

THE DECISION MAKING PROCESS OF HIGH SCHOOL STUDENTS WITH HIGH MATHEMATICAL ABILITY IN SOLVING SOCIAL ARITHMETIC PROBLEMS

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Abstract

The decision making process is the individual steps in choosing an appropriate alternative choice from the various alternatives available to solve the problem. The purpose of this study is to describe the decision making process of high school students with high mathematical abilities in solving social arithmetic problems. This is expected to help educators to apply more creative and innovative learning models to overcome problems that involve students decision making process in solving social arithmetic problems by paying attention to students' mathematical abilities. The type and research approach used in this study is qualitative descriptive research. The process of collecting data uses several instruments consisting of mathematics ability tests, social arithmetic problem solving tests, and interview guidelines. This research was conducted on 11th grade high school students in one of the state high schools in Sidoarjo. The subjects of this study consisted of one student with high mathematical abilities. The results showed that students with high mathematical abilities carried out a series of activities in the stages of the decision making process, namely (1) Students were able to explain the reasons for making decisions (2) Students were able to understand the context (3) Students also identified choices contained on the problem (4) Students are able to determine the strengths and weaknesses of the alternative choices that have been made (5) Students choose one option with the provisions have fewer deficiencies than others (6) Students also re-check their choices (7) Students also able to determine his decision by implementing his choice.

Keywords: Problems, Decision Making Process, Social Arithmetic

INTRODUCTION

The problem is defined as a condition where there is a something wrong between the current situation and the future situation or with the desired goal (Suharman, 2005). When solving a problem, each individual is required to be able to analyze what problems are being faced to take appropriate action. Problems can also arise in various fields, especially in the field of knowledge. According to Polya (1973), problem solving is an attempt to find a solution or a solution to the problem being faced by an individual.

The things that must be considered by students when solving problems especially in mathematics is understanding the problems, so they can find the effective solutions. The Government established appropriate regulatory boundaries to realize this through the Minister of National Education Regulation of the Republic of Indonesia Number 58 of 2014 which

outlines the objectives of mathematics learning which are outlined in three points. The contents of the discussion on the second point is the government emphasizes the process of solving problems that must be passed by students. Therefore, in learning mathematics, teachers or educational institutions that emphasize problem solving when learning mathematics in the classroom and outside the classroom, both in the form of questions provided and learning models.

Problem solving can also be identified as a cognitive process in the brain located in the higher cognitive layer to find solutions of the problems that are given in order to achieve the desired goals (Wang & Chiew, 2010). According to the research conducted by Wang et al. (2006) there are 37 cognitive processes that are modeled in the layered reference model of the brain (LRMB). LRMB is a model that describes brain functions and cognitive processes when the brain is at

work which is grouped into 6 layers, namely sensation, memory, perception, action, metacognitive, and high cognitive levels. One of the cognitive processes included in the LRMB is decision making because in making decisions involving cognitive processes that must be owned by someone. There are several fields of science that study decision making, namely cognitive science, computer science, psychology, management, economics, and mathematics. The research that discusses decision making in the field of mathematics education is still very rarely carried out by some researchers. The example of research that discusses the decision making process is a study conducted by Murtafiah et al., (2019) titled "Decision making of the winner of the national students creativity Program in designing ICT-based learning media" and Abdillah et al., (2016) with the title "The decision making in solving discount problem " The results of both studies is explain about how the student's decision making process when solving a problem. Both of these studies illustrate how each process that occurs when decision making is in progress. The researcher is inspired to conduct similar research with the aim to describe how the students decision making processes when solving problems are reviewed with one aspect that can influence the decision making process.

