The Students' Misconceptions in Using Three-tier Multiple Diagnostic Test on the Angle Relationships

Desfi Ida Muryani [1], Padrul Jana [2, *], Sitti Mutia Umasugi [3]
[1, 2] Universitas PGRI Yogyakarta
[3] Universitas Negeri Yogyakarta

Abstract

Understanding the concept is an ability that students must master in learning mathematics because concepts in mathematics are related to each other. Another finding reported that students had met the criteria for understanding concepts, not understanding concepts, and having misconceptions. The conditions students experience misconceptions need to be considered because if misconception is allowed, it will affect the next concepts. This study aimed to determine the process and results of the analysis of student misconceptions and determined the causes of student misconceptions. The design of this research was descriptive qualitative with the number of subjects as many as 20 students. The Data collection techniques used a diagnostic test, an interview, and documentation. The steps in the data analysis of this research based on Miles and Huberman. The research results showed that there were students' misconceptions in the low and medium level understanding group. Meanwhile, a student in the high conceptual understanding group experienced False Positive criteria where false positives were also part of the misconception. So that student also experienced misconception. Several causes of student's misconceptions in the low-ability students, namely using the concept of angles in a triangle that was not based on the agreement of the experts. Students using their angle concepts that were different from the agreement; wrong in applying the concept of angles, etc. In medium-ability students were inaccurate in operating the algebraic form, wrong in interpreting the picture. The causes of students' misconceptions in the high conceptual understanding group were about inaccuracy in operation.

How to Cite: Muryani, D.I., Jana, P., & Umasugi, S.M. (2022). The students' misconceptions in using three-tier multiple diagnostic test on the angle relationships. *Formatif: Jurnal Ilmiah Pendidikan MIPA, 12* (1): 25-34. http://dx.doi.org/10.30998/formatif.v12i1.9641

INTRODUCTION

Mathematics was a compulsory subject that must be included in the primary and secondary education curriculum (Regulation of the Minister of National Education of the Republic of Indonesia No 22 of 2006). It makes mathematics becomes a compulsory subject in primary and secondary schools. So far, mathematics has become a spotlight for students. Following the 2013 Curriculum, the solitary learning style has turned into a social learning style (Nuh, 2013). It is supported by easy internet access, which is increasingly sophisticated and developing. Therefore, students can gain knowledge from anyone who can be contacted anywhere or from the internet. Subject materials can be accessed easily. Besides, the current curriculum requires students to be active and be allowed to develop their abilities. The freedom to access the internet has made the role of

teachers even more important in this regard. Thus, the information obtained from the internet does not become a crude assumption. Not all internet sources are reliable, considering that anyone can upload anything easily via the internet. The teacher only helps to straighten out facts, concepts, procedures, and incorrect principles, or which have not been included. Recognizing the types of errors that students usually make is also an important thing to pay attention to.

An understanding was defined as knowing and comprehending something in-depth as a thought process needed in daily life (Rahmawati & Kusuma, 2019). The concept also meant everything in the form of new meanings that arose from thinking results (Sarlina, 2015). Therefore, understanding a concept is an ability that a person has in following the agreement of scientists and is constant and does not change in any situation. Conceptual understanding is an interrelated concept. When a problem is solved with the wrong concept, it influences the solving of other problems. The conceptual understanding was a condition when students were asked to comprehend or understand an idea (abstract), ideas, or views that allowed students to defend, differentiate, give examples (Arikunto, 2012). If the misunderstanding of the concept is left unchecked, it impacts students' understanding, resulting in low students' scores. The thing to worry about is when students with full confidence try to construct their concepts that are not following the agreement of the experts. It is known as a misconception. A misconception was also defined as a conception held by students as a misunderstanding that was inconsistent with a scientific concept and expressed with full confidence by students, according to Pesman & Eryilmaz (2010). According to Hammer (2000), a misconception was a cognitive structure that was stable to Changde, so it could affect students' understanding of scientific concepts and must be overcome to learn scientific concepts effectively. Misconceptions cannot be ignored because they will affect the following concepts. Students who experience misconceptions do not realize that they are experiencing misconceptions because they are already embedded in incorrect concepts but have high confidence in their concepts. The causes of misconceptions could come from self-study results both through books and the internet. It also could come from teaching methods and environmental factors when interacting daily or previous learning experiences (Mujib, 2017).

