ICMSE (2023): 63-66
International Conference on Mathematics, Science, and Education
QRCBN 62-6861-0508-697
https://proceeding.unnes.ac.id/icmse

Analysis of Understanding Concept of College Students Based on APOS Theory in the Ethnic-Math HOTS Question

Novia Dwi Rahmawati[1, a)], Wardono[2, b)], YL. Sukestiyarno[3, b)], Zaenuri[4, b)], Iqbal Kharisudin[5, b)]

Author Affiliations
[1]*Doctoral of Postgraduate Mathematics Education, Universitas Negeri Semarang, Jl. Kelud Utara III Semarang 50237, Indonesia*
[2,3,4,5]*postgraduate Program of Mathematics Education, Universitas Negeri Semarang*

Author Emails
[a)] Corresponding author: noviadwirahmawati@students.unnes.ac.id
[b)] wardono.unnes@gmail.com
[c)] sukestiyarno@mail.unnes.ac.id
[c)] zaenuri.mipa@gmail.unnes.ac.id
[d)] iqbalkharisudin@mail.unnes.ac.id

Abstract. The purpose of this research is to describe the concept of understanding college students'ethic-math HOTS question: Mathematics Higher Order Thinking Skill based on culture and local wisdom APOS theory. The type of the research used is descriptive qualitative. The subject of this research were 9 mathematics education students in the high, medium, and low categories. Each categories was taken by 3 students. This research used data collection techniques to the students' conceptual understanding based on APOS theory and interview methods. The validity of research materials is obtained through time triangulation. The research results show that the level of understanding of students' mathematical concepts based on APOS theory is at different stages. Namely, subjects with high abilities have understanding at the Action, Process, Object, and Scheme stages. Meanwhile, subject with moderate have three stages of understanding Action, Process, and Object and students with low ability only have the action stage.

INTRODUCTION

Mathematics learning, which has so far from explaining concepts, giving examples, doing exercise, has produced students who only rely on their ability to think using certain algorithms [1]. When faced with questions that are somewhat different, students start to get confused and are unable to solve them. On the other hand, Higher Order Thinking Skill (HOTS) based learning is based on the principles of constructivism. Students must be educated to discover for themselves the concepts what they want to learn. This learning starts from what is known and known, especially in students' daily lives. Thus, when facing different problems, students use HOTS abilities to solve them. [2]. In the line with this, APOS theory is a constructivist theory that studies how to learn mathematical concepts through four stages, namely: action, process, object and scheme. [3].

APOS theory is an attempt to understand the reflexive abstraction introduced by Piaget to describe the development of children's logical thinking, and this idea for advanced mathematical concept [4]. Action is the transformation of objects that are studied and which are perceived by students as external and as necessary, explicit from memory, step by step instructions on how to perform operation [5]. Kazunga & Bansilal stated that individual activities in understanding the process of developing internal control over actions and gaining understanding of objects though encapsulation. However, understanding of objects is the most difficult mental construct to obtain. Schemes, on the other hand, are all cognitive structures in an individual's mind regarding a mathematical concept to develop a scheme of understanding, actions, processes and different objects must be link to a new construction [6].

Previous research has carried out various APOS analyses in mathematics learning. Rahayu et al. (2023) is a problem-solving process for students with a reflective cognitive style based on action-process-object-schema theory. Inglis (2015) discusses the importance of APOS theory in learning arithmetic. Sumaji et al. (2020) studied junior high school students' communication process in solving problems based on the APOS theory framework. A

QRCBN 62-6861-0508-697
https://proceeding.unnes.ac.id/icmse

weakness of this previous study is that it only examined the mental structure of actions, processes, objects, and schemas constructed by students and preservation teachers. It is still rare to look more closely at the characteristics of prospective students at the stage of the process of understanding concepts in building mental structures and mental mechanisms, especially in HOTS ethnic-math question.

