It is implied that prospective educators should be equipped with the competence and skills to carry out academic tasks.(Tabuyo, 2024). Of the several teacher competencies, the focus of this study is professional competency, namely the ability of teachers to master the study of their scientific field and skills in problem solving. Several studies on prospective teachers predominantly focus on learning, learning methods and development based on analysis using VoSViewer



It is felt that there is a gap in studies that specifically examine how prospective teachers master and implement Polya's framework in mathematical problem solving to meet 21st century skills.(Kurniawati et al., 2019). Previous studies tend to focus on general abilities or cognitive aspects of prospective teachers without delving deeply into their thinking processes at each stage.(Polya, 1985), understanding problems, planning solutions, implementing plans, and evaluating results. The lack of empirical evidence that maps these skills in detail has resulted in suboptimal interventions in the learning of prospective teachers. In fact, structured and systematic problem-solving skills are crucial for future educators in shaping students' ways of thinking in achieving high achievement, success, innovation and creativity.(Adeoye & Jimoh, 2023; Bariyah, 2021). As for(Walters et al., 2018)focuses on prospective teachers regarding the use of technology for problem solving. However, full confidence in the use of technology will occur optimally when users have a strong understanding of the material.(Meldi et al., 2022). Thus, before we focus on the use of media, it is necessary to know the problem-solving abilities of prospective mathematics teachers. Therefore, this study attempts to fill this gap by specifically analyzing the problem-solving abilities of prospective teachers using the Polya framework which ultimately contributes to improving PISA achievements in the future.

Several studies have obtained facts about the problem-solving abilities of prospective mathematics teachers, including:(Andri Nugroho & Dwijayanti, 2019; Nissa & Lestari, 2015;Zhuang, 2013;Yuntawati, 2017;Suratman, Darma, et al., 2022;Zuhri, 2019AndSumarni et al., 2021)However, the studies found have not yet led to PISA content specifically on uncertainty and data, considering that problem-solving skills in AKM and international assessments are currently focusing on this content. Thus, with early evaluation of problem-solving skills, prospective teachers can be directly acted upon responsively to become the focus of early coaching in the learning process. Future learning can emphasize and strengthen problem-solving skills based on the Polya framework. This is an important investment in improving the quality of national and international education. This is because teachers who have good problem-solving skills will be able to transmit critical and analytical thinking to students. It is important for educators to pay attention to the diversity of thinking skills that are facilitated in learning(Nugroho & Dwijayanti, 2019). Therefore, the importance of evaluating or knowing the abilities of prospective teacher students on uncertainty and data content is considered very necessary to provide scientific information. Thus, this study aims to describe the problem solving abilities of prospective mathematics teacher students on Uncertainty and data content.It is hoped that this research can contribute to improving education in Indonesia on a national or global scale in order to prepare professional prospective teachers..

If we focus on solving problems in the content of uncertainty and data, of course there needs to be an adjustment according to the habits of the research subjects. Based on the study of other factors, the lack of maximum content in uncertainty and data, which mostly occurs in the resolution procedure (Fazzilah et al., 2020). It cannot be denied that other causes occur due to a lack of understanding of the questions, this is because the questions presented are non-routine in nature which are rarely accepted in schools. (Pambudi et al., 2022) so the ability to solve problems is still relatively low (Thamsir et al., 2019; (Harahap, 2022)). In addition, non-routine questions on PISA are in the form of test questions presented in multiple choice and essay questions with open answers for students to independently formulate their responses. (OECD, 2023). On the other hand, the level of questions and presentation of questions in PISA are global and worldwide. This is because the research subjects are from students from various countries.

The academic community is often active in developing PISA-oriented questions from various tested content. (Mutia, 2021; Yansen, 2022; Junika et al., 2020; Suratman et al., 2022; (Hasibuan & Fauzi, 2020)). Among them, it is developed to adapt to local habits so that students can understand the questions well so that the solutions can be done correctly, in line with the NCTM principles. (NCTM, 2000). The questions developed are of course oriented towards mathematical power. (Sumarni, Nuranita Adiasuty, Mohamad Riyadi, Dania Khairun Nisa, Alfin Muhammad Restu, 2023). For example, in problem solving, for example, it is the heart of mathematics learning and one of the curriculum achievements and is an indirect object of mathematics. (Branca, 1980; Darma et al., 2016; Meria Uktra Gusteti, 2022). The Programme for International Student Assessment (PISA) also always uses instruments that require high-level thinking skills. This means that there is a strong correlation between problem solving and PISA, reinforced by the results of exploration. (T.D. Wilson, Nigel Ford, David Ellis, Allen Foster, 2002) reveals that there is a relationship between problem solving in uncertainty content and data. To obtain accurate information on the abilities of prospective teacher students, this study tries not to ignore other extrinsic causes, for example, in the presentation of questions that are difficult to understand due to differences in local customs and language as an initial foundation in understanding problems to be solved. (Meldi et al., 2023). Therefore, this study aims to describe the problem-solving abilities of prospective mathematics teacher students on uncertainty and data content on statistics topics that have been modified according to the habits of the research area.

