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IMPROVING MATHEMATICAL UNDERSTANDING THROUGH ACTION, PROCESS, OBJECT AND SCHEMA BASED DISCOVERY LEARNING MODEL

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Abstract

Learning that does not encourage students to learn in building knowledge results in weak mathematical understanding skills. The strategy that is expected to foster mathematical understanding skills is through the APOS-based discovery learning model. The purpose of this study was to determine the increase in mathematical understanding skills after receiving learning using the APOS-based discovery learning model, and to determine the interaction between learning and student levels on improving mathematical understanding skills. This study uses a quantitative approach with a pre-test and post-test control group design. The population of this study was grade VIII students of MTsN 1 Aceh Selatan by taking a sample of two classes consisting of an experimental class and a control class. The selection of samples in the study was carried out by random sampling. The instrument used in this study was a mathematical understanding ability test. The data analysis technique in this study used the ANOVA test. Based on the results of the study, it was found that there was a difference in improving students' mathematical understanding skills taught through the application of the APOS-based discovery learning model with conventional learning. Furthermore, the results of this study also identified that there was no interaction between learning and student levels on improving mathematical understanding skills. Therefore, teachers are expected to be able to expand the application of the discovery learning model to other materials without having to look at the background of the students' ability levels because this discovery learning model is suitable for application to all levels of students.

Keywords: ***Mathematical Understanding, discovery learning, APOS***

INTRODUCTION

Mathematical understanding is a basic mathematical competency that includes the ability to absorb material, remember mathematical formulas and concepts and apply them in simple cases or similar cases, estimate the truth of a statement, and apply formulas and theorems in solving mathematical problems (Hendriana, et al., 2017). Students need to have mathematical understanding in learning mathematics, especially in learning geometry. In learning mathematics, students must first understand the concepts and structures of mathematics in order to be able to solve mathematical problems and be able to apply them in learning (Baroody, 2007).

Empirical evidence in the field shows that there are still many students who have difficulty in learning geometry, and even geometry is a unit of mathematics that is classified as difficult (Soedjadi, 2000). Students' mathematical understanding of the material, both basic geometry in junior high school and advanced geometry in high school, is less than satisfactory when compared to other mathematics materials (Abdussakir, 2010). Sunardi's research (2020) shows that in general, junior high school students' understanding of geometric concepts, geometric elements and logical reasoning is still lacking.

The discovery learning model is a learning model that emphasizes students to be actively involved in finding concepts and principles through their own mental processes (Kemendikbud, 2016). Discovery learning can make students learn to identify a problem, find a solution to the problem, find relevant information, develop various solutions to the problem, implement the chosen solution and involve students directly in activities to solve problems together. These learning activities make students active in the teaching and learning process (Borthick & Jones, 2000).The discovery learning model can be optimized by designing worksheets according to understanding. One of the worksheets that can be used is based on APOS. APOS theory is a constructivist theory about how the

possibility of achieving/learning a mathematical concept or principle occurs. A person in understanding a mathematical idea, the process starts from action, process, object, scheme (Dubinsky, 2001). The APOS theory can be used directly to compare the success or failure of individuals in relation to the mental structure that has been formed for a mathematical concept. With the APOS theory, it can be further detected who has better mastery of mathematical concepts, namely if someone can further explain the concept then he is at a better level (Dubinsky, 2003).

There are many previous studies that have examined the effectiveness of using the discovery learning model in learning, including research by Mohammad (2019) which states that the average self-concept of students in learning geometry through the model*discovery learning*increase.There are also many studies that have examined APOS, including Arnawa (2007) who stated that abstract algebra learning based on APOS theory has a better level of understanding when compared to students who receive regular learning. Furthermore, Widada's research (2017) stated that APOS theory can be used directly in analyzing data on a person's schema behavior. Based on the background that has been described, this study aims to determine whether the increase in students' mathematical understanding abilities is taught using the model*discovery learning*APOS basedbetter than the mathematical understanding abilities of students who are taught through conventional learning.

METHOD

This study was conducted using a quantitative approach with an experimental research type with a pre-test and post-test control-group design. This study involved two classes, namely the control class and the experimental class. The experimental class is a class that follows APOS-based discovery learning and the control class applies conventional learning. The research procedure consists of the problem identification stage, the research planning stage, the implementation stage and the data analysis stage.