The reality that happened at Junior High School 1 of Kasihan at the observation time when students learned about algebraic arithmetic operations material presented that some students worked with the wrong concept on the same problem when operating algebra. Information obtained from the interview results with the mathematics teacher stated that more than half of the students had difficulty understanding the concept. However, some students could grasp or understand concepts quickly and satisfactorily.

One of the steps to detect misconceptions was a diagnostic test (Wahidah S. et al., 2017). Diagnostic tests are tests that can detect a disease/ problem in some instances. Diagnostic tests in education could be used to detect students' understanding and strengths (Zhao, 2013). This misconception analysis will use a three-tier multiple-choice diagnostic test. According to Mubarak, Susilaningsih, & Cahyono (2016), one of the advantages of the three-tier multiple-choice diagnostic test was that it could be used for further learning planning to minimize misconceptions. By using a three-level multiple-choice diagnostic test, the answers were known, the reasons for selecting students' answers, and the level of student confidence in choosing these answers as expressed by Wiyono, Sugiyanto, & Yulianti (2016).

Teachers can take some actions to overcome early detected misconceptions because the longer is letting misconceptions occur in students, the more difficult to rebuild concepts that are under the rules of the expert. Therefore, researchers researched misconceptions in the seventh grade, hoping that if there was a misconception, there was

still a chance to improve in the next class due to the importance of detecting misconceptions on the seventh-grade students. This study examined the misconceptions in the linear equations in one variable material that were applied to the material on the relationship between the angles that occurred on students of class VII-B of Junior High School 1 of Kasihan using the Three-Tier Multiple Choice Diagnostic Test.

METHODS

This research was a qualitative descriptive study to describe the causes of misconceptions in students with low, medium, and high abilities. The research subjects were the VII grade students of Junior High School 1 of Kasihan, which consisted of 45 students, 25 students for the pilot test of the instruments to check the validity and reliability, while 20 students for the sample of research subjects. This research was conducted online using the WhatsApp application due to the situation and conditions of the Covid-19 (Corona Virus), making it impossible to conduct face-to-face research. To maintain the confidentiality of the data source, the names of this research participants were presented only through the initials of the alphabet.

The data collection techniques were carried out as followed: (1) The ability test to understand the concept in the form of three-tier multiple-choice diagnostic test questions. The test consisted of 10 items. The test scores at the second tier were used to grouping students into three groups, namely, students with low, medium, and high conceptual understanding abilities. The score of each item was used to grouping students into five groups using these criteria (understanding the concept, not understanding the concept, misconception, false negative, and false positive), Understanding the concept is a condition in which students answered using a correct conception, their solution was correct, and also have full confidence about the answer. Not understand the concept is a condition where students have low confidence about the answer whether it is a right or wrong answer. Misconception refers to a condition where students answered with the wrong conception but have full confidence in the answer. False-negative is a condition where students answered with the correct conception but the answer was not correct and have full confidence about their answer, and False positive is included in the Misconception because false positive is a condition where students answer with full confidence in the answer with the wrong conception even though the answer is correct. (2) Documentation in the form of student test results. (3) A semi-structured interview to deepen the findings of misconceptions was conducted based on an interview guide. However, it could openly adjust respondents to be carried out in-depth (Sugiyono, 2015). The interview was conducted with the teacher and students that based on student test results that indicated misconceptions.

The data analysis was done for all informants that consist of 20 students. The data analysis of this study used three stages, including (1) Data reduction, the data obtained was recorded, detailed, and researched to select main points and focus on misconceptions. (2) Data display, which was the presentation of data in a brief description, chart, or image to state research findings. (3) Withdrawing conclusions, in which the conclusions were obtained from the presented data supported by valid evidence. The conclusions presented misconceptions on students with low, medium, and high conceptual understanding and the causes of students experiencing misconceptions in the material on the relationship between angles.

To check the research's validity, the researcher used technical triangulation, namely checking the data from the same source using different techniques. In this study, the results of the test, interview, and documentation were matched.