## **METHODS**

This qualitative descriptive research will describe the abilities of prospective teacher students from high, medium and low abilities. This research was conducted in the even semester of the 2023/2024 academic year with prospective mathematics teacher students in semester VII of FKIP Tanjungpura University as the subjects with a sample of 55 students. The selection of research subjects with purposeful sampling was based on research needs that could answer the formulation of the problem. The subjects were chosen because the research subjects had received almost all the courses that supported their problem solving abilities so that they could find out their completeness and understanding based on the answers to the questions given.

The PISA questions given are questions with uncertainty content and data on the topic of statistics. Questions as data collection instruments are given to prospective mathematics teacher students who are then studied to reveal their problem solving abilities. (Nissa & Lestari, 2015). The

data that became the subject of the study were written results of working on Uncertainty and data questions and the results of answer confirmation through interviews. The questions given have been modified according to the habituation of the research area. In the modification process, PISA questions were collected first on the uncertainty and data content. After the original PISA questions were obtained, an analysis of the main scope tested on the content was carried out which was separated based on its level. When the questions obtained with data presentations that were less meaningful due to cultural differences, for example, there were PISA questions presenting kangross and penguin data or sales of band CDs(Nusantara et al., nd), then the choice of objects used as data is adjusted such as traditional cake sales data with the scope and level of questions. However, if the PISA questions have been understood by students, the researcher adopts and adapts the narrative and data in the questions. Questions that have been created according to the problem solving indicators are continued with the validation process by the validator. Based on the PISA Mathematics framework, the coverage category of uncertainty and data content is presented which then becomes the basis for developing question instruments(OECD, 1967)

TABLE I  
development questions intrument in problem solving

Coverage	PISA Questions
<b>Formation of data presentation</b>	Able to work with mathematical modeling of complex situations and then be able to integrate different representations (Question 1-Level 4) Able to represent data and relate it to different situations (Question 4 - Level 4)
<b>Interpretation and evaluation of conclusions based on data interpretation</b>	Able to work from a complex situation representation and then make guesses to solve problems related to the model (Question 2- level 5) Able to use information from mathematical modeling and analysis of complex situations. Then connect different information by comparing and translating it (Question 3-Level 6) Able to make estimates by interpreting data from percentage estimates by integrating different representations and connecting them (Questions 5,6 - Level 4) Able to use information from mathematical representations and analysis of complex situations. Then connect different information by comparing and translating it (Question 7-Level 6)

Based on the table above, numbers 1-4 are selected for analysis which can represent two different scopes in PISA questions, namely in the formation of data presentation and interpretation and evaluation of conclusions based on data interpretation. The four questions are presented in different contexts and overall strategies. The questions are constructed based on the situation of the surrounding area and its environment regarding shoe size data, traditional cake sales data, pocket money data and flash disk storage.

There are seven questions given from various levels of questions. As data, the completion of the answers in the form of descriptions is subjected to in-depth analysis which is then classified into three categories according to the abilities of high, medium and low-level students. The ability categorization process is carried out based on the test results with normative assessment rules, namely comparing the test results with the test results of the same group which are the basis for the grouping.

After obtaining the grouping, the object of analysis is then taken randomly so that the analysis results represent the population. To strengthen the results of the study through documentation of test results, interviews were also conducted. Interviews focused on the answers to the completion were chosen as this data collection technique so that the analysis of the results obtained valid and accurate information. The data analysis techniques used include data reduction, presentation and drawing conclusions based on the PISA indicators of Uncertainty and data content on the topic of statistics.

## RESULT AND DISCUSSION

The solution of school statistics problems oriented to PISA questions with Uncertainty and data content is the topic of this research. The problems raised have been adapted according to the surrounding culture. Based on the solution of the PISA questions given, a summary of the conclusions of the work based on Polya's Steps based on the level of student ability is obtained in the following table

TABLE II  
 recapitulation of polya step work based on group level

Polya Stages	High Group				Medium Group				Low Group				
	Number Question				Number Question				Number Question				
	1	2	3	4	1	2	3	4	1	2	3	4	
<b>Understanding the problem</b>													
Identify known and asked completely	√	√	√	√	X	√	X		X	√	√	√	√
Identify existing information that is not contradictory	√	√	√	√	√	√	√	√	√	√	√	√	√
Identifying the information provided can be used to obtain answers.	√	√	√	√	√	X	√		X	X	√	√	
Understand the problems asked in the questions	√	√	√	√	√	X	√		X	X	√	√	
<b>Making a plan</b>													
Connecting information to the question	√	√	√	√	√	X	√		√	√	√	√	√
Have the right strategy or method	√	√	√	√	√	X	√		√	X	√	√	√
Designing Steps Systematically	√	√	√	√	√	X	√		√	√	√	√	√
<b>Executing the Plan</b>													
Implement the designed steps	√	√	√	√	√	X	√		√	√	√	√	√
Do the calculations correctly	√	√	√	√	√	X	√		X	X	√	√	√
<b>Perform Verification</b>													
Evaluate the end of the examination with the initial questions	X	X	X	X	X	X	X		X	X	X	X	X
Justify the logicity of the answer	X	X	X	X	X	X	X		X	X	X	X	X
Perform verification in addition to procedural checks	X	X	X	X	X	X	X		X	X	X	X	X

