



## Students' Thinking in Solving Integer Problems Based on APOS Theory in View of Gender

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### ABSTRACT

This research aims to describe the thinking of male and female students in solving whole number problems based on APOS theory. This descriptive qualitative research was conducted with two subjects, namely one subject with male gender and one subject with female gender. Both subjects are students with high mathematics ability. Subject selection was carried out using purposive sampling. Subjects were selected based on the scores obtained on the math problem test sheet. This research was conducted at one of the State Junior High Schools in Malang Regency. The instruments used in this study were math problem test sheets on integers and interviews. The results showed that: 1) Male students are able to fulfill all thinking indicators in each APOS mental structure in solving problems. Male students solve math problems through mental structures of action, process, object, and scheme; 2) Female students are able to fulfill all thinking indicators on each APOS mental structure in solving problems. Female students solve math problems through action, process, object and scheme mental structures.

Keywords: gender; integer; thinking

### INTRODUCTION

Mathematics is very popular in society, especially the world of education. Mathematics is a strong basis in the world of science, because mathematics is involved in many other branches of science (Kristiono, et al). This means that every subject must involve mathematics (Kurniati & Zayyadi, 2018; Murtafiah et al., 2022). In learning mathematics itself, NCTM (National Council of Teachers of Mathematics) includes cognitive aspects, skills and the use of mathematics in everyday life as part of the learning objectives of mathematics. (Edy et al, 2024). Math learning is usually related to doing problems. However, often teachers only teach students to perform mechanical manipulations when solving problems without paying attention to whether students understand what processes are carried out when solving them (Darwis et al., 2020). One of the math materials that is very important to learn is integers. Integer material is a subject that must be mastered by junior high school students, especially grade VII.

Based on previous observations, it was found that out of 30 students who were prospective research subjects, 27 students (83.87%) did not meet the Minimum Completion Criteria (KKM) with a KKM score of 70 on whole number material. Overcoming learning difficulties about logarithms can be done effectively if you know the source of the cause. Knowing the causes of student learning difficulties can be done by identifying what is happening in the minds of students. Problems in mathematics problems are said to be challenges that must be solved so that students can directly solve them. Knowing how the steps or procedures taken to solve the problem (Hidayah, 2023). Problem solving ability is

related to the thinking process (Hidayat, et al., 2019). Thinking is also used by someone to make a decision, solve problems, produce something new, and control one's subconscious (Rusyna, 2014). The sequence of a person's thinking ability is carried out by a thoughtful, planned, and systematic process in the context of space, time, and the media used which results in changes to the objects that affect it (Kuswana, 2014). The thinking process begins with receiving, processing, storing information in memory, and reusing it when needed for further processing (Sukmaningthias & Hadi, 2016).

Thinking is one of the aspects that need to be instilled in learning mathematics. As stated in the Merdeka Curriculum in Indonesia, one of the achievements and objectives of learning mathematics is to train how to think and reason (Kemendikbud, 2022). The thinking process is a sequence of mental events that occur naturally. The student's thinking process in interpreting the information he receives can be seen through observing the student's behavior while learning mathematics. Lailiyah (2015) explains that thinking is a cognitive process that involves some manipulation of knowledge so as to produce action in solving something. Therefore, it is necessary to have a theory that can be used as an analytical tool to describe students' thinking processes in solving math problems. One of the theories that can be used is APOS theory.

APOS theory is a constructivist theory developed by Dubinsky. APOS theory is a learning theory that describes how a student's mental activities are in the form of actions, processes, objects, and schemes when constructing mathematical problems. This theory has several stages including action (action), process (process). Object, and schema. The advantage of APOS theory is that through this theory a person can construct or reconstruct mathematical ideas through actions, processes and mathematical objects, which are then organized in a scheme to be used in solving a problem at hand. According to (Rizal, 2011) one of the tasks of mathematics educators is to clarify the thinking process of students in learning mathematics with the aim of improving mathematics learning in schools. To improve students' ability to learn mathematics, it is important to know students' thinking and reasoning processes (Sanit et al., 2019). By knowing students' thinking and reasoning processes, teachers can find out where students' mistakes and difficulties are so that teachers can correct these mistakes.