Decision making can also be defined as one of the cognitive processes of human behavior that must choose from several alternative choices based on certain criteria (Wang & Ruhe, 2007). Wang defines decision making as one of the cognitive processes, therefore decision making is often found in everyday life, especially when we got the problems. According to Hafni & Nurlaelah (2018) there are several styles in decision making namely analytic style, directive style, conceptual style, and behavioral style. Analytic style has the characteristics of students tend to solve problems more accurately, more detail, and well structured, directive style has the characteristics of students tend to formulate problems using data based on facts and answer descriptions are also structured, then the characteristics of students conceptual thinking style creatively and have a broad view in solving a problem, while the behavior style has the characteristics of students tend to only give opinions and descriptions that are not structured.

Sometimes, every student has different time intensities and answers when solving math problems. One factor that causes is because mathematical ability possessed by students. Mathematical abilities in students can be grouped into three categories, namely high,

medium, and low mathematical abilities (Ratumanan, 2003). The higher mathematical ability of students will affect their knowledge to solve problems. Students with high mathematical abilities in solving mathematical problems use logic and more structured algorithms. "Difficulties in thinking can influence decision making in problem solving" (Tambychik et al., 2010: 172), the statement emphasizes that difficulties in thinking can influence the decision making process. There are many factors that influence, one of which is the lack of students' knowledge and insight related to the problem at hand. Because mathematical ability can also be categorized as one of the factors that influence the decision making process, the researcher establishes mathematical ability as one of the aspects of the review chosen in this study, especially high mathematical ability. It is expected that research on mathematical abilities, especially in decision making, can help educators or prospective educators to find out how the decision making process of students with high mathematical abilities when solving a problem. Thus, educators can devise unique and interesting learning methods to overcome the lack of student decision making due to differences in mathematical abilities by considering the decision making process by students high mathematical abilities.

A good decision can be concluded based on the analysis conducted. The students can make the wrong decision if they does not understand the problem he is facing. According to Piaget in a book written by Slavin (2009) children's intellectual development can be divided into four phases. Based on the division of intellectual development phases by Piaget, high school students are accustomed to solving abstract problems. They are also accustomed to using more symbols in their thinking and describing their arguments based on their scientific knowledge. There is a relationship between scientific thought with decision making, especially when using logic rules and evidence to identify problems (Ardiana & Sudarmin, 2016). Therefore, high school students were chosen as the subject of this study because high school students can describe the results of their answers scientifically and factually based on prior knowledge. This is expected to be a bridge for educators to find out how the decision making process is carried out by high school students and can be an evaluation of the learning undertaken.

Decision making is also closely related to what happens all the time, so to make learning mathematics

more meaningful, there needs to be a condition for connecting real life experiences with ideas in mathematics. So, students can associate mathematics learning with their decision making. One chapter that is close to daily life is social arithmetic. Because in social arithmetic there are uses of a number of operations that are often found in everyday life. In social arithmetic material, students are taught about how buying and selling transactions are carried out. Every human being must have experienced buying and selling transactions whether it is buying something or selling the goods they have. In this era, technological advances have influenced the increasingly frequent use of social arithmetic in everyday life. An example is the issue of discount which is now a trend among many shops both online stores and stores in the Mall. As consumers, both students and lay people need to know the importance of mastering the ability to solve social arithmetic problems. This is so students can make effective decisions, that is when buying good items and having lower prices. This statement is also supported by research conducted by Masrurotullaily (2013) which says that students need to master their abilities in the field of financial mathematics, especially in social arithmetic material, to make decisions in solving problems. Therefore, social arithmetic material is possible to be a link between the problems presented with the decision making process when solving problems. Based on this description, the aims of this study to describe the decision making process of high school students with high mathematical abilities to solve social arithmetic problems. The difference with previous related research is that this study illustrates student decision making in terms of mathematical abilities, especially in high mathematical abilities. While the existing research is not describing mathematical abilities when making the decision.