### 1. Question 1

Question number 1 is brought to the general nuance of the question by presenting data on student shoe sizes from two different classes. The data presented in the form of a mathematical model that requires students to be able to work with mathematical modeling of complex situations

which are then able to integrate different representations that are poured into the presentation of the data. The following are the results obtained from the subject based on Polya's steps

### *1) Understanding the Problem*

For high group students, the subject understands the problem very well, as seen from the oral and written answers. In the written answer, the subject can write in detail and accurately what is known and asked in the question. The subject knows correctly the type of data and information in the question is very appropriate by saying that all the information in the question is used to answer the question, there is no overlapping or contradictory information. After understanding the symbols and modeling, it is then said that the completeness of the information includes the example of the number of students for each shoe size and the modeling of the number of students based on shoe size is very complete and clear. The questions in the question are clear and have no double meaning. The completeness of the question information is written well in the answer, but for what is asked or what is not yet known, it is not written. However, during the interview it was confirmed that the understanding of the information known or asked was more than what was written in the answer.

For students in the middle group, they write down the information they know, are asked and explain it verbally, but in terms of completeness it is not as complete as high-level students. For example, it is directly directed at the data, without providing information on the source and data about what and presentation in a table. For students in the low group, they write down the information they know and take action on the completion procedure. Through the interview results, the information provided is incomplete as with students in the low group. In addition, students in the low group also have an understanding of information from representation, slightly different from the data of class 11 with shoe size 37 which was not given the data, this should indicate the number is 0, but this confusion is in the cognitive which was found in the interview process.

### *2) Developing a Problem Solving Plan*

For high group students, in making plans, from the available information the subject felt that they had received questions that could be categorized as similar and said that the questions were more complex than usual. The complexity that became the subject's argument was based on the fact that the data presentation was usually directly in the form of numbers, but this time it was presented in the form of mathematical modeling. The subject developed a strategy by finding connections between known and asked information. connecting between models with the substitution method to obtain complete data. It did not stop there, further connections were made after obtaining all the data which was then presented in the data presentation. The strategies of the high, medium and low groups were almost similar, the difference was that the high group directly wrote numerical data represented through mathematical models without detailing the method and process, while for the medium and low groups it was done by detailing it.

### *3) Executing the Plan*

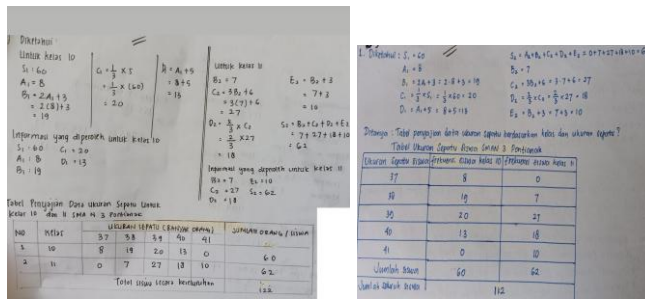


Fig. 1 Low Group Student Work

Based on the picture above, the high, medium and low groups carry out the solution according to the plan. Starting from the data information presented in the mathematical modeling, the substitution method is used from the equation whose value is already known to obtain and . Finding the value that can be obtained from S. After the class 10 data is fulfilled, the same method is used to find class 11 data. There is a slight difference in finding data in class 11, namely obtaining the value of the number of students according to shoe size which then obtains the total number of class 11. After obtaining all the data information correctly, it is continued with data presentation. The subject chooses data presentation in the form of a table with 3 rows and 8 columns. In the low group, the work is complete and correct, although there are erroneous final results in the calculations for low student 2. After being confirmed during the interview, it turned out that this happened because of an unintentional error in the calculation.  $A_1 B_1 D_1 C_1$