RESULTS AND DISCUSSION

Test Results

The test was done by using t*hree-tier multiple-choice diagnostic test* questions. The test questions were made based on the indicator of conceptual understanding with a total of 10 questions. These questions were tried out on a total of 25 students. The results of the test questions were then processed using validity and reliability tests. From these results, seven valid questions were obtained, then, these questions would be used for tests on different students, namely as many as 20 students. Based on the test results on 20 students, these could be categorized into three parts according to Ziadatul Malikha (2018) as followed:

Table 1. Categories of Students based on the Results of the Conceptual Understanding Ability Test

Score	Category of the conceptual understanding ability	Total of Students
$80 \leq x \leq 100$	High Ability	6
$60 \leq x < 80$	Medium Ability	10
$0 \leq x < 60$	Low Ability	4

As many as 30% of students had high conceptual understanding abilities, 50% of students had medium conceptual understanding abilities, and 20% of students had low conceptual understanding abilities. With the highest score of 89 and the lowest score of 29, the class average was 69. From the test results, students could be classified into five groups according to Gurel, Eryilmaz, & McDermott (2015), namely understanding the concept, not understanding the concept, false negatives, false positives, and misconceptions. From the results of student tests on seven questions, these could be categorized as in Figure 1.
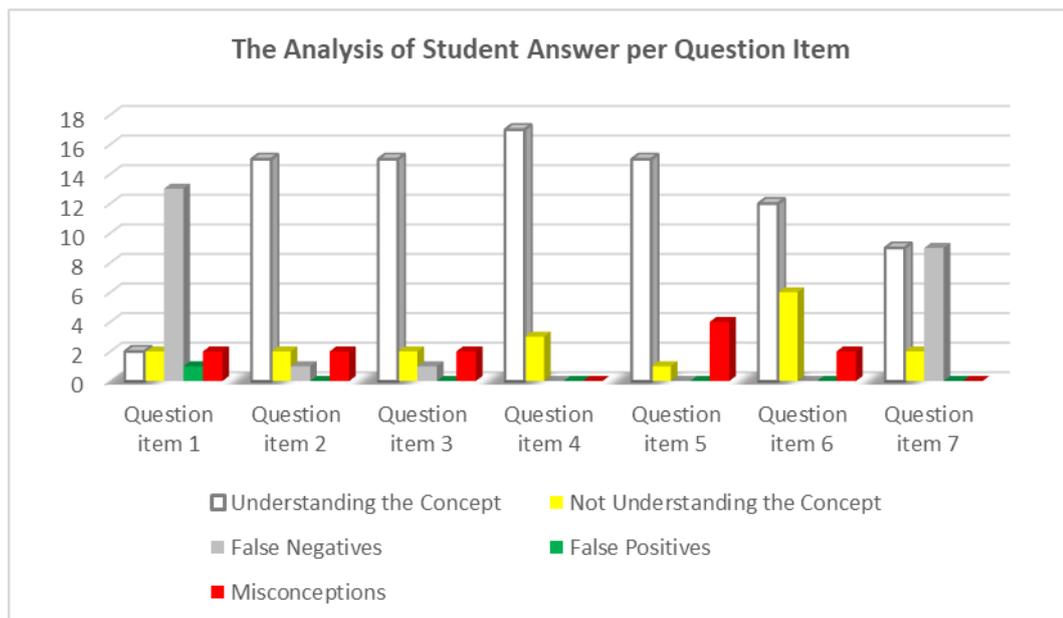