METHOD

Based on the purpose of this study, which is to describe how the decision making process of high school students with high mathematical ability in solving social arithmetic problems, the qualitative research approach and qualitative descriptive research were chosen as type of the research. The subjects of this study consisted of one high school student selected based on high mathematical abilities. This research instrument consisted of two types of instruments, namely the main instrument and supporting instruments. The main

instrument is the researcher itself while the supporting instruments consist of mathematics ability test questions, social arithmetic problem solving test questions, and interview guidelines. The preparation of the mathematical ability test instrument was adopted from the high school level mathematics national exam questions by considering the prerequisite material on problem solving tests namely single interest and compound interest. While the problem solving test instruments are arranged based on the following criteria, namely the questions containing material that has been studied by students before, the questions presented are not questions that are often or have been done by students (non-routine), the questions that are unusual means to be able to solve the problem in-depth analysis and thinking is needed, and the problem cannot be solve directly with the formula but must look for one of the missing components to be able to use the formula through the help of another formula in order to get the solution. Interview guidelines were prepared based on the decision making indicators in this study.

The mathematics ability test aims to assist researchers in classifying students based on high, medium, and low mathematical abilities. Furthermore, social arithmetic problem solving tests aim to describe the decision making process of high school students with high mathematical ability in solving social arithmetic problems mainly through students' written answers. While the interview guidelines aim to assist researchers in describing the decision making process of high school students with high mathematical abilities in solving social arithmetic problems so that no information is missed and interviews become more focused. Data collection techniques in this study consisted of the written test method and the interview method.

Students' math ability test results are assessed according to the math ability test guidelines. Furthermore, the scores obtained are grouped in advance according to the rating scale referring to the research conducted by Arifin (2009), which is as follows.

Table 1. Grading Scale and Description of Students' Mathematics Ability

Students Mathematical Abilities	Range of Value
High	$80 \leq \text{Score} \leq 100$
Medium	$60 \leq \text{Score} < 80$

Low	$0 \leq \text{Score} < 60$
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While the data from social arithmetic problem tests and interview guidelines were analyzed in accordance with indicators of students' decision making processes in solving social arithmetic problems that were adapted from the decision making process by Rusell-Jones (2000). The following indicators will be used to analyze the stages of students decision making.

Table 2. The Indicators of Decision Making

The steps	Indicators	Code
define the decision	Students explain the reasons for making decisions that must be solve in the problems that have been presented	A1
understand the context	Students find several important elements in a problem, namely the informations of what is known and what is asked	B1
	Students use their knowledge that has been previously learned to help link the relationship between the solution to be sought and the problem that has been presented	B2
	Students convert sentences in problems into mathematical sentences	B3
identify the options	Students identify alternative choices contained in the problem and are presented in the form of choices	C1
evaluate the consequences	Students determine the relationship between strengths and weaknesses of alternative choices that have been made before	D1
prioritise the options	Students choose one option with the	E1

The steps	Indicators	Code
	provisions having fewer deficiencies than the other	
review the decision	Students re-examine selected options to get more effective solutions	F1
take action	Students determine their decisions by applying their choices.	G1

This is the examples of problem solving test instruments that given to the subject.

Pertanyaan :

1. Pada suatu hari Santi, Ani, dan Budi mengalami masalah pada keuangannya. Mereka berinisiatif untuk meminjam uang di Koperasi Simpan Pinjam. Santi meminjam uang di Koperasi A sebesar x rupiah dengan bunga majemuk sebesar 5% per bulan. Santi mengembalikan uang pinjamannya ke Koperasi A dalam waktu 4 bulan setelah peminjaman. Sedangkan Ani meminjam uang di Koperasi B sebesar x rupiah dengan bunga tunggal sebesar i% per bulan. Berbeda dengan Santi, Ani mengembalikan uang pinjamannya ke Koperasi B dalam waktu 2 bulan setelah peminjaman. Jika jumlah uang yang dikembalikan oleh Santi di Koperasi A sama dengan jumlah uang yang dikembalikan oleh Ani di Koperasi B, manakah Koperasi yang harus dipilih oleh Budi apabila ia ingin meminjam uang senilai Rp3.500.00,00 dan dikembalikan tepat 3 bulan setelah meminjam? Jelaskan alasanmu memilih Koperasi tersebut!

