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HOW TO MAKE AN ILL-STRUCTURED PROBLEM TO BE WELL DONE? A STUDY ABOUT DECISION MAKING OF PROSPECTIVE MATHEMATICS TEACHER

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Abstract

Ill-Structured Problem has authenticity, complexity, and openness properties, so that the characteristic of Ill-Structured Problem is unique, especially in incompletely of structure. The qualitative study was held to describe the decision making in completing the structured of Ill Structured problem. The research subjects are 3 out of 22 prospective Mathematics teachers who perform decision making in achieving Ill Structured Problem. The research found that each item shows a different response in the decision-making stage that involves generating, clarifying, and assessing reasonableness idea depend on knowledge, experience in their daily life.

Keywords: Ill-Structured Problem, Decision making, Delivery Case

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We make numerous decisions every day, and our choices may range from routine, every-day types of decisions to those decisions which will have far-reaching impacts. Research subject about decision making has become a phenomenon in some research (Cokely & Kelley, 2009 Yingxu Wang & Ruhe, 2007). Result of the study giving enough information about student's cognitive process in a domain needed to create instructional correction, the cognitive process of decision making can be applied into many other systems which based on the decision, while the user of intuition is one way of approaching decision making in managerial field. Decision making is involving someone cognitive process Wang & Ruhe, 2007). Decision making is a process that chooses a preferred option or a course of actions from among a set of alternatives based on given criteria or strategies (Y Wang, Wang, Patel, & Patel, 2001).

In making decisions, someone does a thought process that starts with generating ideas, clarifying ideas, and evaluating the reasonableness of ideas (Swartz & Reagan, 1998). When someone makes a decision, the teacher tries to generate ideas that will be used in making these decisions. The idea that raised must be explained by considering similarities and differences, combining those that have similarities and separating different ideas. But not all ideas are following the expected conditions, so the idea must be evaluated to make the best decisions used in decision making.

Decision making can be applied to a decision-based system or carried out by someone in choosing something. Various decision-based systems employ cognitive decision-making processes such as cognitive informatics, software agent systems, expert systems, and decision support systems Wang & Ruhe, 2007). Decision making is done by someone in solving problems (Abdillah, T., Susanto, & Abadyo, 2016). Decision making also used by teacher or prospective teacher in design learning media (Murtafiah, Sa'dijah, Chandra, & Susiswo, 2019).

Regarding problem-solving, ill-structured problems are examples of challenging problems. Some expert opinions about Ill-structured problems. Ill-structured has vague definitions or unclear

goals and constraints not stated (Voss & CR., 1988.). Having a relationship between concepts, rules, and principles that are not appropriate between cases requires students to make judgments about problems and can defend their opinions (Jonassen, 1997). Thus ill-structured problems that were presented to students are problems that involve unknown elements, have a connection to several concepts, several solutions, solution paths that require someone to express personal opinions because they are related to unique human interpersonal activities. Ill-structured problems arise from a specific context, having the following characteristics: first, the aspect of the situation is not concrete; second, the problem is not well defined; third, this problem is based on real-life situations and has openness; and finally, complex cases are presented (Chi & Glaser, 1985).

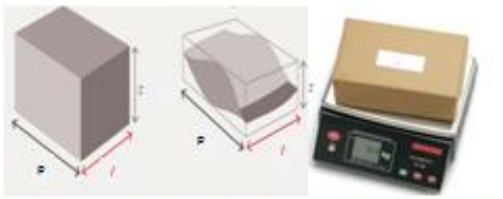
Jonassen (1997) considers that complexity attributes contain: the uncertainty of concepts, rules, and principles needed to solve problems, or how the problem is organized. The relationship between ideas and rules and principles that were not set. In terms of openness, Jonassen said: first, several evaluation criteria must be in place to solve the problem; second, the clarity of the intent of the problem is not presented; third, students must express personal opinions and beliefs about the problem; fourth, it is recommended that students judge and defend problems.

There are several studies related to the ill-structured problem (Hong & Kim, 2016.) analyzing the ability of mathematical abstraction shown by the fifth grade when trying to solve the ill-structured problem. Ge & Land (2003) conveyed question prompts and peer interactions had a significant effect on each ill-structured problem-solving step taken by students. Walker (2006) used CRT as a tool used to detect problems with a lack of structure, namely the ill-structured problem. Connie & and Charlene. T. A. N (2006) conducted a study that examined the extent to which one-class pain-structured problem-solving process from 21 pre-service teachers at the postgraduate level at the asynchronous online environment in Singapore. Hong & Kim (2015) stated about expert effects in ill-structured problem-solving.