One of the many elements that can affect students' aptitude in mathematics, especially mathematics subjects is gender (Aminah & Kurniawati, 2018). Male students and female students learn math in different ways due to variations in physiology and psychology which are undoubtedly influenced by gender (Maspupah & Purnama, 2020). It should be realized together that gender differences can affect students' understanding of concepts, based on research by Imamuddin et al, (2019) showing that gender differences can affect students' ability to solve mathematical problems. Based on the description above, the author is interested in conducting a study of students' thinking about integers based on APOS theory. The topic of integers discussed is how students can solve integer problems in the form of story problems. This study aims to see how male and female students think in solving integer problems based on APOS theory.

## **RESEARCH METHODS**

This research is a qualitative descriptive research. Descriptive research is research that is intended to collect information about existing symptoms, namely the state of what is happening at the time the research is conducted. The purpose of descriptive research is to describe a phenomenon that occurs at the time of research. The approach used in this research is a qualitative approach. This research was conducted at SMPN 4 Kepanjen with the research subjects of grade VII students. The researcher chose the seventh grade students based on the integer material studied in the seventh grade. Furthermore, students were given an integer problem solving test sheet. Then the researcher grouped the test results based on the student's answer score. The researcher made the group that answered the test correctly with a score of 85-100 as the subject. From the group that answered the test correctly, the researcher re-categorized the subjects based on gender, namely male students and female students. Then the researcher took two subjects from each category who were then analyzed for their thinking process based on APOS theory.

The research instruments used are: (1) written tests, in the form of math problem sheets; (2) semi-structured interview guidelines. Sugiyono (2016) explained that the semi-structured interview technique aims to find problems more openly, where students who are interviewed are asked to convey their opinions and ideas. This study used semi-structured interview techniques to develop questions and explore deeper information in addition to the information obtained from the main questions. The math problem test sheet and interview guidelines were developed by the researcher. The data collection technique used in this research is by collecting field data, namely test answers that have been completed by the subject and the results of semi-structured interviews. Data analysis is the process of searching and compiling data obtained from interviews, field notes, and documentation by describing, compiling, and selecting what is important and what will be studied and making conclusions so that it is easily understood by oneself and others (Rijali, 2019).

The data analysis used refers to data analysis according to Huberman, et al (2014), namely data reduction, data presentation, and conclusion drawing. The data reduction stages in this study are: (a) Collecting, summarizing, correcting and grouping data from the test results of solving integer problems done by students, documentation, and conducting interviews. (b) The results of student work in the form of raw data were transformed into notes as material for interviews. (c) The results of interviews with students were simplified into a good language structure and then transformed into notes. (3) After data reduction, the next step is to present the data in the form of compiled student work. The form of data presentation in this study is: presentation of student work as interview subjects, and presentation of interview results with respondents. The results of the data presentation were analyzed and then concluded in the form of data findings to answer the research formulation in this study. (4) Drawing conclusions is done by comparing the results of student work with the results of interviews so that it can be concluded how students think in solving the integer test.

## RESULTS AND DISCUSSION

Students' test results were corrected and analyzed after students took the written test. After analyzing the students' answer sheets, interviews were conducted with the two high-ability students, namely 1 male student and 1 female student. The following are the results of the answers of the two students.