Figure 1. Test Instrument for Solving Social Arithmetic Problems

RESULT AND DISCUSSION

The research was conducted at SMAN 1 Krian with 11th grade totaling 29 students. After carrying out the mathematics ability test, it was found that the results of the analysis of the mathematical ability test with students with high mathematical ability were 14 people, students with moderate mathematical ability were 9 people, and students with low mathematical ability were 6 people. Then, after obtaining data from the results of the mathematics ability test, one student with high mathematical ability was chosen based on the results of discussions with the mathematics teacher and also the results of the previous math ability test. The students is subjects with the initial RHUA with a score of 85 on a math ability test. The analysis of the results of tests of social arithmetic problem solving and interview guidelines is explained as follows.

a. Define The Decision Stage

At this stage, the activity shown by RHUA explained that the problem contained conditions in which Budi had to choose one of the Cooperatives between Cooperative A and Cooperative B. RHUA also explained that the reason for the decision was so

that Budi knew the smallest interest value among Cooperatives A using compound interest or Cooperative B using a single interest before Budi borrowed money from one of the Cooperatives. Therefore, RHUA did not immediately choose one of the cooperatives because he wanna get a smaller interest value with the calculation. This Data obtained after interview with RHUA.

b. Understand The Context Stage

There are three indicators discussed at this stage. RHUA activities refer to the first indicator shown in the figure below

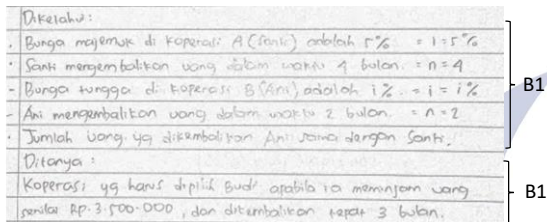


Figure 2. Information Section Known on RHUA Subjects

At this stage, RHUA writes the information that is known and asked first before solving the problem. In code B1, RHUA writes information that is known using a sentence as usual followed by converting to a mathematical sentence. However, there is information that is forgotten by RHUA that is writing down the capital that Budi wants to borrow and the length of time to borrow it. RHUA write it on the information requested. The information presented by RHUA in the part that is known is compound interest in Cooperative A of 5% changed to the mathematical sentence is $i = 5\%$, money returned by Santi within 4 months after the loan or $n = 4$, then a single interest given by Cooperative B is the same with $i = 1\%$, the length of time Ani borrowed money from Cooperative B for 2 months or $n = 2$, and wrote the money returned by Ani the same as Santi's money. Whereas in the information asked, RHUA wrote it in ordinary sentence without converting to a mathematical sentence. RHUA wrote the information that was asked was which Cooperative should Budi choose if he borrowed Rp3,500,000 and returned it in exactly 3 months.

Explanations on the RHUA answer sheet are also supported based on interviews with the subject. RHUA explained that the information was already in the problem and RHUA only wrote it down. Through the presentation of RHUA above, it can be concluded

that RHUA is able to find several important elements in the problem, namely information that is known and asked for the questions that have been given.

RHUA's activity in the next indicator is to use his knowledge that has been previously learned to help connect the relationship between the solution to be sought with the problem that has been presented.

On the answer sheet, RHUA uses the formula of single interest and compound interest to solve a given problem. RHUA looks for final capital using the compound interest formula in Cooperative A, while looking for the value of final capital in Cooperative B, RHUA uses the single interest formula. The single interest formula used by RHUA is $Mn = Mo (1 + i \cdot n)$ and the compound interest formula is $Mn = Mo (1 + i)^n$. The reason RHUA uses these two formulas is because there is already a statement in the problem. Based on the description above, it can be concluded that RHUA uses knowledge that has been previously studied, namely the formula of single interest and compound interest to find the solutions to be sought for the problems that have been presented.