Figure 1. The Analysis of Student Answers per Question Item

From Figure 1, it could be seen that the question items which caused students to experience misconceptions were items number 1, 2, 3, 5, and 6. From the results of the analysis of all items about the students' misconceptions, it was found that students experienced the most misconceptions in item number 5, with a total of 4 students. Seven students had misconceptions in solving these questions (see Figure 2).
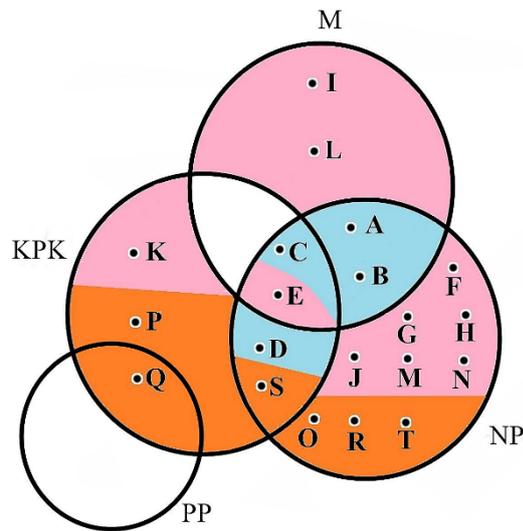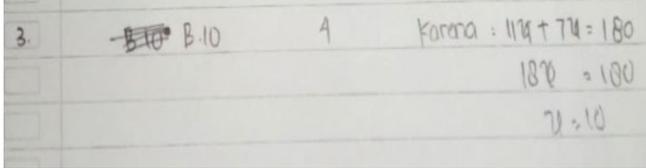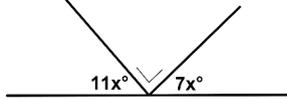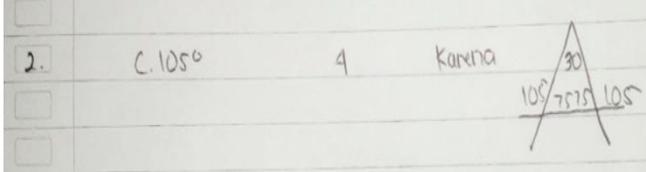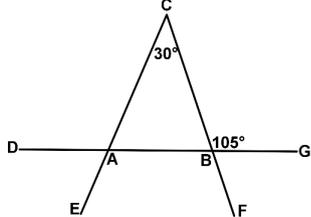

Figure 2. Distribution of 20 Respondents Based on the Student's Test Results in All Items

With the information:

�\[blue\]	= Low Conceptual Understanding Abilities
�\[pink\]	= Medium Conceptual Understanding Abilities
▊\[orange\]	= High Conceptual Understanding Abilities
M	= Misconceptions
NP	= False Negatives
PP	= False Positives
KPK	= Lack of Conceptual Understanding

Based on Figure 2, it could be seen that seven students experienced misconceptions which consisted of three students with low conceptual understanding abilities, namely students A, B, and C, Three students with medium conceptual understanding abilities, namely students E, I, and L. And there was a student who experienced misconceptions in the high conceptual understanding abilities group namely Q, that student having misconceptions in the false positives category. Then we conducted interviews for students who experienced misconceptions and False positive because false positives it is also a part of misconceptions. The technique used was semi-structured interviews based on Sugiyono (2015). The interviews were carried out using interview guidelines, but they could be in-depth, adjusting the respondents so they could be carried out in-depth. The results of the analyses of some of the students' answers after tests and interviews could be shown in the following table:

Table 2. The analysis results of several samples of students that experienced misconceptions

Fragment Answers	The causes of misconceptions
3. ~~B.10~~ B.10 A Karena : 11x + 7x = 180 18x = 180 x = 10	 11x° 7x° In this question, the students did not apply the concept of equations in a straight line correctly. Students only wrote $11x + 7x = 180$, it should be $11x + 7x + 90 = 180$. Meanwhile, the level of confidence in the correctness of the answer was high. Based on the results of the interview, students knew the magnitude of the right angle symbol was 90° but could not apply the concept of angle to a straight line.
2. C. 105° A Karena 30 105 75 75 105	 C 30° D 105° G A B E F In this question, what was being asked was the magnitude of the DAE angle while the students determined the magnitude of the DAC angle. Based on the results of the interview, when asked about the location of an angle, students could indicate its location but could not determine the magnitude of the angle being asked. Students said that the magnitude of $\angle CBG = 105$ and $\angle DAE = 105 - 30 = 75$. However, students could not explain the reasons using this method, and they could not explain the concept of the opposite angles.

Fragment Answers	The causes of misconceptions
	In this question, students wrote an angle of 45 in three adjacent angles. Based on the results of the interview, students could use the concept of angles in a triangle appropriately, but it was wrong to apply the relationship between angles which was the opposite, while the angles did not meet the opposite requirements. When the researcher gave a picture that seemed on a book, they could mention the relationships between the angles. Students only memorized and were fixated on examples, they did not understand the opposite concept, so it was difficult to apply them to the questions.
	 In this question, the students stated that the magnitude of x = y-5. Based on the results of the interview, students only saw the picture and concluded that the angle value was the same. Meanwhile, the steps to work were according to mathematical procedures.