Based on the information above, it is clear that no research focuses on how a problem solver completes the structure of an ill-structured problem in the decision-making process. Therefore this study aimed to investigate the decision making process student made.

RESEARCH METHODS

This study uses a qualitative approach with descriptive exploration methods. This study describes, records, analyzes, and interprets the conditions that occur. This study involved 22 prospective mathematics teachers in the 6th and 7th semester. Data mining are done through tests and interviews. The ISP test questions provided adapted from mathematical literacy test by Lestari, Juniati, & Suwarsono (2018). The adaptation refers to the characteristics of the Ill-Structured Problem. The problem presented in Figure 1.



Gambar 1. Pengukuran volume paket barang Gambar 2. Pengukuran be

A courier service company sets the cost of sending goods (the item to be sent and its packaging) based on the weight of the package. There are two types of package weight, namely actual weight and volumetric weight. The actual weight is the weight based on the weight of the goods package scale, while the volumetric weight is the weight based on the volume of the package. The package of goods to be sent is weighed in advance to find out the weight, then proceed to the volume measurement. Then the following rules are applied.

i. If the volume of the package is less than 18,000, then the weight of the package of goods is the actual weight, and the calculation of shipping costs is carried out according to the actual weight.

ii. If the volume of the package is ≥ 18,000, then the weight of the package of goods is volumetric weight calculated using the formula:

$$Bv = \frac{p \times l \times t}{6000}$$ kg (length, width, and height calculated in centimeters)

with the calculation of shipping costs carried out according to the volumetric weight of the package of goods to be sent (BV)

iii. If the weight of the box is not more than 1 kg, the shipping cost is a minimum fee of Rp. 25,000.00

iv. If the weight of the package is more than 1 kg, the excess weight of the package will be subject to an additional shipping fee of IDR 5,000.00 / Ounce.

If Budi will send a package in the form of a flat-screen television. Determine the costs that must be paid by Budi

Figure 1. Ill-Structured Problems about Delivery

RESULT AND DISCUSSION

Based on the analysis of problem-solving answers from 22 test participants, it was found that there were four types of decision making conducted by participants in terms of the participant's way in completing "the unknown" of the ill-structured problem to solve it. Table 1. provides an overview of the results of the analysis.

Table 1. Distribution of Student Response for ISP

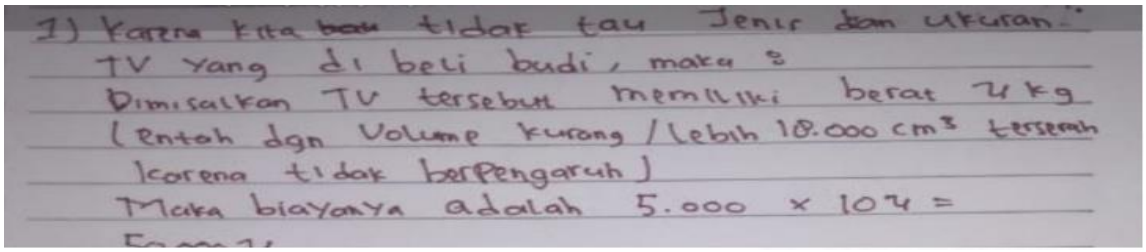
Responses Description	**Number of participants**
Rewrite the question	6
Use variable x	4
Use a certain weight	2
Use the size of the TV	10

In this research, the prospective teachers that rewrite the question directly are “not categorized” because it will be challenging to explore the decision making as it leaves blank. Therefore, we will not discuss the prospective teachers that rewrite the question directly and explore the other three categories. The first category is called as A category, B category, and C category. A category is a

category for prospective mathematics teacher choosing to use variable x to complete the problem structure. B category is a category for prospective mathematics teacher choosing to use TV weight to complete the structure. C category is a category for prospective mathematics teacher choosing to give TV size first to complete the problem structure. The following is the decision making the process of prospective mathematics teachers from each category.

Decision Making of A Category's Prospective Mathematics Teacher

The prospective mathematics teacher in A category chooses to find missing variables and specifies the weight in the independent variable x as in Figure 2.



Translation:
Since the kind and size of TV bought not given, we pretend that the TV weights x kg (the volume doesn't affect) then the cost

Figure 2. The decision-making product of A category's of prospective mathematics teacher

The decision-making process can be presented in the passage of the interview between the researcher (P) and A category's of prospective mathematics teacher (S1) as follows:

P : Have you ever worked on such questions?

