Description of students' mathematical concept understanding ability, in terms of initial mathematical ability

L Agustina, Zaenuri, Wardono

1Postgraduate Mathematics Education, Universitas Negeri Semarang, Indonesia
2Mathematics Department Faculty of Mathematics and Natural Sciences Universitas Negeri Semarang, Indonesia

*Corresponding author: lasiaagustina@students.unnes.ac.id

Abstract. The purpose of this study was to determine the description of students' ability to understand mathematical concepts in the basic introductory course of mathematics in terms of their initial mathematical abilities. This research is a qualitative research. The subjects in this study were students of the Mathematics Education Study Program who took an Introduction to Basic Mathematics at Indraprasta University PGRI Jakarta. The sampling technique used was purposive sampling, while the instruments used were documents (test results of students' initial mathematical abilities and understanding of mathematical concepts), observation sheets, interview guides, and researchers. The research data were collected using triangulation techniques. The results of this study were that the students' initial mathematical abilities were good enough, but the indicators of student functional understanding were still a little difficult.

1. Introduction

In the world of education, mathematics is considered a branch of science that play an important role in human life and becomes the fondation for other sciences. Learning mathematics is a complex undertaking that is cognitively and sometimes emotionally challenging [1]. Mathematics material is dominated by abstract objects [2]. The notion of mathematics is to understand the actual concept of mathematical concepts, namely being able to translate, interpret and conclude mathematical concepts based on the formation of one’s own knowledge, not just memorizing [3]. Mathematical in higher education is more difficult to learn because the material presented is more abstract, such as the Introduction to Basic Mathematics. As one of the important disciplines, Mathematics has a role in developing students' abilities, one of which is thinking skills [4]. This subject is one of the courses at the S1 level of the Mathematics Education Study Program, Indraprasta University, PGRI Jakarta, which is given in odd semesters. The material studied is more theoretical, such as the concept of sets, relations, functions and mathematical logic, so that various mathematical abilities are needed, one of which is that mathematical concepts can be understood properly and correctly.

The aim of teaching mathematics in the educational process based on Permendikbud no. 58 of 2014 is understanding mathematical concepts. Being able to understand mathematical concepts well is the main goal in learning mathematics. Understanding concept is an ability that becomes the basis for students in doing math [5]. Mathematical concepts can be interpreted as the ability to understand a definition, the symbols that exist in a concept, then the relationship between several concepts, and the transformation of concepts from simple to more complex concepts. [6]. For certain, the concept of mathematics can be understood as the initial foundation for the achievement of other learning objectives, because it can understand a concept, mathematics is considered capable of realizing achievement in the ability to reason, communicate and solve math problems. It can be concluded that the understanding of
a mathematical concept plays an important role in the process of achieving other mathematical understanding abilities. The potential shown from the talent inherent in a person (individual) to do something physical or mental activity that he/she is born with, the results of learning and experience. To understand means to understand correctly. The approach currently recommended in the curriculum used in Indonesia is the scientific approach [7]. Comprehension is the depth of cognitive and affective that an individual has or understanding is a process of understanding that the individual receives and can understand the information obtained from learning obtained from attention. [8]. However, the fact is that mathematics ability in Indonesia is low. Because the understanding of mathematical concepts is still low does not only occur in students at the secondary level, but also among students at a higher level of education. This can be seen from the results of the PISA (Program for International Student Assessment) evaluation in 2015. The average score of students' math skills in Indonesia is 386 while the average score in PISA is 490 [9]. OECD / PISA mathematical literacy skills are related to students' competence in analyzing, conveying reasons, and being able to communicate and convey ideas effectively when they propose, formulate, solve, and interpret mathematics in various situations. [10]. As a result, students experience difficulties in studying the Basic Introduction to Mathematics course. The lack of students' ability to understand mathematical concepts is due to several factors including students being treated as objects and teachers as the owner of the highest scientific authority, as well as subject-oriented material in education orientation in Indonesia [11]. This is because the inability of students to complete a process is due to the inability to complete a process related to the absence of mastery of the prerequisite concepts in the material provided. [12]. In studying mathematics, teachers have a very large and important role in determining the appropriate learning method so that the objectives of learning mathematics can be achieved [13].