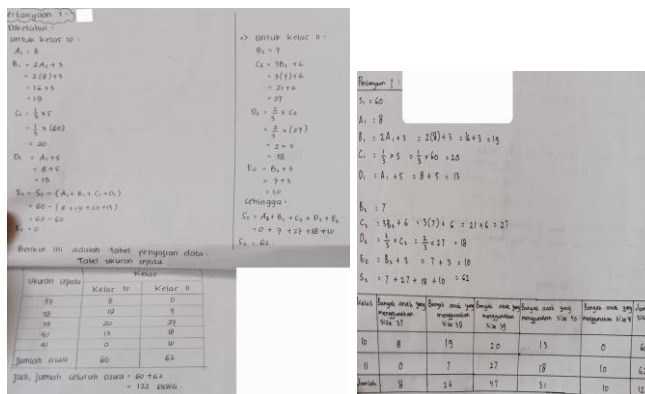


Fig. 1 Medium Group Student Work

Based on Figure 2, it can be seen in the sequential work procedure from the known information to the final answer process. The subject carries out the substitution process with the same steps as the low group students above. The difference lies in the presentation of the final data in the table only, but the information and data provided are correct and precise. Based on the work, students are able to work with mathematical modeling of complex situations from data presentations which are then able to integrate different representations in the form of table data presentations containing numerical information from the data obtained.

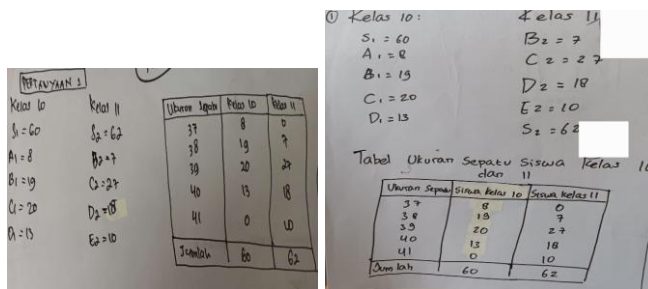


Fig. 3 High Group Student Work

Based on Figure 3, the work of high group students has a fast and concise but precise work procedure. It shows that the way of thinking of the high group is fairly fast and can be obtained without scribbling. The speed of thinking of the high class, although not written in full, is illustrated that the students' expertise in working directly in their minds and immediately writing the results on the worksheet. The high group immediately processes data from mathematical modeling into numerical data and presents it in a table accurately. Based on interviews from the three groups, it was said that the method they used was a single procedure to get answers using the substitution method and data presentation.

#### 4) Executing the Plan

The subject conducted a check at each stage of the work and cross-checked the whole thing. The subject argued that the results obtained would not have duplicate results, if the impossibility occurred only due to an error in the calculation. The most effective method used to get the answer was only using the substitution method. Based on the high, medium and low groups, the written answers contained the verification work in medium group 1 only, while the others did not write it down. However, it was revealed in the interview process that low group students said that in verifying the answers, they did it by checking the steps one by one, at a glance or by re-adding each shoe size data based on its class and the total number of class members.

## 2. Question 2

Question number 2 is brought to the nuance of a general question by presenting data on sales of traditional regional cakes. The data presented in the form of a pie chart with a percentage that requires students to be able to work by processing the percentage of cake sales from different days. Students must interpret the statement "an increase of 35 klepon cakes from the previous day's sales" as a basis for determining the number of cake sales today. The following are the results obtained from the subject based on Polya's steps

### 1) Understanding the Problem

For high group students, the subjects understand the problem very well, as seen from their oral and written answers. In written answers, the subjects can write in detail and precisely what is known and asked in the questions. The subjects know correctly the types of data and information in the questions are very appropriate. Low group students said that the information provided is the presentation of data in the form of circles in percentages and also cake price data. In addition, it was also said that all information in the questions was used to answer the questions, there was no overlapping or contradictory information. After understanding the presentation of data, there is a

further statement that must be understood so that students are able to determine estimates or new data information to be processed.

There was confusion among students in medium group 1 in understanding the narrative "an increase of 35 klepon cakes from the previous day's sales", the confusion that occurred was how to calculate the number of other types of cakes that were not mentioned in the previous day's sales, whether they were the same or different from today's sales. In addition, it was reversed in determining the number of cakes that should be sold today, which is 245 cakes which is the result of an increase of 35 cakes from the previous day, which means 210 cakes yesterday and 245 cakes for today. However, the understanding is 245 cakes plus 35 cakes for today's sales and yesterday's sales were 245 cakes minus 35 cakes which made it wrong to understand the problem. The next wrong understanding is making today's klepon cake sales the total number of cakes sold today, as well as the previous day so that the results of calculating other types of cakes as a whole are wrong.

For middle group 2 students, misunderstandings occurred when determining the sale of cakes other than klepon. It means that the percentage presented in the pie chart is the amount of decrease in the number of cakes sold, which should be compared with the klepon cake data to obtain the number of other types of cakes. Thus, the entire number of cakes in yesterday's sales was wrong except for klepon cakes. Even so, it has an impact on the requested answer, namely the average profit from today's and yesterday's cake sales. Overall, the completeness of the question information is written well in the answer, although in terms of understanding there are several subjects that are wrong. For those asked or those not yet known, it is not written. However, during the interview it was confirmed that the understanding of the information known or asked was more than that written in the answer.