The population in this study were all students of grade VIII consisting of 4 classes at MTsN 1 Aceh Selatan in the 2021/2022 academic year. Sampling was carried out randomly, so that class VIII-B was obtained as the experimental class and class VIII-A as the control class. The data collection technique used in this study was the Mathematical comprehension ability test questions referred to in this study were APOS-based mathematical comprehension questions on geometry material. The test questions were adapted from Sukestiyarno (2019).

Data analysis consists of analysis of differences in initial mathematical understanding and analysis of differences in increasing mathematical understanding. Analysis of differences in initial mathematical understanding aims to determine the mathematical understanding of the two classes before the study, while analysis of differences in increasing mathematical understanding aims to determine whether there is a difference in increasing mathematical understanding that applies APOS-based discovery learning with conventional learning. The data analysis technique used is the ANOVA test by analyzing the N-gain value. Before conducting the ANOVA test, a prerequisite test is first carried out in the form of a normality and homogeneity test.

RESULTS AND DISCUSSION

Based on the results of statistical analysis to determine the differences in the increase in students' mathematical understanding abilities, a significant value was obtained for all students of 0.00, namely$\alpha < 0.05$. which means that H0 is rejected. It can be concluded that there is a difference in the increase in students' mathematical understanding abilities that apply the APOS-based discovery learning model with conventional learning. Likewise, in the increaseMathematical understanding ability is reviewed based on student grouping (high, medium, low). In the mathematical understanding of students in the high group, it is obtainedsig. value = 0.021, namely $\alpha < 0.05$, which means that H0 is rejected. It can be concluded that there is a difference in increasing the mathematical understanding of students who apply the discovery learning model.APOS basedwith conventional learning reviewed based on the high level of students. In the mathematical understanding of students in the medium group,sig. value = 0.024, namely $\alpha < 0.05$, which means that H0 is rejected.

It can be concluded that there is a difference in increasing the mathematical understanding of students who apply the discovery learning model.APOS basedwith conventional learning reviewed based on the level of students in the middle. In the mathematical understanding of students in the low group, it was obtainedsig. value = 0.029, namely $\alpha < 0.05$, which means that H0 is rejected. It can be concluded that there is a difference in increasing the mathematical understanding of students who apply the discovery learning model.APOS basedwith conventional learning reviewed based on low student levels.

The results of this study are in line with the research of Isnarto, et al., (2014), which stated that discovery learning and APOS theory contribute more to the achievement of mathematical understanding abilities. Another

study by Herlina (2015), which stated that students who receive discovery learning and APOS learning can develop their mathematical abilities to be better. Then Suryana's research (2020) APOS-based discovery learning as an alternative to innovative learning that can overcome students' difficulties in solving mathematics problems. Furthermore, Syamsuddin's research (2021), which stated that the implementation of APOS-based discovery learning makes students active in constructing concepts and can develop their cognitive abilities more optimally. Based on the results of data analysis, it was found that there was no interaction between learning and student level on improving students' mathematical understanding. Interaction occurs when the effect of a variable is different for different levels of the second variable (Mc.Millan & Schumcher, 1997). In addition, Ruseffendi (1988) stated that interaction occurs when the difference in ability to be improved through variable factors is convincingly (significantly) greater than the difference in ability to be improved through other independent variable factors.

In this study, the interaction discussed is the interaction between learning factors and student levels on improving mathematical understanding abilities. Based on the results of the analysis in the previous discussion, it has been obtained that the significance value between learning and student levels is 0.277, and it is more than 0.05. This means that learning factors and student levels simultaneously (together) do not have a significant effect on improving students' mathematical understanding (Hirotsu, 2017).

This finding shows that learning with the APOS-based discovery learning model is suitable to be applied as an alternative model of mathematics learning at all levels of students in developing students' mathematical understanding. The results of this study are in line with research (Juanda et al., 2014; Machmud et al., 2013; Sugiman & Kusumah, 2010) which found that there was no interaction between learning model factors and student levels on improving mathematical understanding abilities. Interaction only occurs if no group has the same increase as the other group.