Based on those explanations, an innovation in learning mathematics is needed, namely the development of a HOTS mathematical problem instrument and in accordance with real-world conditions. This is in line with the Regulation of the Minister of Education and Culture No. 68 of 2013 which supports innovative and contextual learning patterns. Thus, the learning process is expect to be interactive, fun, motivating, challenging and to create a single learning pattern becoming a multidisciplinary learning pattern [10]. The HOTS problem of mathematics based on culture and local wisdom (Ethnic-Math HOTS) can be a solution to solve these problems. This is in accordance with the opinion of Rahmawati (2020) that by providing contextual and interesting questions from the problems around them, such as cultural-based questions in the area, it will make students more interested and also make it easier for students to understand and answer these questions.

METHODS

This research uses a qualitative descriptive research method. The research was located at Hasyim Asy'ari University of Jombang, in the odd semester of the 2022/2023 academic year. The research sample was 9 students in the first semester of the mathematics education study program who took basic mathematics courses, consisting of 3 students with high conceptual understanding abilities, 3 medium students and 3 low students. The subject sampling technique used a purposive sampling technique. Method for collecting data. This research uses students' conceptual understanding based on APOS theory and interview methods. Data analysis in this research includes data reduction, data presentation, and drawing conclusions, while testing the validity of the data in this research uses the time triangulation technique.

RESEARCH FINDING AND DISCUSSION

The research results obtained from the results of tests and interviews on 9 subjects were based on understanding the concepts of APOS theory in basic mathematics courses. The findings obtained are an understanding of the HOTS ethnic-math concept as an action by the majority of students. This statement was obtained from the analysis of answers to questions in the findings. Then the results of this research will be presented based on the APOS theory, namely:

1. The ability to understand action stages
   When solving HOTS ethnic-math questions. Students in this category can focus their mental processes on understanding the concepts given in basic mathematics courses. If this activity is carried out repeatedly, it will become a process. From the various questions that were completed, it was clear that the students had mastered the concepts of HOTS ethnic-math questions from start to finish. Likewise, students can differentiate the concepts of the HOTS ethnic-math questions given. If these conditions are met, students can easily process the HOTS ethnic-math questions. If the student has entered the Action stage. Then, based on the results of solving these questions, students are able to understand what they already know about the questions. Likewise, if students are given a question about a different type of derivative, they immediately understand it. Based on this research, all students with high, medium and low comprehension ability categories fulfill the Action stage.
2. The ability to understand Process Stages
   Students at this stage if the process occurs under individual control which is carried out internally. If a student's thinking is limited to the mathematical ideas they encounter and is characterized by the emergence of the ability to reflect on these mathematical ideas, then the student is said to be experiencing a process regarding a concept (Ningsih, 2018). Students who successfully complete the process stage are the only students who have a high comprehension ability category.

3. Object Stage Understanding Ability
   A student is said to be an object of mathematics if the student is able to treat the concept as a cognitive object which includes the ability to take action on the object, as well as provide reasons or explanations about its properties. Apart from that, the individual is able to decompose an object that is intended and used (Haryati, 2019). From the HOTS ethnic-math questions given, go from the Action stage to the Object stage. Students already understand the concepts in HOTS ethnic-math. So that students can explain and reason for solving these questions, students are able to complete from the action to object stage and are able to explain and reason for the HOTS ethnic-math concepts used. From the above process, students with low comprehension ability categories are not capable of the Object stage.
4. Object Stage Understanding Ability
   A certain mathematical material from a scheme is a series of actions, processes, objects and other schemes that are connected to each other so that in a person's mind or brain an interrelated framework is formed (Ningsih, 2018). Students must be able to connect the Actions, Processes, and Objects they have to solve problems related to the HOTS ethnic-math questions given. Students whose data can complete this stage are students with high and medium comprehension ability categories.

CONCLUSION

The conceptual understanding of students who take basic mathematics courses in the Mathematics Education study Program with HOTS ethnic-math questions varies greatly. For students in the high comprehension ability category, they have an understanding of the Action, Process, Object and Scheme stages; for students in the medium comprehension ability category, they have an understanding of the Action, Process and Object stages. Then, for students in the low comprehension ability category, they only have an understanding of the action stage. So that conclusions can be drawn, namely: 1. The three categories of students' understanding abilities have an Action stage. 2. Students' ability to understand concepts in basic mathematics courses is still weak because they only enter the realm of understanding related formulas and solution methods.

