

Analysis of Junior High School Students' Misconceptions Based on Constructivism Theory in Solving Numeracy Literacy Problems

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 <http://dx.doi.org/10.30595/alphamath.v10i2.21791>

ABSTRACT

This study aims to use constructivist principles to find out how misunderstandings arise when solving arithmetic problems among students of grade 7 C of SMPN 2 Ciruas and to identify the factors responsible for them so that this problem can be presented to students and teachers as a reference for more effective learning. The subjects of this study were students of grade 7 C with high, medium and low comprehension skills. This study is qualitative and uses descriptive methods. It uses test instruments in the form of AKM sample questions and interview guides related to constructivist principles. The data analysis techniques used are data reduction, data display and inference. The results of this study explain the misunderstandings that students, especially those with low comprehension, experience when presented with numerical problems in a mathematical format. According to constructivist theory, factors that cause misunderstandings include: 1) lack of additional study time; 2) poor prior knowledge; 3) lack of understanding of the problem; 4) not taking an active role in the classroom; and 5) incorrect interpretation of the problem.

Keywords: Constructivism Theory, Misconceptions, Numeracy

ABSTRAK

Penelitian ini bertujuan untuk mengetahui bagaimana miskonsepsi yang terjadi pada siswa kelas VII C SMPN 2 Ciruas dalam menyelesaikan soal numerasi serta mengetahui faktor penyebabnya melalui prinsip konstruktivisme sehingga permasalahan ini dapat dijadikan acuan bagi guru untuk pembelajaran yang lebih efektif. Subyek penelitian ini merupakan siswa kelas VII C yang berkemampuan pemahaman tingkat tinggi, sedang, dan rendah. Penelitian ini adalah penelitian kualitatif dengan metode deskriptif. Penelitian ini menggunakan instrumen tes berupa contoh soal AKM dan pedoman wawancara yang mengacu terhadap prinsip konstruktivisme. Teknik analisis data yang digunakan yaitu reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian ini mendeskripsikan miskonsepsi yang dialami siswa dalam merepresentasikan soal numerasi ke dalam bentuk matematikanya terutama siswa dengan kemampuan pemahaman tingkat rendah. Sedangkan faktor penyebab terjadinya miskonsepsi yang ditemukan berdasarkan teori konstruktivisme yaitu 1) kurangnya waktu belajar tambahan; 2) pengetahuan awal yang kurang baik; 3) tidak kritis dalam memahami soal; 4) tidak berperan aktif dalam kelas; dan 5) tidak menginterpretasikan soal dengan baik.

Kata kunci: Teori Konstruktivisme, Miskonsepsi, Numerasi

Received : May 7, 2024

Accepted : November 28, 2024

Published : November 29, 2024

Introduction

The National Education Standards Agency is an independent body established under Government Regulation - National Education Standards. According to (Dikti, 2008), there are several objectives of mathematics that contain several abilities, one of which

is understanding mathematical concepts, explaining the relationship between concepts and applying concepts or algorithms flexibly, accurately, efficiently, and appropriately in problem solving.

According to Gagne in (Syafri, 2018), concepts in mathematics are abstract ideas that convince people to classify or group objects or events into examples or non-examples of a particular object. When someone makes a concept error (misconception), this understanding will affect the understanding of other concepts because in mathematics itself there is an interrelationship between concepts.

Abraham's opinion in (Lutfiana, 2021) is able to detect misconceptions that occur by providing a grouping of degrees of understanding of concepts. The grouping is divided into 3 groups, namely understanding concepts, misconceptions, and not understanding concepts. This can be used as a reference in assessing students to see how the condition of understanding possessed by students. Numeracy literacy skills are very necessary in mathematics, because mathematics is not only always related to formulas, but also requires students' reasoning power or critical thinking patterns in answering each problem presented (Salvia, 2022).

Based on preliminary studies conducted by interviewing mathematics teachers at SMPN 2 Ciruas on October 16, 2023 related to student understanding and the results of the interview that in solving numeracy problems students are only able to solve math practice problems if the teacher gives numeracy problems that are the same as examples of numeracy problems that have been explained in front of the class. When given a different type of numeracy problem, students have difficulty representing the sentence into symbols. Also seen from the results of student work from the exams that have been carried out, there are wrong answers to questions in applying concepts.