### Male Student Data Exposure (LK)

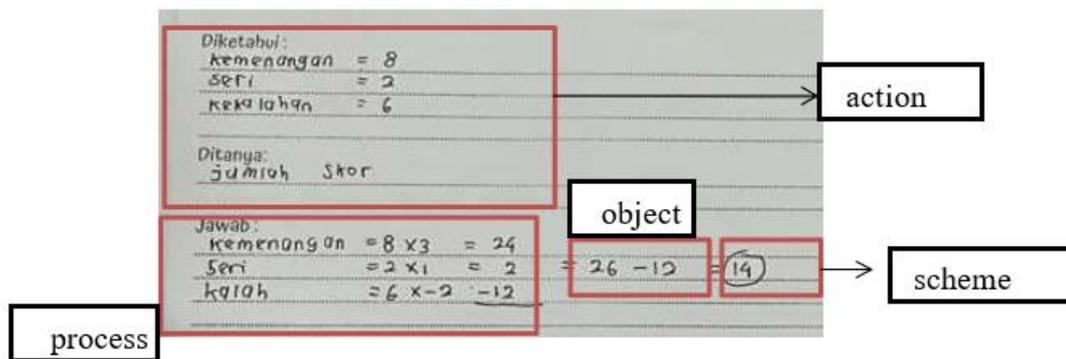


Figure 1. LK Answer Sheet

The following is a discussion of the level of understanding of student concepts in solving integer problem solving based on the stages of APOS theory. At the action stage, LK starts by reading the problem followed by determining what is known and asked. LK was able to identify the information in the problem. LK wrote what was known and asked on the answer sheet, namely "victory = 8, draw = 2, defeat = 6, and what was asked was the total score". This is in accordance with Ajai & Imoko (2015) and Miller & Halpern (2014) who stated that men's mathematical performance tends to be good when faced with mathematical problems.

After performing the action, LK connects some information that has previously been sorted out. Furthermore, at the process stage, LK separates and compares the scores of wins, draws and losses according to the match scoring rules. Then LK grouped the parts found in the form of the number of wins, ties and losses obtained by the team. At the process stage, LK wrote down the procedure or operation in the form of multiplication used to solve the futsal tournament problem. On the answer sheet, LK wrote "win=8×3=24, draw= 2×1=2, lose = 6×(-2)= (-12)".

At the object stage, LK found the number of team winning scores, the number of team tie scores, and the number of team losing scores. Then LK can conclude the total score obtained by the team by adding up the scores of victory, draw, and defeat. The mental structure of the scheme found by LK in solving mathematical problems is characterized by students being able to find the correct answer. During the interview session, the researcher asked LK's confidence in his answer. students expressed confidence in their answers, but were reluctant to look back at the results they had done. This is in line with Indrawati & Tasni (2016) and Reilly et al (2015) who explained that men tend to be quick in making decisions and attitudes. Based on the scheme presented, the answer obtained by LK is correct, but the conclusion obtained is incomplete. In the Schema Stage, overall LK has gone

through the APOS structure and mechanism as a whole. This is indicated by the correct answer found by LK. The tendency of men who make decisions quickly, makes them fast and confident in the truth of the answer, without considering the possibility of other alternative solutions. In Figure 2 below is the flow of thinking of male students in solving the futsal tournament problem.

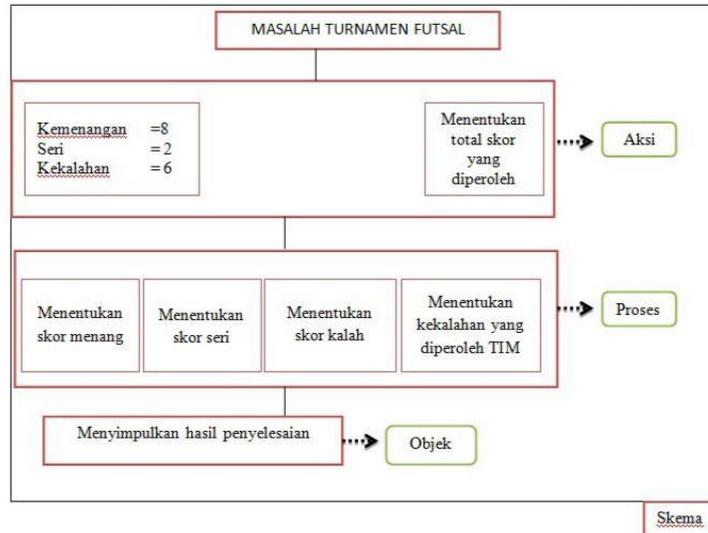


Figure 2. Male Students' Thinking Flow

### Female Student Data Exposure (PR)

**Jawaban:**

**Diketahui:**  
 Turnamen futsal di ikuti oleh = 17 Tim ,  
 Aturan permainan = Menang diberi skor = 3  
 Kalah = -2  
 seri = 1

**Ditanya:**  
 Tentukan skor yg di peroleh Tim Dani

**Jawab:**  
 Menang =  $8 \times 3 = 24$   
 kalah =  $6 \times -2 = -12$   
 seri =  $2 \times 1 = 2$   
 14

jadi skor yg di peroleh Tim Dani adalah 14 skor

Figure 3. PR Answer Sheet

In this section, the results of research findings and their relationship with theories in other studies on female students are presented. In the action stage, female students are able to understand the problem, identify information in the problem, write down what is known and asked, this is in accordance with Ajai & Imoko (2015) and Indrawati & Tasni (2016) who state that women tend to be careful, skillful, and careful when faced with mathematical problems. The following is a discussion of the students' thought process in solving integer problem solving based on the stages of APOS theory. In the action stage, PR starts by reading the problem followed by identifying the known and questionable information and then writing it down. PR identifies the information in the problem. PR wrote

what was known and asked on the answer sheet, namely "victory = 8, draw = 2, defeat = 6, and what was asked was the total score".