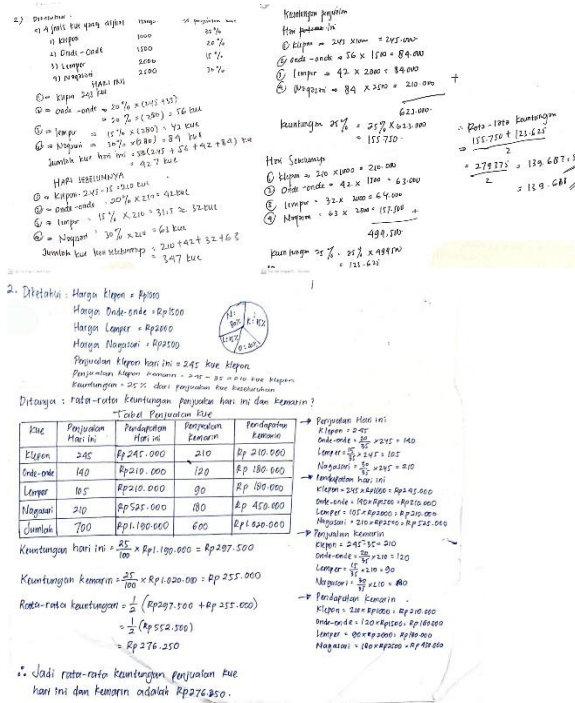
For students in the low group, they were very confused in understanding the information in the questions, which ultimately resulted in them not working on question number 2. It was revealed through the interview process that they were confused about finding sales profits because the information known in the questions was only the number of klepon in numerical form, there was confusion in finding and connecting the information in the pie chart.

## *2) Developing a Problem Solving Plan*

For high group students, in making a plan, from the available information the subject felt that they had received a similar question that required logic and understanding in understanding the narrative of the question. The subject strategized from the data information given with what was asked. The subject mainly interpreted the main information in the question related to the number of klepon cakes which was a clue to find the number of other types of cakes. After knowing for sure and correctly the number of klepon today and yesterday, it was then connected with the presentation of data in the form of a percentage pie chart with the concept of comparison. The concept of comparison used was by comparing the percentage and number of klepon sales today with the percentage of sales of other types of cakes to obtain the number of other types of cakes which also became data on cake sales today and yesterday other than klepon cakes. After obtaining each number of cakes, data on the price per cake was used to obtain the nominal sales money obtained today and yesterday which was then continued with the search for profit from a percentage of 25%. After obtaining profit today and yesterday, the search for the average profit on both days was carried out. Planning was not carried out by the low group because they failed to understand the

information in the question and connect it. However, almost the same planning was done by medium group students, there was a slight difference in the medium group which was in determining the number of cakes today and yesterday. The subject developed a connection strategy from what was known and asked in the question. Connecting the presentation of data and information on changes in the number of klepon cake sales that were different from before

### 3) Executing the Plan



2) Diketahui: Harga Klepon = Rp800  
 Harga Onde-onde = Rp1500  
 Harga Lemper = Rp2000  
 Harga Nagasari = Rp2500

Penjualan klepon hari ini = 245 kue klepon  
 Penjualan klepon kemarin = 245 = 245 = 245 kue klepon  
 Keuntungan = 25% dari penjualan dan kembalian

Ditanya: rata-rata keuntungan penjualan hari ini dan kemarin?

Jenis	Penjualan Hari ini	Pendapatan Hari ini	Penjualan Kemarin	Pendapatan Kemarin
Klepon	245	Rp 196.000	210	Rp 168.000
Onde-onde	140	Rp 210.000	120	Rp 180.000
Lemper	105	Rp 210.000	80	Rp 160.000
Nagasari	210	Rp 525.000	80	Rp 200.000
Jumlah	700	Rp 1.141.000	490	Rp 708.000

Keuntungan hari ini =  $\frac{25}{100} \times Rp 1.141.000 = Rp 285.250$   
 Keuntungan kemarin =  $\frac{25}{100} \times Rp 708.000 = Rp 177.000$   
 Rata-rata keuntungan =  $\frac{1}{2} (Rp 285.250 + Rp 177.000) = Rp 231.125$

\* Jadi rata-rata keuntungan penjualan kue hari ini dan kemarin adalah Rp 231.125.

