The Logical Thinking Ability of Mathematics Education Students of Riau University on Algorithms and Programming Courses

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Abstract - Algorithms are logical and systematic steps to solve the problems. Therefore, in making algorithms it is very necessary the logical thinking ability. This study aims to determine the logical thinking ability of Mathematics Education students of Riau University who will attend the Algorithm and Programming courses in the academic year 2019/2020, amounting to 64 people. The results obtained can be a reference for researchers in applying approaches/models/strategies/methods of learning to the Algorithms and Programming courses. This research is descriptive research. Data collection was carried out through a pretest with a four-item in essay. The questions refers to the characteristics of logical thinking abilities, namely coherent thinking, the ability to argue, and drawing conclusions. The results of the study showed that there were 15.63% of students who were able to think coherently in solving problems, 82.81% of students were able to give reasons precisely, and 87.5% of students were able to draw conclusions correctly. This data indicates that students have been able to give reasons for each step/stage of problem solving and draw conclusions as the end of a process. But students have not been able to write down steps/stages that are structured to solve problems.

Keywords: The logical thinking ability; coherent thinking; ability to argue; conclusion drawing; algorithm.

1. Introduction

The Algorithm and Programming course is one of the compulsory courses for students in the Mathematics Education Department of Riau University. This course aims to make students able to use their logical thinking with patterns systematically in solving problems, which are then implemented into programming languages. The problem is a mathematical problem. If students are trained to use algorithms in solving mathematical problems, students can also apply the 'algorithm' to solve the problems in their life. This is refers to the Higher Education National Standards which require that one of the general skills that must be possessed by graduates of the Bachelor Program is to be able to apply logical, critical, systematic, and innovative thinking in the context of developing or implementing science and technology that takes into account and applies the value of the humanities in accordance with their area of expertise.

Logical thinking is an activity with decision making and solving problems. Both of these activities are often found in everyday life. The solving problem requires the ability to think that has rules or rules that must be followed. The ability to think that follows certain rules is called logic. In logic, learned the rules that must be held so that the thinking process is valid. According to Syafmen and Marbun (2014), logical thinking is a process of using reasoning consistently to draw conclusions. Logical thinking can also be interpreted as a person's ability to draw legitimate conclusions according to the rules of logic and can prove the conclusions are true (valid) in accordance with previous knowledge already known (Siswono, 2009).

The logical thinking ability must be built on the student so that it becomes a character or personality that is imprinted in their life to solve all the problems of their life by identifying any information they receives then being able to evaluate and then conclude systematically and then be able to express opinions in an organized manner (Wijaya et al ., 1996). The logical thinking ability is the ability to think according to certain patterns or rules of logical inference or principles of logic to obtain conclusions (Suryasumantri, Minderovic, Sponias in Septiati, 2016).

The logical thinking ability is needed by the individual when they are active in making decisions, drawing conclusions, and solving problems. The activities can be related to mathematical problems and problems found in daily life. Other activities by individuals in logical thinking are when explaining why and how an outcome is obtained, how to draw conclusions from the premises available, and draw conclusions based on certain rules of inference. A broader form of activity for the the logical thinking ability is to solve problems in a reasonable way. Problems or situations that involve logical thinking require structure, relationships between facts, arguments and a series of understanble reasoning.

The logical thinking ability has been identified as a very essential ability to support the development of learning science and mathematics (Adey and Shayer, 1994). In mathematics, someone who has mathematical logical intelligence has the characteristics of being able to think according to the rules of logic, based on structure, in the appropriate order, classifying, categorizing and being able to analyze numbers and have the sharpness in speculating using their logical abilities.

Considering the importance of logical thinking ability, the researcher is interested in knowing the logical thinking ability of Mathematics Education students of Riau University who will attend the Algorithms and Programming lectures in Academic Year 2019/2020. Based on the experiences of researchers while studying this course, students still have difficulty in presenting algorithms. To present the algorithm, students must be understand the problem, then plan to solve the problem, and then execute the plan. In problem solving planning, logical thinking abilitiy is needed so that the plan will be easy to execute.