After the PR performs the action, the PR connects some information that has previously been sorted out. In the process stage, PR separates and compares the scores of wins, draws and losses according to the match scoring rules. Then PR grouped the parts found in the form of the number of wins, draws and losses obtained by the team. At this stage, PR connects, multiplies, adds, divides, operates, and compares the parts found. In the process stage, PR did more than LK, because PR was able to decipher the information in depth. In the process stage, PR wrote the procedure or operation in the form of multiplication used to solve the futsal tournament problem. On the answer sheet, PR wrote "win =  $8 \times 3 = 24$ , draw =  $2 \times 1 = 2$ , lose =  $6 \times (-2) = (-12)$ ". The stages of the PR process are more than LK, because PR is able to describe information in depth. So that the process carried out to find more alternative answers.

At the object stage, the homeworker finds the number of winning scores obtained by the team, the number of tie scores obtained by the team, and the number of losing scores obtained by the team. In addition, PR then summed up the total score obtained by the team with the scores of wins, ties, and defeats so as to obtain the conclusion

PR is able to solve the problem correctly accompanied by a series of processes, so it can be said that students have been able to form a schema. The mental schema structure found in solving mathematical problems is characterized by PR being able to find the correct answer. During the interview session, the researcher asked PR about her confidence in her answer. PR stated that she was sure of her answer, and stated that she had checked her answer again. This is in line with Indrawati & Tasni (2016) and Reilly et al (2015) who explained that women tend to be careful in making decisions. Based on the schema presented, the answer obtained by PR is correct and complete. In Figure 4 below is the flow of thinking of male students in solving the futsal tournament problem.

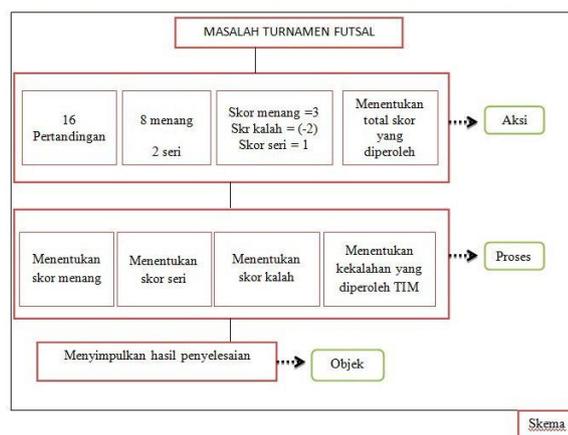


Figure 4. Female Students' Thinking Flow

## CONCLUSION

Based on the results of the research and discussion presented above, it can be concluded that:

1. The thought process of male mathematics students based on APOS theory are: (1) In the action mental structure, students are able to understand the problem, identify important

- and relevant information, classify information, and label information. (2) In the mental process structure, students are able to distinguish each part found, classify work steps, connect certain parts to find new parts, and give conclusions to the parts found. (3) In the mental object structure, students are able to compare the parts they find, interpret the problem solving strategy, and conclude each part found. (4) In the schema mental structure, students are able to find the correct answer, but the conclusion they get is incomplete. students do not review the answers they find.
2. The thought processes of female students based on APOS theory are: (1) In the action mental structure, female students are able to understand the problem, identify important and relevant information, classify information, and label information. (2) In the process mental structure, female students are able to distinguish each part found, classify work steps, connect certain parts to find new parts, design solution strategies, and give conclusions to the parts found. (3) In the object mental structure, students are able to compare the parts they find, interpret the problem solving strategy, and conclude each part found. (4) In the schema mental structure, students are able to find the correct and complete answers and students review the answers they find.

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