After conducting the interview, it could be seen that the causes of students experiencing misconceptions included the following: (1) The causes of Students' misconceptions in the Low Conceptual Understanding Group were: they used the concept of the angles in a triangle that was not following the rules of the experts, could not apply the straight-line concept, it has constructed the opposite concept incorrectly because it adapted a daily language. The opposite meant being in front precisely, Carelessness in work on problems of the straight-line concept, and They have constructed the opposite concept incorrectly because they were fixated on examples in textbooks. (2) The causes of students' misconceptions in the medium conceptual understanding group included:
using the concept of one-sided angles while the questions did not meet the unilateral terms, not carefully working on algebraic equations, using other concepts that were not

following the expert agreement because respondents were fixated on the picture, making mistakes in operating algebraic forms because they did not understand the concept of subtraction and addition, lacking knowledge about the concept of angles in triangles. (3) The causes of students' misconceptions in the high conceptual understanding group were about algebraic division operation. In this problem the students wrote minus (-) divided by minus (-) was minus (-), the right answer was it should be positive (+). Based on the results of the interview, the student did a mistake because of inaccuracy in answering the questions.

Discussion

Based on the results of the analysis of the answers to the low and medium conceptual understanding group on the results of test and interview, it was found that there were misconceptions in the material of the relationship between angles in which there was the concept of angles in a triangle, the angular relationship between two intersecting lines, the relationship of two parallel lines is intersected by a transversal and algebraic arithmetic operation. Similar to the research results by Herutomo, Edi, & Saputro (2014), there was a misconception in algebraic material with errors in the concept of variables, addition operations, multiplication operations, and errors in forming equations.

Based on the analysis on the group with low understanding ability, it was found that the cause of misconception was using the formula for the concept of angles in a triangle but unable to understand the concept, unable to apply angles to straight lines, and unable to apply the opposite concept to angles, not careful in working on angular equations to a straight line, and it was not appropriate to apply the concept of opposite angles because it was based on the example in the book, used the concept in a different triangle or one that was different from what has been agreed upon and was wrong in applying the concept of opposite angles.

Based on the analysis on the group with the medium understanding ability, it was found that the cause of misconception was using the concept of one-sided angle, not being careful in working on problems on algebraic equations, assuming the same angle was only based on the picture on the problem, having lack of understanding in operating the algebraic form, not understanding the problem, and not knowing the concept of angles in triangles.

The researcher also analyzed students in the high conceptual understanding group. The analysis results found that the student experienced false positives, namely with a high level of confidence criteria, and answered correctly but wrote down the reasons incorrectly. Then, the researcher interviewed this student. The test and interview results reported that the students experienced misconceptions in the algebraic division arithmetic operation. The students' error in counting operations carried out was when (-) was divided (-) should result in positive (+) in the answer of question number 1. After being interviewed, the student realized his mistake that he was not careful in answering the questions. It was similar to the finding of research by Fitrianingrum, Sarwi, & Astuti (2017) that false positives usually became the cause of misconceptions. This shows that the correct answer does not necessarily mean that the student understands a concept and all wrong answers do not necessarily experience misconceptions Pesman & Eryilmaz (2010).

CONCLUSION

From the results analysis results of the test and interview, it was found that from 20 students seven students experienced misconceptions. six students of the low and medium conceptual understanding group, while a student of the high conceptual understanding group is particularly in the false-positive category. It can be seen that causes of misconceptions of low-ability students, namely using the concept of angles in a triangle that was not based on the agreement of the experts. Students using their angle concepts that were different from the agreement; wrong in applying the concept of angles. Students were influenced by daily language to apply the concept that was adjustable to the daily concepts and memorized handbooks; not careful in working on straight line equation problems, students made mistakes in operating algebra. Meanwhile, the causes of students with medium abilities were inaccurate in operating the algebraic form, wrong in interpreting the picture or just looking at the picture, at a glance, and memorizing it like in a handbook. They ignored the concept in the problem and did not understand the concept of addition and subtraction arithmetic operations in algebra, Therefore, students were confused in answering; they did not know the concept of angles in triangles. Some students did not know the concept of angles in triangles, and the causes of students' misconceptions in the high conceptual understanding group were about inaccuracy in operation. Various kinds of misconceptions experienced by students are also due to different reasons. Suggestions for us as educators we can use more effective methods to avoid misconceptions, and also eliminate the present misconceptions. and suggestions for researchers, we can use better assessment techniques, data collection, and instruments to find out more about misconceptions in specific topics of mathematics. for better research can also be carried out in a larger and in-depth scope.