The logical thinking ability reviewed in this study refers to Andriawan and Budiarto (2014) which states that there are three characteristics of the logical thinking ability, namely:

1) Coherent thinking, that is the ability to express all the steps used in problem solving.
2) The ability to argue, namely the ability to give reasons in accordance with the facts or information available related to the steps of solving the problem.
3) Drawing conclusions, namely the ability to give conclusions precisely from a problem.

2. Methodology

This research was conducted in the Mathematics Education Department, Riau University. The method used is descriptive method to describe the students' logical thinking ability in terms of coherent thinking, the ability to argue, and drawing conclusions. The subjects in this study were all students who took the Algorithm and Programming course in the odd semester of the academic year 2019/2020, amounting to 64 people. The data in this study are written data obtained from the solutions of problems related to the algorithm. Data collection is done by using a test technique, in this case is a pretest. The research instrument consisted of four items in the essay. Each items refers to the three characteristics logical thinking ability, that is two items to measure the coherent thinking, one item to measure the ability to argue, and one item to measure drawing conclusions. The data analysis technique was carried out by scoring students' answers in accordance with the rubric of logical

thinking ability. Students are categorized into high logical thinking groups when the score is in the range of 27% highest score, and categorized into low thinking groups if the score is in the range of 27% lowest score.

3. Result and Discussion

In this study, the logical thinking ability is shown by the students' answers to the problem related to algorithm. Figure 1 shows the number of Mathematics Education Students of Riau University who received a maximum score (max score = 2) for each characteristic of logical thinking ability.
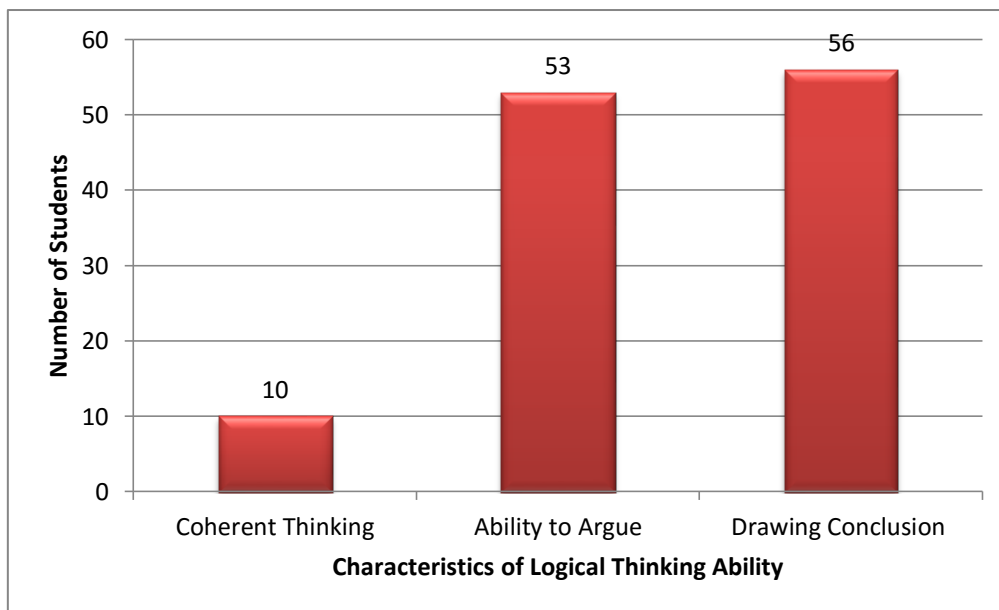

Figure 1. The Logical Thinking Ability of Mathematics Education Students of Riau University

From Figure 1 it can be seen that of the three characteristics of logical thinking ability, students dominate the ability to argue (82.81%) and draw conclusions (87.5%). While, coherent thinking which only reaches 15.63%. The following will present the results of identifying students' logical thinking abilities for each characteristic.