Lumbantoruan (2020) believes that Misconceptions are students' understanding or interpretation of concepts that already exist in students' minds as a result of the teaching and learning process. Learning should be done in a way that can reduce students' misconceptions in solving numerical problems, one of which is the constructivism approach. Sopiany et al., (2019) argue that the constructivism approach is a learning that can reduce misconceptions in students because it has a learning syntax that can build good understanding and abilities. Students are expected to understand concepts through the way they think by building or constructing all relevant knowledge to find new concepts. Building and constructing activities are activities where students gain experience that will be stored long and easily remembered.

According to Dikti in (Nurtiana, 2023), numeracy literacy plays a role in determining the way and direction of mathematics learning in schools, so that contextual mathematics learning is more meaningful for students. Hanifah (2023) believes that numeracy literacy skills can also help students make the right decisions to solve daily problems and understand information when in society so they can be competitive in increasing employment and economic prosperity. Nurmawanti (2020) believes that the importance of generalization and algebraic thinking skills must receive attention in schools.

Baharuddin et al. (2022) argue that students' mathematical literacy abilities are influenced by many factors. One of them is the difference in abilities of each individual. In the research of (Nurussama et al., 2022) suggested the principles of constructivism learning, among others 1) student learning outcomes are influenced by the learning environment and the prior knowledge that students have; 2) through the knowledge that has been learned, students can form and build relationships between concepts; 3) the process of forming and connecting between concepts will take place actively and continuously; 4) the process of forming concepts begins when students receive the knowledge that students are learning, therefore students are responsible for their learning outcomes; and 5) the resulting learning experience and the results of concept formation affect students' patterns when constructing concepts.

Fauzi et al. (2021) argue that the numeracy abilities of students at school are used as a reflection of the numeracy learning process. Previous research conducted by (Sari et al., 2020) found that students experienced misconceptions in algebraic arithmetic operation material which was categorized based on the form of errors made. Apriyani (2021) argue that Algebra material is key material in school mathematics. The categories in question are generalization misconceptions, notation misconceptions, letter meaning misconceptions, and rule application misconceptions. This is cautioned because students will experience difficulties in the learning process. Based on these problems, a new research was conducted with a differentiator, namely the form of questions used. In this study, numeracy questions were prepared to see how the misconceptions that students experience. In addition, these misconceptions will be reviewed based on constructivism theory to determine the factors that cause misconceptions using the learning principles of constructivism theory.

Research Methods

This research uses a qualitative type of research design with descriptive methods. The purposive sampling is a non-random sampling method where a researcher ensures the citation of illustrations through a method of determining special identities that suit the research objectives so that they are expected to be able to respond to research cases

(Lenaini, 2021). The procedure in this research starts from 1) The preparation stage; 2) Implementation stage; and 3) The final stage. In the preparation stage, first determine the topic of the existing phenomenon. After determining the topic, problem identification and collecting information from various appropriate references were carried out. Before entering the next stage, a preliminary study was conducted by conducting observations at the school, SMPN 2 Ciruas. A theoretical framework was prepared as a research guide. The next step was to compile research instruments consisting of test instruments in the form of sample AKM questions and interviews which were then validated by validators. The next stage is implementation, the test instruments prepared are distributed to the subjects to collect the necessary data. Other information is obtained from interviews conducted with subjects. After that, in the final stage, data analysis was carried out by describing the results of the subjects and providing conclusions on the whole research.

The subjects in this study amounted to 16 students of class VII C who were then selected 8 students consisting of two students with high comprehension ability, two students with medium comprehension ability, and four students with low comprehension ability. The subjects were selected based on the category of comprehension ability scores obtained when solving the numeracy problems given. However, in this article only one subject for each category will be taken. Based on the test results that have been conducted to 16 students of class VII C SMPN 2 Ciruas, the following are the results of the numeracy test (Table 1).

Table 1. Numeracy Ability Test Results

Range of Score	Student Count	Percentage
0 – 59	10	62,5%
60 – 79	3	18,75%
80 – 100	3	18,75%
Total	16	100%

This study used a test instrument prepared based on the example of AKM questions with a total of 5 items. This study used test instruments that were prepared based on examples of AKM questions with a total of 5 items. The instrument was tested on IX B to determine whether the instrument was suitable for use. The following are the results of the trial conducted (Table 2).