While the activity on the last indicator is using symbols related to the use of formulas for single interest and compound interest. RHUA changes the initial capital to Mo , the length of the loan period in the Cooperative with n , and i which states the interest rate used, and uses Mn as the final result stating the solution to the problem presented. Based on the results of the interview, RHUA explained that to change sentences in a problem must to use mathematical sentences or related symbols to find more effective solutions.

Based on that statement, it can be concluded that RHUA is able to convert sentences in problems into mathematical sentences related to the use of a single interest formula and compound interest to find solutions to those problems.

c. Identify The Options Stage

Based on the answers of the questions given, RHUA identifies the options on the question by dividing it into two choices, namely (a) If Budi borrows money in Cooperative A and (b) If Budi borrows money in Cooperative B. Based on the results of the interview, RHUA also emphasizes if each choice also has an influence on the solutions of the problems. Therefore, there are several choices that must be identified first before choosing one.

It can be conclude that RHUA is able to identify choices on the problem namely Budi must choose in Cooperative A or Cooperative B.

d. Evaluate The Consequences Stage

The activity carried out by RHUA at this stage is to identify the choices that have been made previously. The first thing done by RHUA is to find the value of Mn in cooperative A, because the information provided in the problem has been used to find the value of Mn . this is the answer sheet from RHUA.

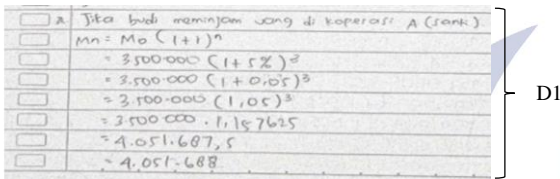


Figure 3. Calculation of RHUA Subjects in Cooperatives A

RHUA uses the compound interest formula which is $Mn = Mo(1+i)^n$ to find a solution. RHUA replaced Mo with Rp. 3,500,000, i with 5%, then changed to 0.05, and n replaced with 3 years. After changing the value of each of the known information and he gets the final result is $Mn = Rp4,051,688$.

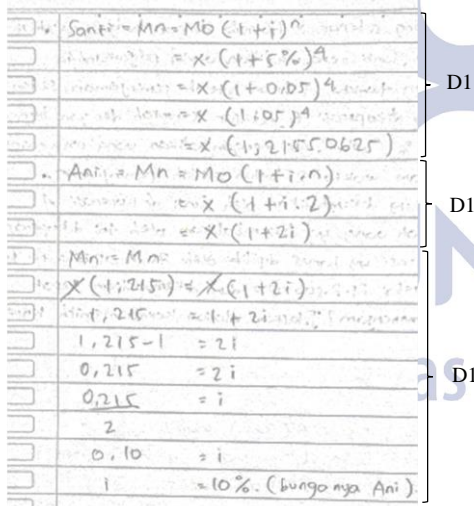


Figure 4. Calculation of RHUA on Value i

Before looking for money that must be returned if borrowing in Cooperative B, the first step RHUA looks for the value of i . On the answer sheet, RHUA writes Mn in cooperative A is the same as Mn . In the calculation of the money returned by Santi, RHUA substitutes Mo with x , i with 5%, and n stated by 4.

After the calculation is obtained the amount of money that must be returned by Santi in Cooperative A is 1.21550625x. While in Ani's calculation in Cooperative B, RHUA substitutes Mo with x , i is written permanently, and n is substituted with 2. After the calculation, the final result obtained by RHUA is the interest rate given by Cooperative B by 10%. Following are the results of the RHUA calculation in Cooperative B after the i is obtained.

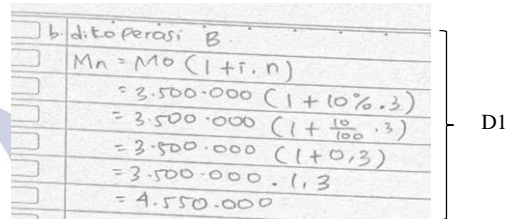


Figure 5. The Calculations of Cooperatives B

The first step taken by RHUA is to substitute Mo with Rp3,500,000, i with 10%, and n with 3. Then, RHUA does the calculation and the final result of the amount of money that must be returned by Budi to Cooperative B is Rp4,550,000.