ACKNOWLEDGMENTS

We are very grateful to the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia for the financial support in the forms of research grants.

REFERENCES

1. B. Tanujaya, R. C. I. Prahmana and J. Mumu. Mathematics instruction, problems, challenges and opportunities: A case study in Manokwari Regency, Indonesia.*World Transactions on Engineering and Technology Education,***15**(3), 287 – 291(2017).
2. B. Tanujaya, "Ethnic-HOTS Instruction Berbasis budaya dan Alam Papua,"Pidato Pengukuhan Guru besar, Universitas Papua, 2020.
3. E. Dubinsky, Using a Theory of Learning in College Mathematics Courses, Kent State Univesity, 2000.
4. Isnani, S.B. Waluyo, Dwijanto and T.S.N. Asih. "Analisis kemampuan pemahaman Konsep mahasiswa Berbasis teori Apos Pada Pembelajaran matematika" in Prosiding Seminar Nasional Pascasarjana. (Universitas Negeri Semarang, 2022), pp. 546-549
5. E.Dubinsky and M. A. McDonald. "APOS: A constructivist theory of learning in undergraduate mathematics education research, "In The teaching and learning of mathematics at university level (Springer, Dordrecht, 2001)
6. Supratman, marniati and L.O. Sirad. Analisis Pemahaman Konsep mahasiswa USN Kolaka dalam Menyelesaikan Masalah Persamaan Differensial Berdasarkan Teori APOS. Aksioma: Jurnal program Studi Pendidikan Matematika, **11**(4), 3019-3030 (2022)
7. R. Rahayu, Kartono, Dwijanto and A. Agoestanto. Problem-Solving Process Of Students With A Reflective Cognitive Style Based On The Action-Prosses-Object-Schema Theory. European Journal of Education Research, 12(1), 41-58 (2023)
8. M. Inglis. Review of APOS Theory. International Journal of Research in Undergraduate Mathematics Education, 1, 413-417(2015). https://doi.org/10.1007/s40753-015-0015-9

QRCBN 62-6861-0508-697
https://proceeding.unnes.ac.id/icmse

9. Sumaji, C.Sa'dijah, Susiswo, & Sisworo. Mathematical communication process of junior high school students in solving problems based on APOS Theory. Journal for the Education of Gifted Young Scientists, **8**(1), 197–221(2020) https://doi.org/10.17478/jegys.652055
10. F. Mulyatna, A. Omsyatama and N.D. Rahmawati. Design Ethnic-Math HOTS: Mathematics Higher Order Th inking Skill Questions based on culture and local wisdom. Malikussaleh Journal of Mathematics Learning (MJML), 4(1). pp. 48-51 (2021)
12. L. Hartati. "Analisis Kemampuan Pemahaman Matematis Mahasiswa pada Mata Kuliah Kalkulus Berdasarkan Teori APOS". In Prosiding Seminar Nasional Pendidikan KALUNI (Universitas Indraprasta PGRI, 2019), pp.174-183
13. Y. L. Ningsih & R . Rohana. Pemahaman Mahasiswa Terhadap Persamaan Diferensial Biasa Berdasarkan Teori APOS. JPPM (Jurnal Penelitian dan Pembelajaran Matematika), 11(1), 168-176. (2018)
14. N.D. Rahmawati. Pengembangan dan Penyelesaian Higher Order Thinking Skill (HOTS) Melalui Matematika untuk Siswa Sekolah Dasar (Deepublish, Yogyakarta, 2020)
15. N.D. Rahmawati, Komarudin and F. Mulyatna. " Desain Ethnic-Math HOTS pada Museum Islam Indonesia di Tebuireng" in Prosiding Seminar Nasional Pendidikan Matematika (Universitas Indraprasta PGRI, 2022), pp.333-340