Another instrument is an interview guide whose questions are prepared based on the principles of constructivism learning in order to find out the factors that cause misconceptions in students and clarify the results of the test instrument work carried out. Data collection techniques in this study used triangulation, namely observation,

interviews, and documentation. Observations made of students will be checked through interviews and reinforced using documentation. Data analysis techniques in this study began with data reduction, data presentation, and conclusion drawing. After the data was reduced from the test results and student interviews, the data was described and concluded to answer the focus of this research. The data obtained in the form of descriptions in completing the test instrument, namely numeracy questions and misconceptions, will be analyzed based on the criteria for classifying answers referring to Abraham's opinion (Lutfiana, 2021).

Table 2. Trial Result IX B

Questions	r_{count}	r_{table}	Varians	Kriteria
1	0,439902735		0,405797101	Valid
2	0,622682011		0,461956522	Valid
3	0,39041227	0,381	0,42753623	Valid
4	0,635034399		0,331521739	Valid
5	0,816127566		0,476449275	Valid

Result and Discussions

The level of understanding ability, students with high, medium, and low levels of understanding ability were obtained whose answers will be described referring to the criteria for classifying answers and reviewed through the principles of constructivism learning to determine the factors that cause misconceptions.

Subject 1 (Higher Level Comprehension Ability)

The results of working on numeracy problems given by high-ability subjects can be seen in Figure 1. Subject 1 experienced misconceptions in problems number 2 and 5. In other problems, the subject was able to convert the sentence into its mathematical form well so that he could solve it with the right steps.

(2) Dikerjakan = 36 anak" ~~anak~~ anak"
 ditanya = ...? Jumlah paket lengkap → Given: 36 children
 Asked: ...? The
 number of complete
 packages.
 Answer:
 Jawab = $35 + 2.500 + 15 = 52.500$
 $= 52.500 \times 36 = 1890.000$

Figure 1. Subject 1 Answer

According to the criteria for classifying the subject's answers

Based on Figure 1, subject 1 experienced a misconception in question number 2. In question number 2, subject 1 was able to change the sentence into mathematical form

but wrote the wrong nominal so that the results obtained did not match the existing solution steps. The same mistake was also made by subject 1 in question number 5, namely misinterpreting the given question. Subject 1 was wrong because he only determined the difference in fractions, subject 1 did not include the nominal and did not arrive at the final result, namely the amount of salary difference.

According to the learning principle of constructivism

The learning environment around the subject is quite good. Subject 1 conducts learning activities independently at his home with sufficient time duration. Subject 1 also received support from others so that the learning process of subject 1 was helped. For students' prior knowledge, subject 1 stated that he did not know about algebra. Subject 1 has no prior knowledge related to this material. This is one of the obstacles that causes students to experience misconceptions. Subject 1 is one of the active students in the class. The subject diligently took notes and understood the explanation from the teacher. When the subject does not understand, the subject asks without hesitation to the teacher to ask for an explanation again. Based on the interviews conducted, subject 1 gave a statement that he knew the location of the error in working on the numerical problem given. Subject 1 realized that he made a mistake. This shows that the subject is able to construct his knowledge. When subject 1 was asked to explain the results of his work, subject 1 was able to convey what he wrote back. This proves that subject 1 understands the material he learned. In summarizing the material learned, subject 1 looks confused to give what he understands related to algebra. That way, this situation is also an obstacle for subject 1 in learning.

Subject 2 (Moderate Comprehension Ability)