In order for the ability to understand mathematical concepts to be well defined, students' initial mathematical abilities are very important to pay attention to properly. Initial math skills is a skill that every student must have before starting a lesson [14]. The process of proof is perceived as a major problem faced by every student due to the lack of understanding of mathematical concepts and definitions, due to the inability to ascertain the correctness of mathematics and to express mathematical notation or the ability to communicate mathematics properly and correctly. [15]. To find out more related to the description of the mastery of mathematical concepts that students have in terms of their initial abilities, the researcher was interested in conducting a study entitled "Descriptions of Students' Mathematical Concept Understanding Ability, in terms of Initial Mathematical Ability". In this study, the description of students' mathematical concept understanding abilities was reviewed as a whole and based on the level of Initial Mathematical Ability / IMA (high, medium, and low). Meanwhile, the students' IMA scores were used for categorization into 3 levels (high, medium, and low). Obtained from the IMA test score of the prerequisite material. In addition, this study uses the Mathematical Concept Understanding Ability (MCUA) with indicators: (1) computational understanding and (2) functional understanding.

2. Method
This research was conducted at the Indraprasta University PGRI Jakarta. This research was descriptive-qualitative research. The subjects was students of the Mathematics Education Study Program who took the Basic Introduction to Mathematics 2020/2021 academic year. In this study, from 30 students, 4 were taken as research subjects. To get more in-depth information about the ability to understand mathematical concepts, the researcher continued with triangulation, namely conducting in-depth interviews and documentation. The data collection method used was the triangulation method, while the data analysis technique used the Miled and Huberman Model. Initial Mathematical Ability Test (IMA) and the Mathematical Concept Understanding Ability (MCUA) test. Data analysis activities in this model include data reduction, data display, and conclusion/verification. [16] To test the validity of the data, researchers used a credibility test (through triangulation), transferability test, dependability test, and confirmability test. For the student IMA grouping technique, the researcher used a modified Noer rule. The rules can be seen in Table 1.
Table 1. Criteria for Students IMA Grouping

| IMA Score (X) | Category     |
|---------------|--------------|
| ≥ 70%         | IMA High     |
| 60% ≤ X < 70% | IMA Medium   |
| < 60%         | Low IMA      |

The Rubric's ability to understand mathematical concepts can be seen in Table 2.

Table 2. Rubric for the test of the ability to understand mathematical concepts

| Indicator (1) | Response to Questions (2) | Score (3) |
|---------------|---------------------------|-----------|
|               | There is no answer or the answer is irrelevant | 0         |
| Computational Understanding | Identify data / concepts / principles contained in the information provided | 0-2       |
|               | Carry out calculations on the mathematical process carried out with include the concepts / principles / rules used at each step of the process | 0-6       |
|               | Establish a final solution with a reason | 0-2       |
|               | Sub-total (one test item) | 0-10      |
|               | There is no answer or the answer is irrelevant | 0         |
|               | Identify the data / concepts / principles contained in the information provided | 0-2       |
|               | Linking concepts / principles to one another and state them in a mathematical symbols | 0-3       |
| Functional Understanding | Carry out calculations on the mathematical process carried out by including the concepts / principles / rules used at each step of the process | 0-3       |
|               | Establish a final solution with a reason | 0-2       |
|               | Sub-total (one test item) | 0-10      |

3. Results and Discussion

3.1. Initial Mathematical Ability Data (IMA)
IMA data were analyzed prior to the study which aimed to classify student IMA into 3 levels, namely high, medium, and low. The results are presented in the Table 3.