Fig. 4 Medium Group Student Work

Based on the picture above, working according to plan even though in planning and working there was a misunderstanding in understanding the problem and connecting information to the problem. If we look at picture 4 (a) the error that occurred was determining the number of cake sales today and yesterday other than klepon cake. For the understanding of the narrative "today's klepon sales increased by 35 cakes from the previous day" has been calculated correctly, but the information that should only occur in klepon cakes is used as additional sales of other types of cakes, each 35 cakes so that the calculation becomes wrong which has a marathon or domino effect on the question regarding the average profit today and yesterday. For 4 (b) has been done according to strategy, even though there was an error in connecting data information. The initial work was done correctly in finding the number of cake sales today and yesterday based on the narrative "today's klepon cake sales increased by 35 cakes from the previous day" Then find the number of cake sales today by connecting information on the number and presentation of klepon today with the percentage of other types of cakes based on data presentation so that the data is obtained correctly and find the total nominal sales results today. But unfortunately the pie chart that should have been completed to be used as a basis for finding answers is used again to find the number of cakes other than klepon which is reduced by the percentage figures of the diagram. For example, in onde-onde cakes which should have been sold yesterday, namely 140 cakes, but yesterday's cake sales were not written as 140 cakes but 120 cakes which is actually wrong. Why is it said to be wrong, reinforced through the results of the interview, it turned out that there was a

misunderstanding in interpreting the percentage of onde-onde cakes of 20% which was the basis for reducing the number of cakes yesterday, of course this is wrong which will be a domino effect on determining the total nominal sales yesterday which has an impact on the amount of profit and the average profit on the two days.

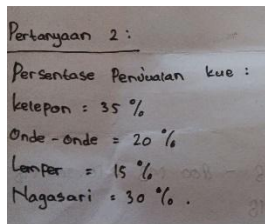


Fig. 5 Low Group Student Work

Based on Figure 5, it can be seen that the low group is only able to write information on the question or nothing other than what is known in the question and is not even complete. In addition, other subjects did not answer at all in the explanation in number 2. After being confirmed through interviews, it turned out that there was confusion in understanding the narrative "today's klepon cake sales increased by 35 cakes from the previous day" and connecting with a pie chart to find the number of cake sales other than klepon. On the other hand, another reason for not answering was because they ran out of time, because after being confused in understanding the information that took quite a long time, they preferred to leave the question temporarily and work on other questions, but because time management was not yet sufficient, answering the question was missed. In fact, during the interview session on subject 2, how the steps were given to the subjects that they could actually do but needed more time to understand and do the work. However, it was different in the middle group 1 which was traced through the interview process did not know and still did not get an idea of how to solve the question.

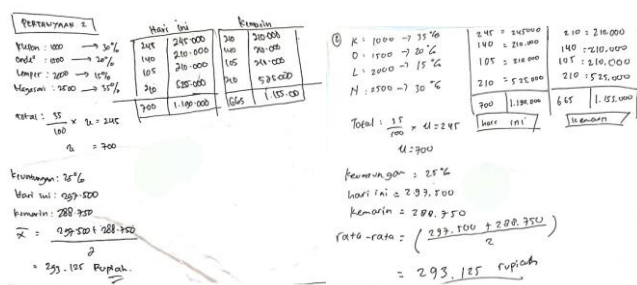


Fig. 6 High Group Student Work

Based on Figure 6, the work of high group students has a fast and concise but precise work procedure. It does not present in detail and step by step but each important step in the work is presented so that there is no significant miss in the analysis of the answer. The speed of thinking of the high class, although not written in full, is illustrated that the student's expertise in working directly in his mind and immediately writing the results on the worksheet. The high group immediately processes data from mathematical modeling into numerical data and presents it in a table accurately. Based on interviews from the three groups, it was said that the method they used was a single procedure to get answers with the substitution method and data presentation.

#### 4) Verifying Answers

The subject conducted a check at each stage of the work and cross-checked as a whole. The subject argued that the results obtained would not have duplicate results, if the impossibility occurred only due to errors in the calculation. The most effective method used to get the answer is to first find the number of klepon sales today and compare it with information on sales of other types of cakes, after that find the nominal sales by multiplying the number of cakes sold by the price of each cake which is then calculated the percentage of profit and find the average profit of sales on two different days, while the others did not write it down. However, it was revealed in the interview process that low-group students said that in verifying the answers, it was done by checking the steps one by one, no other verification strategies were carried out.

### 3. *Question 3*

Question number 3 is brought to the nuance of a general question by presenting information on the nominal pocket money in the form of a mathematical model that is almost similar to the spelling method with number 1. Students must evaluate the statement that Yeni's pocket money is less than Lea's pocket money. There is uniqueness and uniformity in answering question number 3, why is that because all high, medium and low groups can answer the question correctly and precisely. Thus, question number 3 can be categorized as an easy question, for detailed results obtained from the subject based on Polya's steps are presented as follows

#### 1) *Understanding the Problem*

For students in high, medium and low groups, the subjects understood the problem very well, as seen from their oral and written answers. In their written answers, they were able to write in detail and precisely what was known and asked in the questions. The subjects correctly understood the types of data and information in the questions about the pocket money of four different people presented in mathematical modeling. They said that there was no overlapping or contradictory information and all the information in the questions was used to answer. After understanding the presentation of data in the form of mathematical modeling, students were required to be able to use information from mathematical modeling and review of complex situations. Then connect different information by comparing and translating it to be able to justify that the statement in the question is true or false. Most of the information asked or unknown was not written in detail but went directly to the information processing stage in answering. It was also confirmed during the interview that the understanding of the information known or asked was more than that written in the answer.