S1 : never sir

P : What's interesting about the problem

S1 : The problem is open and complicated, and the solution is not clear because something is unknown

P : What is unknown?

S1 : The weight of the TV sir?

P : How did the initial x appear?

S1 : Yes ... from the question you are asked for the shipping costs, and the weight is unknown

P : How about it, then?

S1 : That means the weight must be searched for while the volume is considered less than18,000 cm3

P : Why is it considered 18,000 cm3

S1 : to make it easier

P : What then?

S1 : At first I thought what if given a defined weight which is about 5 kilograms. Then I will calculate the cost later. But I think this is unknown, what if it is wrong later. Besides, I also don't memorize the weight of each TV, and I am worried about being wrong. I just made the weight is x kg, so there are many possibilities for the cost of shipping the goods to be produced.

P : Do you check whether your choice is reasonable or not

S1 : Yes, then I work on the next step according to the question so that the solution was obtained, even though it is still in the general form. Which means that is correct sir.

Based on the results of these interviews, it seems that the A category's of prospective mathematics teacher is constrained by the complexity of the information given in the questions relating to actual weight and volumetric weight, so he rushes to go directly to severe problems regardless of the dimensions of the TV or even the inch size commonly used. **Generating the idea** of setting the weight of a TV, there are several choices built by the S1 namely inventorying some possible weight, for example, 3 kg or 2.8 kg according to the nature of the openness of the problem or choosing the general form of pressure symbolized by *x*, S1 then continuing step by **clarifying the idea** of analyzing arguments when choosing weight in kilograms or general form *x* by conveying the arguments of each choice. Then S1 selects one of the substantial alternatives built, in this case, x. The next step is to **assess the reasonableness of the idea** by analyzing the possible choices for solving the given questions, including checking the answers generated. The decision-making process can be directly in Figure 3.

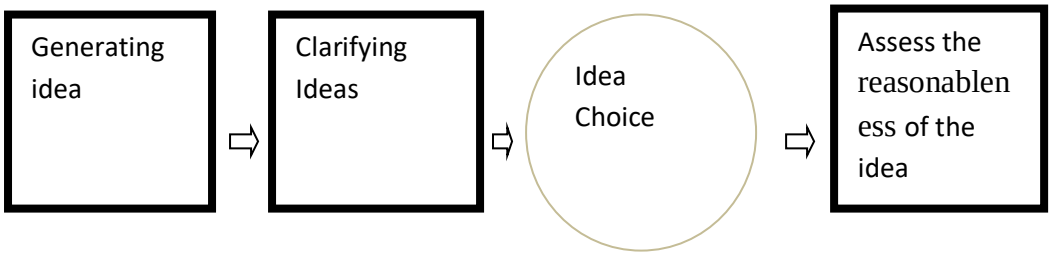
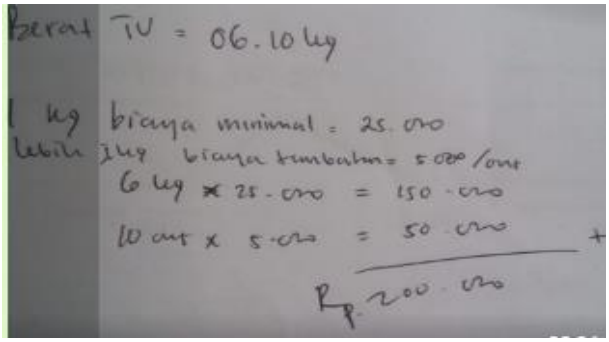


Figure 3. Decision Making Process of A category's of prospective mathematics teacher

Decision Making of B Category's Prospective Mathematics Teacher

The B category is of prospective mathematics teacher who chooses to use TV weight to complete the structure as in Figure 4.



The weight of TV + 06,10 kg

Minimal price: Rp. 25.000

If the weight greater than kg then is adding cost 5000/ons

Figure 4. The decision-making product of B category's of prospective mathematics teacher

The decision-making process can be presented in the passage of the interview between the researcher (P) and the prospective mathematics teacher categorized in B category (S2) as follows:

P : Have you ever worked on such questions?

S2 : Never, sir

P : What do you think about the characteristics of the problem?

S2 : In the matter, there are unspecified but important data, related to daily life and complicated information

P : What is important missing data?

S2 : The type of TV, sir, the brand size and the weight, sir?

P : What do you do about it?

S2 : Look for the weight

P : How do you put the size of 6.10?