CONCLUSION AND SUGGESTIONS

Based on the results of the research and statistical analysis carried out, it can be concluded that there are differences in students' mathematical understanding abilities.which implementsAPOS-based discovery learning model with conventional learning and there is no interaction between learning using the APOS-based discovery learning model and student level towards improving students' mathematical understanding. Based on the suggestions in this study, learning using the APOS-based discovery learning model is very potential to be applied in mathematics learning to develop students' mathematical understanding and self-concept. Students actively explore their understanding abilities so that teachers find it easier to deliver materials while developing students' abilities.

REFERENCES

Abdussakir. (2010). Pembelajaran Geometri Sesuai Teori Van Hiele. *El-Hikmah: Jurnal Kependidikan Dan Keagamaan,*.

Arnawa, I. M., Sumarno, U., Kartasasmita, B., & Baskoro, E. T. (2007). *Applying the APOS theory to improve students sbility to prove on elementary abstract algebra. Journal of the Indonesian Mathematical Society*. https://doi.org/10.22342/jims.13.1.80.133-148

B., D. S. (2000). *Strategi belajar mengajar.* Jakarta : Rineka Cipta.

Baroody. (2007). *An alternative reconceptualization of procedural and conceptual knowledge*.

Dubinsky, E. (2000). *APOS: A constructivist theory of learning in undergraduate mathematics education research. 3(2).*

Dubinsky. (2001). *APOS: A constructivist theory of learning in undergraduate mathematics education research.* In D. Holton.

Hendriana, D. (2017). *Hard skills dan soft skills.* Penerbit: Refika Aditama.

Herlina, E. (2015). Advanced mathematical thinking and the way to enhance it. *Journal of Education and Practice*, 6(5), 79-88.

Hirotsu, C. (2017). *Advanced Analysis Of Variance* (First Edit). Jhon Wiley & Sons, Inc.

Isnarto, I., Wahyudin, W., Suryadi, D., & Dahlan, J. A. (2014). Students' proof ability: Exploratory studies of abstract algebra course. *International Journal of Education and Research*, *2*(6), 215-228.

Juanda, M., Johar, R., & Ikhsan, M. (2014). Peningkatan Kemampuan Pemecahan Masalah dan Komunikasi Matematis Siswa SMP melalui Model Pembelajaran Means-ends Analysis. *Peningkatan Kemampuan Pemecahan Masalah Dan Komunikasi Matematis Siswa SMP Melalui Model Pembelajaran Means-Ends Analysis*, *5*(2), 105–113. https://doi.org/10.15294/kreano.v5i2.3322

Kemendikbud. (2016). *Permendikbud No 020 tahun 2016 Tentang Standar. Kompetensi Lulusan Pendidikan Dasar Dan Menengah.*

Mc.Millan, J. H., & Schumcher, S. (1997). *Research in Education*. Addison Wesley Longman, Inc.

Mohammad. (2019). *E-Learning Berbasis Edmodo*. Yogyakarta: CV. Budi Utama.

Ruseffendi, E. . (1988). *Mengajar Belajar Matematika*. Depdikbud LPTK.

Soedjadi. (2000). *Kiat Pendidikan Matematika di Indonesia konstatasi Keadaan. Masa Kini Menuju Harapan Masa Depan*. Jakarta: Direktorat Jenderal Pendidikan.

Sukestiyarno, Y. L., Isnarto, Rochmad & Lestari, M. D. (2019). The position and causes of students errors in algebraic thinking based on cognitive style. International Journal of Instruction. https://doi.org/10.29333/iji.2019.12191a

Sunardi. (2020). *Profil Kreativitas dalam Pemecahan Masalah Matematika Ditinjau dari Gaya Kognitif*. Bandung: Alfabeta.

Suryana, A & Arfatin, N. (2020). Discovery Learning berbasis APOS: Alternatif Mengatasi Kesulitan Mahasiswa dalam Berpikir Refleksi Matematis. *Dalam Prosiding Seminar SainsI. Sinasis.*

Syamsuddin, Oom Rahmah. (2021). Pelatihan Implementasi Guided Discovery Learning Berbasis APOS pada Guru-guru SMP Plus Al-Azhar. Jurnal Abdimas Prakasa Dakara. https://doi.org/10.37640/japd.v1i2.1014

Widada. (2017). Sistem Informasi Monitoring Dan Evaluasi. Belajar Siswa Berbasis Web Dan Sms Gateway. Yogyakarta: Intan Pariwara PT. Egiatma.