Table 3. Distribution of Research Subjects

| Level IMA | Total |
|-----------|-------|
| High      | 11    |
| Moderate  | 9     |
| Low       | 10    |
| Total     | 30    |

3.2. Data on the Ability to Understand the Concept of Mathematics (MCUA)
The MCUA data analyzed came from post-test data. The data is given in Table 4. Based on Table 4, it can be seen that the achievement of the MCUA mathematics education students in the Basic Mathematics Introduction Course is still not optimal even though the quality of the achievement is categorized as moderate (with an average of 26.40). This can be seen in the indicator 'understanding functional' which indicates that the quality of achievement is in the low category (average 10.68), although the indicator 'computational understanding' shows high achievement (mean 16.40).
3.3. The ability to understand mathematical concepts in the Overall Basic Mathematics Introduction course

3.3.1. The indicator of 'Computational Understanding with reasons' on the MCUA. To strengthen the results of descriptive analysis, the analysis was continued in document analysis (students' MCUA test answers based on IMA level), observation results, and interviews (triangulation). The MCUA questions that reveal the indicators of 'computational understanding with reasons' in the Basic Introduction to Mathematics are as follows.

The X1C class students consist of 31 students. Then there were 15 students who took part in the mathematics competition, then there were also 13 students who took part in the science competition, and the remaining 7 students did not participate in any competitions. Determine how many students take part in both competitions?

The problem above aims to determine the extent to which the subject of Introduction to Basic Mathematics with indicators of computational understanding can be understood by students. The results of document analysis (student's MCUA test answers based on IMA level), observations, and interviews related to the 'computational understanding' indicator are as follows.

a) For students with IMA high, generally they do not experience difficulties in writing down the concepts necessary to resolve the matter.

b) For students with moderate IMA, they do not experience significant difficulties in writing the concepts used in solving these problems.

c) However, their answers are sometimes incomplete in giving reasons related to the concepts used. This can be seen from their reasons in the answer sheet related to the concepts used in solving these questions which are less relevant.

d) For students with low IMA, some of them still have difficulty in giving reasons related to the concept used in solving the problem even though the concept is correct. This can be seen from their explanation in the answer sheet regarding the reasons for the concepts used in solving these questions which are less relevant.
3.3.2. Indicators of 'Functional Understanding' at MCUA. To deepen the results of the descriptive analysis, the analysis was continued in document analysis (student's MCUA test answers based on IMA level), observation results, and interviews (triangulation). The MCUA questions that reveal the 'functional understanding' indicator in the Basic Mathematics Introduction course are as follows.

Known:

\[ K = \{ x \mid 2 < x < 8, x \in \text{original} \} \]

\[ L = \{ x \mid x = \text{first 5 prime numbers} \} \]

Are there any results from \((K \cap L)\) \cup \(K\)? If so, determine the result!

The problem above aims to what extent the mathematical concepts in analyzing connection, irrigation and complement operations related to set material can be understood by students. The following are the results of interviews related to the 'functional understanding' indicator:

1. For students with high IMA, generally they do not experience significant difficulties in checking the correctness of the completion process and its improvements. However, there were some students who were not detailed enough in correcting the wrong resolution process.

2. For students with moderate IMA, they actually have no difficulty checking the correctness of the completion process and its improvements. However, it is the inaccuracy factor that makes the correction still wrong. In addition, there were some students who forgot to correct mistake in the process of solving these questions.

3. For students with low IMA, some of them still have difficulty checking the correctness of the completion process and its improvements. In addition to the inaccuracy factor that made the correction still wrong, the difficulties experienced were also influenced by the weak mastery of concepts from some students, especially in determining the results of joint operations between several set operations.

With the description above, it can be concluded that mathematical concepts related to the indicator of 'functional understanding' at almost all levels of IMA are still difficult for students to understand in general mathematics education. Students with low IMA tend to experience this difficulty. This finding is similar to the results of a study [15] that students with low IMA still experience errors in determining the result members of a set operation concept.

It was found that the score of students' achievement in understanding mathematical concepts in Basic Introduction to Mathematical Indicators for 'computational understanding' was higher than the indicator for 'functional understanding'. In other words, mathematics education students still experience difficulties in solving mathematics understanding problems in the Basic Introduction to Mathematics course, especially on the indicator of 'functional understanding'. Busyness of work is a factor that affects the level of students' ability to understand mathematical concepts in learning Introduction to Basic Mathematics. Almost all of the mathematics education students in the non-regular class are already working. The determinant of their success in learning Basic Mathematics is their ability to divide their time between work and college. Based on the results of observations and interviews, it was found that mathematics education students tend to be able to divide their time between work and study.