3.1. Coherent Thinking

To measure coherent thinking, the researcher gave two items asking students to write the way/steps to exchange a glass of milk with a glass of coffee, and write the ways/steps to determine equilateral triangle, isosceles triangle, or arbitrary triangle. The first problem is general that might happen in student life while the second problem is mathematical problem.

In the first problem, there were 13 students who did not get a score because the steps did not describe problem solving, as presented in Figure 2.
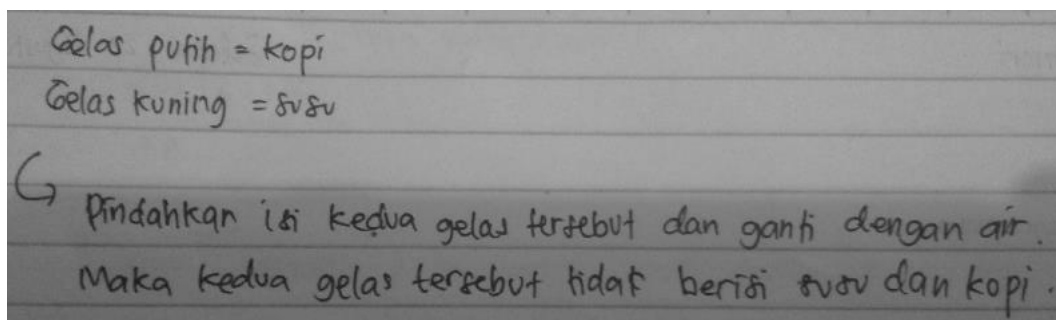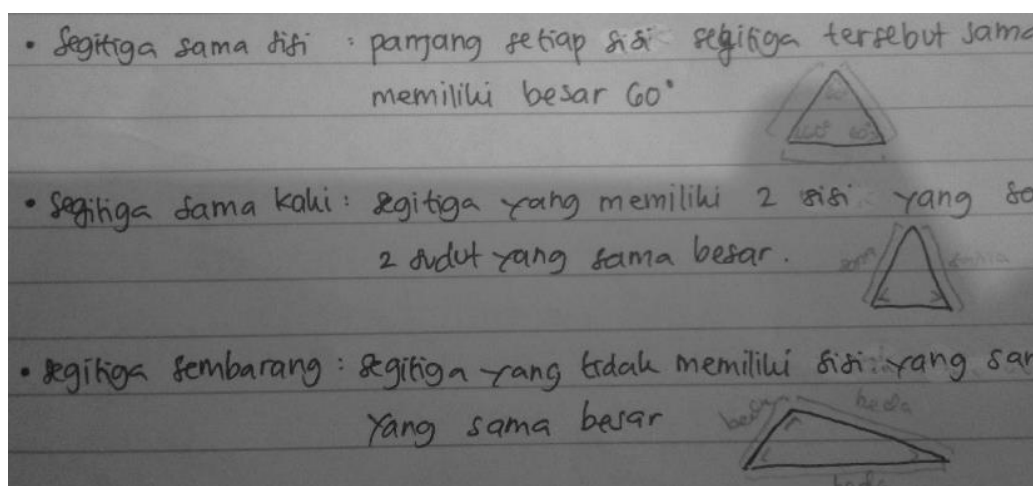
Figure 2. Student Answers on Number 1

From Figure 2, it can be seen that the students' answers do not describe coherent thinking. The completion steps will produce other glass contents that are not desirable, meaning that the problem cannot be solved. While the students who have not gotten a perfect score because they have not written in full the steps to solve the problem. Students gave the right answer to problem solving by using one other glass, but they do not write steps to clean the used glass before moving the new drink. Students do not attent to the problem which emphasizes that the exchange between a glass of coffee and a glass of milk should not produce milk coffee.