REFERENCES

Arikunto, S. (2012). *Dasar-Dasar Evaluasi Pendidikan* (R. Damayanti (ed.); Edisi 2). Bumi Aksara.

Fitrianingrum, A. M., Sarwi, & Astuti, B. (2017). Penerapan instrumen three-tier test untuk mengidentifikasi siswa SMA pada materi keseimbangan benda tegar. *Jurnal Phenomenon*, *07*(2), 88–98. https://doi.org/ISSN: 2088-7868

Gurel, D. K., Eryilmaz, A., & McDermott, L. C. (2015). A review and comparison of diagnostic instruments to identify students' misconceptions in science. *Eurasia Journal of Mathematics, Science and Technology Education*, *11*(5), 989–1008. https://doi.org/10.12973/eurasia.2015.1369a

Hammer, D. (2000). Student resources for learning introductory physics. *American Journal of Physics*, *68*(S1), S52–S59. https://doi.org/10.1119/1.19520

Herutomo, R. A., Edi, T., & Saputro, M. (2014). Analisis kesalahan dan miskonsepsi siswa kelas VIII pada materi aljabar. *Jurnal Ilmu Pendidikan Dan Pengajaran*, *1*(2).

Mubarak, S., Susilaningsih, E., & Cahyono, E. (2016). Pengembangan tes diagnostik three tier multiple choice untuk mengidentifikasi miskonsepsi peserta didik kelas XI. *Journal of Innovative Science Education*, *5*(2), 101–110.

Mujib, A. (2017). Identifikasi miskonsepsi mahasiswa menggunakan CRI pada mata kuliah Kalkulus II. *Mosharafa*, *6*(2), 181–192. https://doi.org/ISSN:2086-4280

Nuh, M. (2013). *Salinan Lampiran Permendikbud No 69 Tahun 2013*. 1–253.

Permendiknas No 22 Tahun 2006. (2006). Permendiknas no 22 tahun 2006 tentang Standar Isi. *Chest*, *25*(1), 1–14.

Peşman, H., & Eryilmaz, A. (2010). Development of a three-tier test to assess

misconceptions about simple electric circuits. *Journal of Educational Research*, *103*(3), 208–222. https://doi.org/10.1080/00220670903383002

Rahmawati, N. K., & Kusuma, A. P. (2019). Hubungan pemahaman konsep aritmatika sosial dengan hasil belajar IPS Materi PPH. *Buana Matematika : Jurnal Ilmiah Matematika Dan Pendidikan Matematika*, *9*(1:), 1–6. https://doi.org/10.36456/buana_matematika.9.1:.1976.1-6

Sarlina. (2015). Miskonsepsi siswa terhadap pemahaman konsep matematika pada pokok bahasan persamaan kuadrat siswa kelas X5 SMA Negeri 11 Makassar. *MaPan: Jurnal Matematika Dan Pembelajaran*, *3*(2), 194–209.

Sugiyono. (2015). *Metode Penelitian Pendidikan (Pendekatan Kuantitatif, Kualitatif, dan R&D)* (21st ed.). ALFABETA.

Wahidah S., S. N., Kusairi, S., & Zulaikah, S. (2017). Diagnosis miskonsepsi siswa SMA di Kota Malang pada konsep suhu dan kalor menggunakan three tier test. *Jurnal Pendidikan Fisika Dan Teknologi*, *2*(3), 95. https://doi.org/10.29303/jpft.v2i3.295

Wiyono, F. M., Sugiyanto, S., & Yulianti, E. (2016). Identifikasi hasil analisis miskonsepsi gerak menggunakan instrumen diagnostik three tier pada siswa SMP. *Jurnal Penelitian Fisika Dan Aplikasinya (JPFA)*, *6*(2), 61.

Zhao, Z. (2013). An overview of studies on diagnostic testing and its implications for the development of diagnostic speaking test. *International Journal of English Linguistics*, *3*(1), 41–45. https://doi.org/10.5539/ijel.v3n1p41

Ziadatul Malikha, M. F. A. (2018). Analisis miskonsepsi siswa kelas V-B MIN Buduran Sidoarjo pada materi pecahan ditinjau dari kemampuan matematika. *Mathematics Education Journal*, *1*(2), 75–81.