#### 2) *Developing a Problem Solving Plan*

The planning strategy in number 3 is almost similar and simpler than question number 3. The three levels develop a strategy for connecting what is known and asked in the question starting from definite information or facts given as a reference or stimulus to find the information sought. The strategy chosen is to use substitution, based on their considerations from learning experiences and knowledge in their cognitive structure, the substitution method is the most effective way to find answers. The initial strategy starts from information about Mia's pocket money which is a clue to get Rani's pocket money with algebraic calculations, then after Rani's pocket money is obtained in the same way, the information is used as a basis for finding Lea's pocket money. To determine Yeni's pocket money, the strategy they choose is to accumulate various information and the total amount of pocket money for the four children, with algebraic and integer operations, Yeni's pocket

money is obtained. After finding all the information needed, the justification for the statement that Yeni's pocket money is less than Lea's pocket money.

### 3) Executing the Plan

In order to implement the plan, due to the similarity of the sequence of answers and all the results obtained being correct and complete, only one example of the work from the lower group will be presented, representing all groups, as follows.

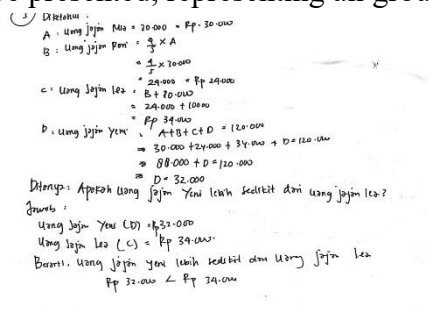


Fig. 7 Medium Group Student Work

Based on the picture above, work according to the plan, namely using algebraic operations or real number calculations. The main information that is a guide in finding other information is Mia's pocket money. By substituting Mia's pocket money (A) in the form so that Rani's pocket money (B) is obtained of Rp24,000. Then make the information obtained previously, namely the nominal value of Rani's pocket money (B) to obtain Lea's pocket money (C) in the form so that Rp34,000 is obtained. slightly different to find Yeni's pocket money, because to get Yeni's pocket money we have to get Rani's pocket money (B) even though Rani (B) is not the one asked in the question, but information about Rani's pocket money helps to get Yeni's pocket money (D) as asked in the question. After obtaining all the information completely, the next process is to evaluate or provide comments on the question "Is Yeni's pocket money less than Lea's pocket money" can be answered.

### 4) Verifying Answers

The subject conducted a check at each stage of the work and cross-checked the whole thing. The subject argued that the results obtained would not have duplicate results, if the impossibility occurred only due to an error in the calculation. The most effective method used to get the answer was to first find each person's pocket money nominal and then compare it according to the question. However, it was revealed in the interview process that low-group students said that in verifying the answers, they only checked the steps one by one, no other verification strategies were used.

## 4. Question 4

Question number 4 is brought to the nuance of a common question with information on flash disk storage capacity in different conversion units. Students must be able to represent data and connect it to different situations. There is uniqueness and uniformity in answering question number 4, why is that because all high, medium and low groups can answer the question correctly and precisely even though there is one person in the medium group whose answer is not finished but exceeds 80%. Thus, question number 4 can be categorized as a fairly easy question, for detailed results obtained from the subject based on Polya's steps are presented as follows

### 1) Understanding the Problem

For students in high, medium and low groups, the subjects understand the problem very well, as seen from their oral and written answers. In their written answers, they can write in detail and precisely what is known and asked in the questions. The subjects know correctly the types of data and information in the questions about flash disk storage and are represented by the presentation of pie chart data. They said that there was no overlapping or contradictory information and all the information in the questions was used to answer. After understanding the presentation of data in the form of mathematical modeling, students are required to be able to represent data and connect it to different situations. Then connect certain cases if you have a new flash disk with different storage space and be able to represent the presentation of data on the new flash disk. The presentation of storage information and details of the stored files are presented in different units, so students must be able to convert them into the same units so that calculations are easier to do and precise. It has also been confirmed during the interview that the understanding of the information known or asked is more than that written in the answer.

### 2) Developing a Problem Solving Plan

Planning strategy in number 4 uses arithmetic operations, but first equates the units from the flash disk capacity conversion stage. After that, the process of deleting files on the flash disk, the narrative leads to the operation of reducing and adding files in the form of a video narrating that the addition operation plays a role in this case. After knowing the capacity of each file stored with the same units after the conversion process. The stage of detailing the data for each storage data for the new flash disk case becomes the final procedure that will help in formulating or presenting data in the form of diagrams, tables, etc. For the group subjects who are planning the same as other students, it's just that the work stops and does not continue to present the data after a change in storage space so that the request for the question has not been completed

### 3) Executing the Plan

In order to implement the plan, due to the similarity of the sequence of answers and all the results obtained are correct and complete, then only one example of the work from the low group will be presented, representing 5 subjects from various group levels and one from the medium group which is almost finished with its work as follows.