Based on the calculation results of the two choices that have been identified previously, interviews were conducted to obtain the results of RHUA identification on the advantages and disadvantages of the choices. Based on the results of the interview, RHUA said that the advantages if borrowing at Cooperative A would be cheaper for the money to be returned than borrowing money at Cooperative B. The advantages and disadvantages of the two Cooperatives also greatly affect the final choice which will have to be prioritized.

Based on the explanation through interviews and answer sheets, RHUA was able to determine the strengths and weaknesses of each Cooperative before prioritizing one of them.

e. Prioritise The Options Stage

RHUA's activities are related to prioritizing the option stages as follows.

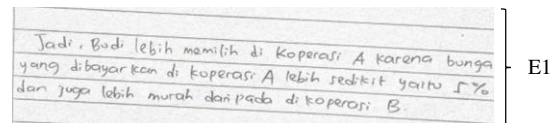


Figure 6. The RHUA's Conclusions on the Answer Sheet

Based on the results of the analysis and interview, RHUA chose Cooperative A as a result of

completing the questions that were given. because if Budi chooses Cooperative A then the interest is less than Cooperative B which is 5%. Another reason is that the amount of money to be paid to Cooperative A is cheaper than Cooperative B.

Based on the description above, RHUA can conclude by choosing one option with the provision of having fewer deficiencies than the other namely Cooperative A.

f. Review The Decision Stage

On the answer sheet, RHUA explains that before gathering the results of the answers, he checks the results of his work so that there are no errors. The final result of RHUA is the first choice that has been reviewed without revision.

Based on these descriptions, RHUA conducts activities to check the answers before being collected to researchers.

g. Take Action Stage

Based on the results of interviews with the subject, RHUA explained that he would do the same thing when in conditions as before. it does not mean RHUA directly uses a single interest or compound interest, but he analyzes what mathematical formulas are related and can be used to find solutions.

So, it can be concluded that RHUA can determine its decision by implementing its choices.

Discussion

Based on the results of the analysis on the answer sheets and also interviews about the decision making process carried out by RHUA in solving social arithmetic problems, discussions can be conducted from the data presented. Discussions conducted were also reviewed based on the activities carried out by RHUA and related to seven indicators in decision making according to Rusell-Jones (2000). The activities carried out are also related to decision making theory according to Wang & Ruhe (2007) to complement some activities that have not been discussed. The results of data analysis that have been obtained previously are in line with some of the activities that have emerged and are found in research results from Murtafiah et al., (2019) and Abdillah et al., (2016). Subjects with the initial RHUA carry out all activities contained in the stages of the decision making process. These stages are determining decisions, understanding the context, identifying options, evaluating the consequences, prioritizing the options, reviewing decisions, and taking action.

CLOSURE

Conclusions

Based on the results of the analysis and discussion, it can be concluded that the decision making process of students with high mathematical ability in solving social arithmetic problems do all the activities at the stage of decision making process namely (1) Students are able to explain the reasons for making decisions (2) Students are able to understand the context in decision making (3) Students also identify the choices contained in the problem (4) Students are able to determine the advantages and disadvantages of alternative choices that have been made (5) Students choose one option with the provisions having fewer deficiencies than others (6) Students also re-check their choices (7) Students are also able to determine their decisions by implementing their choices.

Suggestions

Based on the results of previous studies, the researchers gave the following advice:

1. In the results and previous discussions, it can be observed that there is still in-depth analysis and extracting information about the subject. this is due to lack of facilities and also lack of time support. It is hoped that in future studies this can be completed soon.
2. There are still less relevant sources of information about mathematics education to get more optimal results.

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