S2 : Because I was asked for shipping costs, I had to know the weight of the items sent. At first, I thought how much weight I would like to put on, so the cardboard or styrofoam was counted or not

P : So what is the weight of the TV that you think is only 6, 10 kg?

S2 : No, there are various types of brands and sizes. The greater the weight, the more it increases. Initially thought it weighed 2 or 3 or 6 kg but it didn't work

P : Why?

S2 : Later it will be too light for TV size, so I finally chose 6, 10 kg

P : Do you not pay attention to the volume?

S2 : I don't know the size of the TV

P : Does it mean there is no need to pay attention to the volumetric frequency?

S2 : Hehe... no sir

P : Why is the size 6.10

S2 : I see the estimates in the picture, sir

P : What's with the picture?

S2 : Based on the figure given, the size was rather large, so it was about 6.10 kg

P : Why are there 10 ounces

S2 : Yes, the weight of the item is not always round.

P : Did you check whether that made sense?

S2 : Yes sir, in my opinion, it makes sense, if you look at the large volume, there are also electronic items, surely the weight, when inserted into the problem, can also produce an answer of Rp. 200,000.00

Based on the interview, the A category's of prospective mathematics teacher understands that the problem is a problem with the incomplete structure and considers the complexity of the problem. The prospective mathematics teacher categorized in the B category, by looking at the complexity of the problem was then hurrying to override the volume of the item as the basis for determining the item. Then she **Generating an idea** by looking at a picture by producing three answer choices and immediately choosing 6.10 based on the estimates in the picture. She was **clarifying ideas** by presenting various underlying arguments. **She assesses the reasonableness of an idea** by looking at the excellent condition of goods and types of products and checking whether the results of choice can give the correct answer The decision-making process can be simplified as Figure

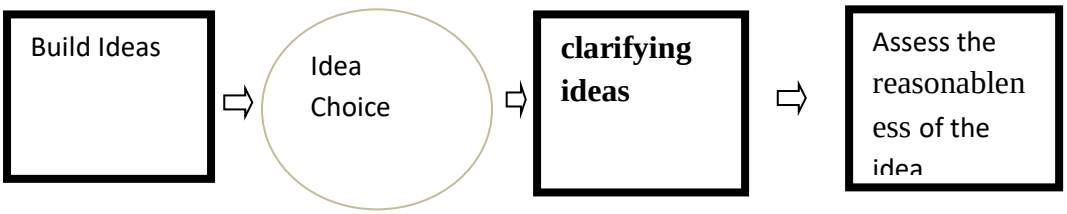


Figure 5. The B Category's of Prospective Mathematics Teacher Decision Making Process

Decision Making of C Category's Prospective Mathematics Teacher

The C category is of prospective mathematics teacher who chooses to use TV size to complete the structure as in Figure 4.

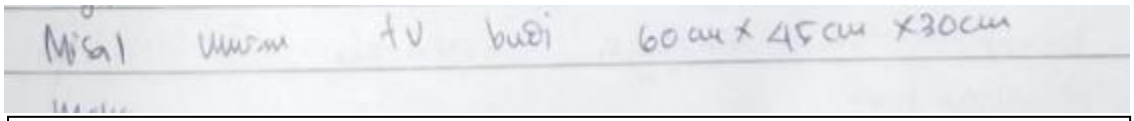


Fig 6. The response of C Category's of Prospective Mathematics Teacher

Based on the response, an interview is followed. Then the decision-making process can be presented in the passage of the interview between the researcher (P) and the C Category's of Prospective Mathematics Teacher (S3) as follows:

P : How do you think about the problem you did earlier?

S3 : The process depends on the perceptions that work on it, sir, because it's not clear?

P : So how do you tax it?

S3 : I searched for the size of the TV first

P : Why are you looking for a Tv size first?

S3 : To choose whether to use actual weight or volumetric weight

P : So why choose the TV size?

S3 : Yes actually I think of some small ones and big ones

P : What is the size?

S3 : 60 x 45 x30 and 40x30 x15 and small ones 20 x 15 x 5 and 10 x 8 x5

P : Why choose that size?

S3 : Yes, I just installed two sizes with a volume of more than 1800 and less than 1800. The size of all the cartons and the styrofoam fit for the tv. Because the type of TV was not mentioned, I think it can fit 21 inches, 29 inches or 32 inch

P : Then, what is Ms.

S3 : The small one doesn't seem to make sense because no TV can be loaded even though it is a 14 inch TV.

P : how if it's big?