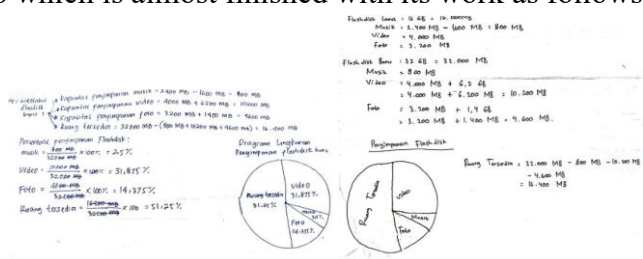


Fig. 8 Low and Medium Group Student Work

Based on the picture above, working according to the plan is to calculate after being able to convert units in storage using number operations. Calculating to obtain the storage capacity of each file (music, video and photo) based on the occurrence of adding data or conversely deleting data in order to obtain the capacity of each file and be able to formulate a decision whether the storage space on the flash disk is sufficient or not. Unfortunately, the students in the planning group stopped here. However, for low-ability students, they continued by connecting new information to the second case. The second case that emerged was a new storage space on a flash disk with a larger

capacity. The ability to connect the two different situations and construct the presentation of case 2 using a pie chart with a percentage was carried out by the low group correctly and completely.

#### 4) *Verifying Answers*

The subject conducted a check at each stage of the work and cross-checked the whole thing. The subject argued that the results obtained would not have duplicate results, if the impossibility occurred only due to errors in the calculation. The most effective method used to obtain answers is by integer arithmetic operations and presentation of statistical data with diagrams. However, it was revealed in the interview process that in verifying the answers, it was done by checking the steps only, no other verification strategies were carried out.

Based on the work on the four questions based on Polya's steps, prospective teacher students need to be improved and given reinforcement in problem solving procedures, in line with (Julianawati et al., 2025; Aljaberi & Gheith, 2016). In this study, it was found that most of the written Polya steps did not describe the overall steps systematically. However, these results were validated during the interview process. So that the Polya steps actually occur in their thinking framework, only they are not written in the answers. Based on the results of the documentation of the work that was analyzed and validated through interviews, it was found that there were still quite a lot of students who had difficulty working on uncertainty questions and data using Polya stages in line with (Luthfiyah, 2022). In fact, the target of the test is students at the secondary school level. Especially in Steps 2 and 4. Why are Steps 2 and 4 highlighted? Because their habit when working is only writing down the solution to the answer, so that the process of making a plan can be implicitly drawn from Step 3. Especially the verification process seems monotonous and ineffective. It is said that, because, all levels of students give the same answers during the interview to verify by looking at the work procedure from start to finish. Of course, this is said to be ineffective and does not differentiate between the abilities of prospective teachers and students. It is said that, because Education must have more skills than its students, so that in the process of correcting or verifying right or wrong answers can be done with strategies other than rechecking the answers from step by step. Based on the findings of this study, recommendations and suggestions are given in line with (Barham, 2020; Aljaberi & Gheith, 2016) namely to strengthen and improve the problem-solving abilities of prospective teachers in the future.

## CONCLUSIONS

Based on the above research results, subjects from various levels of ability are able to understand problems and identify problems about what is known, asked, conditions and linking various different cases or events. At stage 1 polya, questions 1-4 can be understood well from various levels of groups except for number 2. At number 2 at stage 1 polya, low group students had a misunderstanding regarding the emergence of different cases to determine data on the second day from the narrative "today there are 245 klepon cakes sold and this number has increased by 35 klepon cakes from the previous day's sales". At stage 2 polya, in preparing the plan, it has happened very well and according to plan. The preparation of the plan is constructed based on learning experiences, familiar problems and planning using methods or methods that are appropriate to the problem. Mistakes in planning can occur due to the impact of stage 1 polya with the same subject. The domino effect occurs at number 2 which occurs in the planning of calculating each cake sold yesterday which has an impact on planning the next problem solving. Stage 3 polya, in

implementing the plan according to stage 2 in low ability students and one medium ability student there was an error in planning so that an error occurred in implementing the settlement procedure. At the looking back stage in the fourth stage of polya, all questions, students do not yet have an effective verification strategy because they only check from step by step and it is not possible for differences in results if understanding, planning and work procedures are carried out correctly. Problem solving is holistic, clearly stated in the polya steps that describe the relationship between steps. For the high group because of the understanding of the problem there is no misunderstanding that has an impact on the preparation of plans and work procedures that occur very well. While the medium group is divided into two, some are able to understand the problem but not completely and some do not understand at all which has an impact on the next polya problem solving step being less appropriate and complete. While students who are categorized as low groups have an incomplete understanding of several questions and are almost similar to the medium group.

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