Jumlah mahasiswa yang tidak mendapatkan skor meningkat pada soal kedua, yaitu 44 mahasiswa Kesalahan fatal yang dilakukan mahasiswa adalah hanya menuliskan defenisi dan atau gambar segitiga samasisi, samakaki, dan sebarang seperti yang disajikan pada Gambar 3
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The number of students who did not get a score increased in the second question, namely 44 students. The fatal error made by students was writing definitions and/or drawings of equilateral triangle, isosceles triangle, and arbitrary triangle as presented in Figure 3.
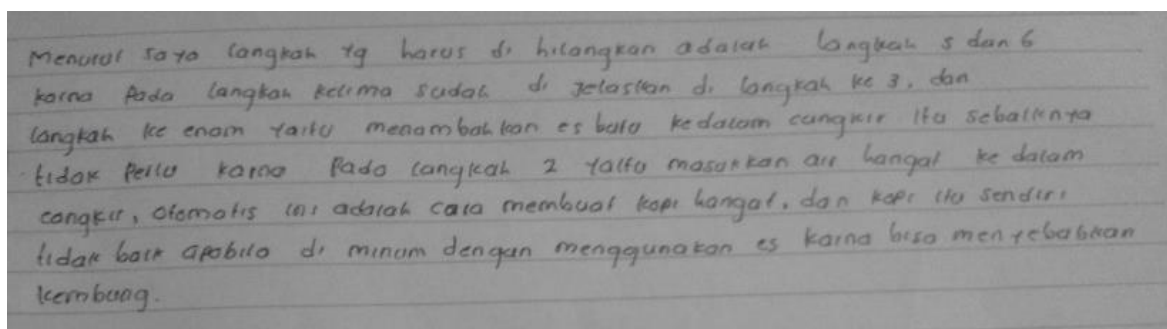

Figure 3. Student Answers on Number 4

Students already know what is meant by equilateral triangle, isosceles triangle, and arbitrary triangle. But students have not been able to solve the problem because students can not answer is a way or steps to determine the type of a triangle based on the length of the sides. If related to the algorithm, the student's way of thinking is reversed (not coherent) because students write the output (types of triangles) at the first, then write the process (same or not), and input (side length).

Coherent thinking is very necessary in the Algorithms and Programming course because the algorithm is an orderly steps (systematic) that can be done (reasonable) to solve the problem. Students must be able to distinguish which input (initial condition/existing information) with output (expected final condition) so that they can determine the steps to achieve the final condition as a solution to the problem. This is in accordance with the opinion of Wahyudi (2009) which states that to solve problems or situations involving logical thinking, structure and relationship between facts are needed. Students should connect facts in the form of information from problems to be able to solve problems in a structured way.

3.2. Ability to Argue

Mathematics Education Students of University Riau have good argumentation skills. It means that students are able to give reasons in accordance with the facts and information available. To measure this ability, researcher give algorithms to make cold coffee, and ask students to give reasons about the unnecessary steps of the algorithm. In this problem there are eight students who did not get a score because the reasons are not scientific and there are subjective trends as can be seen in Figure 4.

Figure 4. Student Answers on Number 3

From Figure 4, it can be seen that students' answers state that there is no need to add ice cubes because in the previous step there was already pouring warm water. The step of pouring warm water on the algorithm aims to make the coffee powder and sugar dissolve, but if the step of adding ice cubes is removed then no cold coffee will be obtained. The student also added his own opinion that coffee cannot be drunk using ice cubes because it can cause bloating. This student's explanation shows the inability to give reasons in accordance with facts and information related to problem solving.

3.3. Conclusion Drawing

To measure these characteristics, the researcher gives two mathematical expressions and asks students to determine whether the calculated operation results of the two expressions are the same or different. The difference between two mathematical expressions is in the use of parentheses. All students are able to give the right conclusions for this problem. The error that still occurs is the lack of accuracy in calculating operations, so that although the final conclusion is true, the researcher does not give a maximum score.

4. Conclusion

The logical thinking ability is the object of this study in terms of three characteristics, namely coherent thinking, ability to argue, and conclusion drawing. Of these three characteristics, the ability to draw conclusions and the ability to argue students is very good (> 80%), while the coherent thinking is still

low (15.63%). This is a homework for researchers as lecturers of Algorithms and Programming courses to improve the logical thinking ability of Mathematics Education students of Riau University.

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