S3 : I finished the problem with the size given, and it turns out that it can be found in response to the volume of the steel and the result means that the size can be entered for this problem. Then I choose the big one so that it can fit the big tv.

According to the interview, the C Category's of Prospective Mathematics Teacher choose the correct decision-making strategy, namely by observing the size or dimensions of the items to be sent. This is for consideration whether using actual or volumetric weight. At the time of generating the ideas, she managed to **generate some ideas**, including explaining the details of the idea. When **clarifying the idea**, She presents argument arguments from alternative ideas that are built. Furthermore, She **assesses the reasonableness of ideas** seen from the logical according to reality and whether it can predict the use of ideas to solve problems. The new final stage was decided to choose one idea. The Process of the Decision making can be simplified as Figure 7.

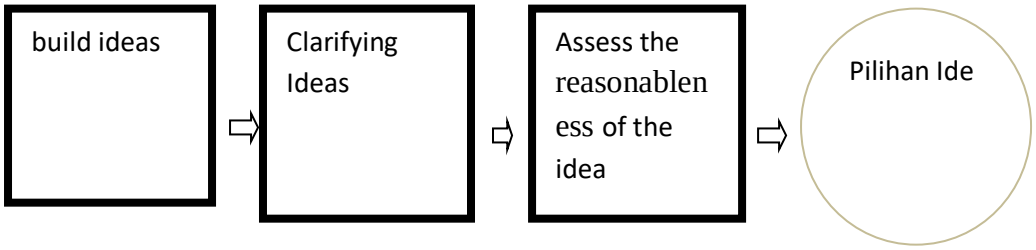


Figure 7. The decision-making process of the C category's of prospective mathematics teacher

DISCUSSION

Student candidates have understood that the question is a matter that has an incomplete, open, complex, and authentic element. Because of that, the essay depends on the perceptions/point of view

of the student. It was also very apparent in the decision to add elements which, according to student-teacher candidates were incomplete.

Generating Idea

At this stage, S1 understands very well that the question is open and that many alternatives can be presented so that S1 chooses to symbolize in general symbols which impact on the openness of answers, while S2 chooses to focus directly on the one answer that results from observing the image. S3 subjects choose several alternatives to be clarified at the next stage

Clarification of ideas

Subject S1 chooses to give an argument why to choose symbol x to represent its weight, while S2 clarifies the weight of 6.10 kg for the reason of observing the image and choosing not to take the risk of calculation for the other choices. S3 is consistent in classifying ideas in this case TV dimensions

Assessing the reasonableness of Idea

The A Category's of Prospective Mathematics Teacher checks the logic of choice by including in solving the problem and producing a solution that is still open. The B Category's of Prospective Mathematics Teacher checks the logic or reasonableness of the idea chosen by calling on day-to-day knowledge and incorporating it into problem-solving and feeling getting answers to problems in a reasonable rupiah. The C Category's of Prospective Mathematics Teacher checks the reasonableness of all alternatives by linking to the realities of daily life, so that eliminates one illogical choice and continues to assess the reasonableness of the idea in solving a problem that produces a reasonable solution so choosing 1 of two choices based on individual perceptions and knowledge. Based on these results, A Category's of Prospective Mathematics Teacher, B Category's of Prospective Mathematics Teacher and C Category's of Prospective Mathematics Teacher have passed through the stages of decision-making described by (Swartz and Reagan 1998), namely generating ideas, clarifying ideas and assessing the reasonableness of ideas. However, due to the characteristics of ill-structured problems that have a relationship between concepts, rules, and principles that are not appropriate between cases, requiring students to make judgments about problems and can defend their opinions (Jonassen, 1997) causes the decision-making process to be different because it requires someone to express personal opinion because it is related to unique human interpersonal activities. This also fits Hong & Kim, 2015) Ill-structured problems, where frames of reference with real problems are contextualized, require learning to define problems as well as skills and skills needed to solve them. The most recent social needs emphasizing students' ability to solve real-life problems is found in modern society.

CONCLUSION

Variations of ideas that are generated and the ability to do the stage of decision-making stage become different between individuals with one another. This has an impact on the determination of ideas as decisions, where individuals can only make choices in the stage of developing ideas, or when

clarifying ideas or even at the end of evaluating the reasonableness of ideas. This is strongly influenced by personal factors such as knowledge, individual experience as a result of complexity, authenticity, the openness of the ill-structured itself. However, this study has a lack that is not revealed how an adversity quotient influence the decision-making process in completing the ISP structure

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