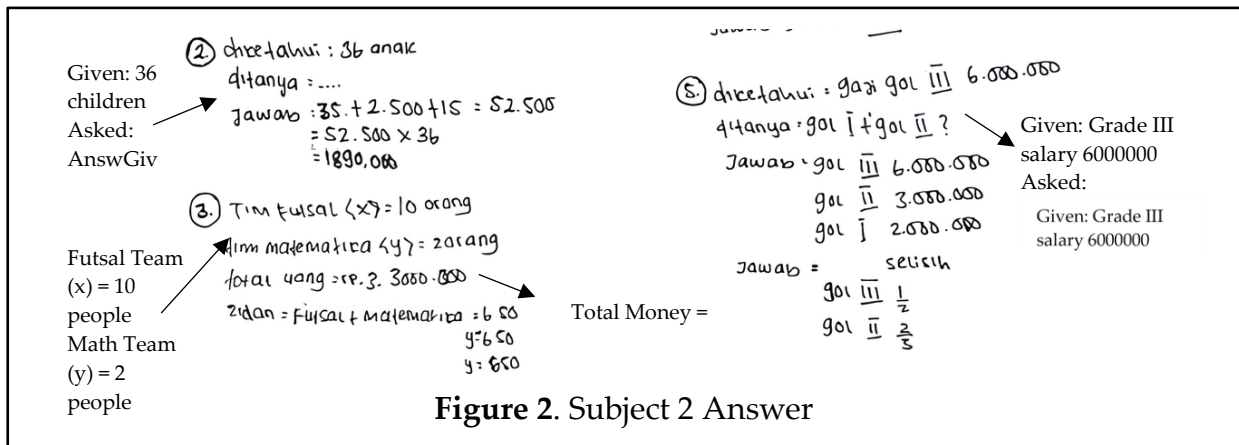
Based on the results of working on subject 2's numeracy problems, it can be concluded that subjects with moderate ability this time experienced misconceptions in questions number 2, 3, and 5. For other questions, subject 2 was able to convert sentences into their mathematical form properly and find the appropriate solution steps.

According to the criteria for classifying the subject's answers

Based on [Figure 2](#), problem number 2 was not done well because there was an error in determining the nominal. In problem number 3, subject 2 did not seem to understand the problem, subject 2 was unable to convert the sentence into mathematical form so he did not find the solution step. And for problem number 5, subject 2 did not continue his work and this was stated as a form of misconception because he was unable to determine the difference correctly.

According to the learning principle of constructivism

In the learning environment, subject 2 has relatively standard learning habits because subject 2 does not always study outside school. Subject 2 studied with a short duration of time with several sources he used. The environment around the subject is quite supportive because subject 2 stated that the friends around him really help him in learning. Based on the results of the interview, subject 2 stated that he knew algebraic material before studying in class. Subject 2 considered algebraic material to be difficult material so that it was not easy to understand. Subject 2 understands that algebra contains counting operations. Subject 2 said that he did not really like math. When the teacher delivered the material, subject 2 understood some of the material but sometimes did not understand it. Subject 2 has a pretty good note-taking habit. Subject 2 also did not hesitate to ask questions either to the teacher or to friends when he did not understand. Based on the information obtained from subject 2, the subject knew that he did not do all the questions correctly. Subject 2 said that he knew of the mistakes made because subject 2 had not completed the problem. When asked for information related to the conclusions obtained by students, subject 2 said that algebra contains positive and negative. More than that, subject 2 did not remember the material well.



Subject 3 (Low Level Comprehension Ability)

Based on the answers obtained from subject 3, it can be seen that subjects with low-level abilities in this study experienced misconceptions. Subject 3 experienced misconceptions in questions number 1, 2, and 4. Whereas in questions number 3 and 5, subject 3 did not understand the concept.

According to the criteria for classifying the subject's answers

Based on the answer classification criteria, for questions number 1, 2, and 4, subject 3 experienced misconceptions. In problem number 1, subject 3 seemed to repeat the sentence from the problem without including the solution steps (Figure 3). Subject 3 seemed unable to convert the sentence into mathematical form properly. Likewise for

problem number 2, subject 3 was unable to represent the problem properly to find the correct answer. Subject 3 only gave conclusions and numbers of unknown origin. In problem number 4, students answered the question correctly but not in accordance with the question at hand. Subject 3 only wrote the price of the book without telling what books could be bought. Therefore, subject 3 is said to have misconceptions. While question number 3 was not able to be understood by students so they wrote answers that could not be defined. In problem number 5, students also experience conceptual misunderstanding both of the problem and basic mathematical concepts. This is reinforced by interviews conducted with subject 3.