Based on the above as well, it could be concluded that the student of mathematics education experience difficulties when meeting with the question of the form of the functional capabilities of the issues that shape the ability of computational As for the factors that influence it is the educational background, age, busy work, and desire learn Introduction to Basic Mathematics. This finding is similar to the results of previous studies that the educational background, age, busy work, and interest in learning affect the level of understanding of students' concepts [3], [5], [6], [8], [11].

4. Conclusion

Based on the results of the research and discussion that has been stated previously, the following conclusions are obtained (a) Mathematics education students as a whole still experience difficulties in solving problems in understanding mathematical concepts in the Basic Introduction to Mathematics,
especially on the indicator of ‘functional understanding’; (b) Mathematics education students generally still have difficulty solving math comprehension questions related to the ‘functional understanding’ indicator for almost all levels of IMA (Initial Mathematical Ability). However, the difficulty experienced by some students lies in operating the set and reading the set notation symbol. Students with low IMA tend to experience this difficulty; (c) There are several factors influence students to experience difficulties in solving problems in understanding mathematical concepts, including educational background, age, busy work, and interest in learning Introduction to Basic Mathematics; and (d) Based on the above conclusion, it is recommended that lecturers who teach the Basic Mathematics Introduction course: (1) provide learning that further develops students’ abilities in understanding mathematical concepts at each level of IMA, especially the indicators of ‘computational understanding’, and (2) check students’ IMA so that day can provide appropriate learning treatments, and (3) reviewing the implementation of learning in order to develop students’ ability to understand mathematical concepts at each level of IMA for indicators of ‘functional understanding’ so that can be followed up in other research.

References
[1] Skagerlund K, Oustergren R, Vastfjall D, and Traff U 2019 *PLOSONE*, 14 1, 1
[2] Muhamad S, Indra RC, Prahmana, and Muhammad I 2018 *J. Math. Educ.*, 9 1, 41
[3] Widyastuti R, Lestari W, Fadhilah U, Nurfarida R, and Rosidin 2019 *J. Phys.*, 1155 01204
[4] Komala E and Suryadi D 2018 *J. Phys. Conf. Ser. Pap.*, 1132 01204
[5] Sinambela JH, Napitupulu EE, Mulyono, Sinambela L 2018 *Am. J. Educ. Res.*, 6 12, 1673
[6] Isnaniah and Imamuddin M, 2020 *J. Phys. Conf. Ser.*, 1471 01205
[7] Sari NM, Darhim, Kartasasmita BG, and Yaniawati P, 2019 *Int. J. Instr.*, 12 4, 495
[8] Nasution ML and Hafizah N, 2020 *J. Phys. Conf. Ser. Pap.*, 1554 01203 1
[9] Ningsih YL and Paradesa R, 2018 *J. Phys. Conf. Ser. Pap.*, 948 012034, 1
[10] Apriandi D, Murtafiah W, Ayuningtyas AD, Rudyanto HE, 2020 *J. Phys. Conf. Ser. Pap.*, 1613 01201
[11] Sari ME, Fauzi MA, and Ahyaningsih F, 2019 *Am. J. Educ. Res.*, 7 1, 24
[12] Rohmah M and Sutiarso S, 2018 *EURASIA J. Math. Sci. Technol. Educ.*, 14 2, 671
[13] Yeni YR, Syarifuddin H, and Ahmad R, 2019 *IOP Conf. Ser. Earth Environ. Sci. Pap.*, 314 012064
[14] Jamaan EZ, Musnir DN, and Syahrial Z, 2020 *J. Phys. Conf. Ser.*, 1554 01203
[15] Ramdhani MR, Usodo B, and Subanti S, 2017 *J. Phys. Conf. Ser.*, 909 012065, 1
[16] Sugiyono. 2019. Bandung: Alfabeta