The image shows a student's handwritten work for a math problem. On the left, there is a printed English text: "Fia is good at math while Kaylia is good at English. Fia's score is 90 while Kaylia got a score of 79 and 75. The possible books purchased by parents are 32.000.00 & 74.000.00. Group 1 = 2,000,000. Group 2 = 3,000,000. Group 3 = 6,000,000. Asked: Salary of Group 1 + Salary of Group 2". On the right, there is handwritten Indonesian text and calculations. The Indonesian text includes: "Setelah mengerjakan...", "1. Fia dan Kaylia...", "2. biaya yang harus dibayar...", "3. ...", "4. kemungkinan buku yang dibeli adalah 32.000.00 dan 74.000.00". Below this, there is a section titled "Jawaban" with calculations: "Gol 1 = 2.000.000", "Gol 2 = 3.000.000", "Gol 3 = 6.000.000", "Ditanya: Gaji Gol 1 + Gol 2?", and "2.000.000 + 3.000.000 = 5.000.000". Arrows point from the English text to the Indonesian work: one from "Fia's score is 90 while Kaylia got a score of 79 and 75" to the Indonesian text, one from "The fee that parents must pay is 60,000.00" to the Indonesian text, and one from "Asked: Salary of Group 1 + Salary of Group 2" to the "Jawaban" section.

Figure 3. Subject 3 Answer

According to the learning principle of constructivism

Around the student learning environment, subject 3 does not have a habit of studying other than at school. Subject 3 only studies when there is homework with the help of his brother. Subject 3's study selection time is also considered less effective because it is not done every day. Even so, subject 3 still received learning support from other friends. The interview results obtained from subject 3 related to the initial knowledge possessed, namely subject 3 did not know what algebra was before learning in class. Subject 3 also said that he did not understand because it was difficult to count. Subject 3's opinion about algebra is counting with small numbers. Subject 3 had no interest in math. He tends to be passive in class even though he does not understand the material being explained. He let himself fall behind because of his inactivity. Subject 3 was not diligent in recording the material and was silent because he felt shy in class. Based on the interview by asking whether the student knew the location of his mistake, subject 3 answered that he was not sure he did the problem correctly and he only wrote what he could write. After being asked to explain the results of his work, subject 3 was less able to explain his answers again. This was influenced by his learning results which

were not in accordance with the existing answer key so that subject 3 had difficulty in explaining what he had done. Subject 3 stated that algebra is about counting. Subject 3 did not provide further information about his understanding.

Based on the results of the description, the categorization of factors causing misconceptions in solving numeracy problems was obtained. Some of the categories obtained are in accordance with the principles of constructivism learning. The results will be presented in the following [Table 3](#). The results above show that the factors that cause misconceptions based on the principles of constructivism come from two factors, namely internal factors and external factors. The misconception factors are also said by (Arsyad et al., 2021), namely internal and external factors of students causing misunderstandings in learning.

Table 3. Categorization of factors causing misconceptions based on misconception learning principles

Number	Principles of Constructivism	Causes of Misconception
1	Learning environment	No study other than at school, little study time, no adult help to study.
2	Students' prior knowledge	No good prior knowledge, low understanding of algebra.
3	Ability to construct relationships between existing knowledge and what is being learned	Not critical in understanding the problem, not using appropriate concepts, not focusing on understanding the material.
4	Student activeness in concept building	Not interested in math, did not understand when the material was explained, did not record the material presented, did not ask questions when they did not know, did not play an active role in the class.
5	Ability to explain back the results done	Did not do the problem correctly, did not interpret the problem well, forgot what had been learned. Did not understand the lesson.

The internal factors in this study are lack of learning time, not having good prior knowledge, not using concepts properly, and not being able to interpret numerical problems properly. While external factors come from lack of support for learning, non-conducive classroom atmosphere, disinterest in the subject, not taking notes diligently, and not contributing actively in class.

Conclusion

Based on research conducted by researchers at SMPN 2 Ciruas, Serang Regency, the results obtained on how misconceptions occur to students with high, medium, and

low abilities by reviewing using the theory of constructivism from class VII C. Thus, it can be concluded that students of class VII C SMPN 2 Ciruas are said to experience misconceptions based on existing criteria and found the causal factors using the principles of constructivism learning then classified into internal and external factors. High and medium level subjects have several problems that allow misconceptions to occur which are obtained from two high level subjects and two medium level subjects. While four low-level subjects clearly experienced misconceptions obtained from the results of research data analysis. Based on the results of the overall discussion in this study, it produces suggestions for making innovations related to the learning approach used. Conceptual Understanding Procedures (CUPs) which is a constructivist learning model can reduce student misconceptions. In addition to the learning model, a teacher can also anticipate these misconceptions with supporting teaching materials and learning media.

Acknowledgement

The researcher also thanked the Department of Mathematics Education, Universitas Tirta Ageng Tirtayasa for supporting this research.

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