



Analogical Reasoning Ability of Mathematics Education Students at Six State Islamic Universities (UIN) in Indonesia

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Abstract

Mathematical abilities that students must possess at the level of primary and secondary education must also be possessed by a student of teacher candidates who will teach mathematics. One of the abilities is an analogical reasoning ability. The main objectives of this research are: 1) To describe and analyze analogical reasoning ability of students of mathematics education at the State Islamic Universities (UIN) in Indonesia, 2) To know the differences of analogical reasoning abilities of students of mathematics education at several State Islamic Universities (UIN) in Indonesia. The study was conducted at 6 UINs in Indonesia with a sample of 203 5th semester students using a survey method. This study's results indicate: 1) Analogical reasoning ability in Mathematics Education students consisting of 6 UINs in Indonesia can be seen from the average value in each sample. The acquisition of the average value of UIN Syarif Hidayatullah Jakarta students' analogical reasoning ability is the highest compared to the other 5 UINs with an average mathematical reasoning ability value of 65. 2. There is a difference in mathematics education students' analogical reasoning ability at the State Islamic Universities (UIN) in Indonesia.

Keywords: mathematical reasoning, analogical reasoning

A. Introduction

In line with the need for human resources that can think critically, since the beginning of the 21st century, there has been a paradigm shift in learning in Indonesia, namely from teacher-centered learning to student-centered learning. Learning that initially focuses on memorizing must change to learning that uses thinking and understanding. This is indicated by the existence of KBK in 2004, KTSP in 2006, and 2013 Curriculum.

The paradigm shift above shows the Indonesian government's desire to produce high-quality human resources through learning that develops thinking skills in schools. It includes higher-order thinking skills that contain critical and creative thinking skills. One form of learning that develops a high level of ability is learning that invites students to carry out various activities, such as analyzing, evaluating, and taking the right conclusions for complex problems.

The need for those abilities is closely related to the dynamic world situation, fast-changing and not easily predictable as it is today. Students need these abilities in an effort to manage and utilize information to survive in circumstances that are always changing, uncertain, and competitive as it is now.

One of the subjects in school that is expected to develop the abilities mentioned above is mathematics. It is not excessively said, considering mathematics is the main subject received by students since elementary school. Besides that, mathematics also contains structured, organized, and logical concepts that can be applied to other subjects.

Mathematical ability is one of students' must-have skills. They will be able to think better in making every decision regarding their lives if they possess this skill. Mathematical abilities demanded by the National Council of Teachers of Mathematics (NCTM, 2000) consist of mathematical communication, mathematical reasoning, mathematical problem solving, mathematical connection and the formation of positive attitudes towards mathematics.

Mathematical abilities that students must possess at the level of primary and secondary education must also be possessed by teacher candidates student who will teach mathematics. The Committee on the Undergraduate Program in Mathematics (CUPM) (MAA, 2004) provides six basic recommendations for majors, programs and courses in mathematics. One of the recommendations explains that each course in mathematics should be an activity that will help students in analytical development, reasoning, problem solving and communication skills. The above CUPM recommendation states that the task of educational institutions that educating prospective mathematics teachers is to prepare students to have mathematical reasoning abilities.

The faculty of education across the countries (LPTK) has the responsibility to generate professional teacher candidates. There is usually Mathematics Education Department at the faculty which educate future Mathematics teachers who will teach mathematics at primary and secondary schools and madrasahs. They need to ensure those teacher candidates are having mathematical reasoning abilities. Mathematical reasoning ability is an ability that can be developed, so that lecturers play a role in developing mathematical reasoning abilities of their students.

According to Ansjar and Sembiring (2000) reasoning is the main characteristic of mathematics that cannot be separated from the activities of learning and developing mathematics or solving a mathematical problem. Wahyudin (2008, pp. 35-36) states that the ability of reasoning is very important for understanding mathematics and reasoning systematically is a process that always takes place in the mind. This is because mathematics is a science that has axiomatic deductive characteristics, which requires the ability to think and reason to understand it.

Graduates at all levels of education were weak in mathematical skills, especially in the working area such as business and industry also was weak in mathematical reasoning ability (Sumartini, 2015). Complaints like these not only focus on basic mathematical skills, but more importantly are the ability of graduates to express facts in solving problems or engage in so-called high-level reasoning and thinking in mathematics.

Empirically it was found that both high school and college students had difficulty using strategy and consistency in logical reasoning (Matlin, 2003). Those students struggle to solve mathematical problems, including connecting initial knowledge (concepts that have been learned) with the problem, looking for strategies or ways to solve, and providing logical reasons for the answers given. Therefore, many people assume that mathematics is a tricky subject.

Students often find problems that cannot be immediately solved in learning mathematics even though they are expected to solve them. Students need to think, guess, or predict answers, look for simple formulations, and then prove the truth. Students need to have thinking-skills, so they can find the right way to solve the problems they face. In addition, students also need to construct ideas, make conclusions, and determine the truth of conclusions and their reasons.

An indication of students' low mathematical reasoning ability stated by Angraini, et al. (2017). She said the lack of mathematical reasoning is caused by lecture activities that are less effective or one-way learning system. One of the causes is probably due to the limited ability of high-level mathematical thinking possessed by high school and college graduates, which include aspects of

reasoning, problem-solving, communication, and mathematical connections, even though this ability is needed in improving global quality and competitiveness graduates in the field of work.

Analogical reasoning ability is an essential ability for students to have. By having good analogical reasoning ability, students will get used to solving more complex problems by seeing the data's similarity. As for the research on the importance of analogical reasoning ability has been carried out by Rahmawati and Pala (2017), Ramdhani (2017), and Mawarni (2020), on the other hand, this research wants to see the analogical reasoning ability possessed by students who received education at the Universities Islam throughout Indonesia, thus the data on analogy reasoning ability can be generalized and it is possible to find the right solution if students' analogical reasoning ability are not good enough. The large amount of data collected in this study is a novelty in itself from this research, especially since this research focuses on students who have studied at Islamic university throughout Indonesia. It is hoped that through the results of this research, certain learning methods can be obtained that are able to improve the analogical reasoning ability of students who received education at all Indonesian Islamic university.

The mathematical reasoning ability to be investigated is the analogical reasoning ability, which means the ability to draw conclusions based on the similarity of processes or data. For this reason, researchers want to conduct research related to the analytical reasoning ability of UIN Mathematics Education students in Indonesia, so this study is entitled "Analogical Reasoning Ability of Mathematics Educations Students at the State Islamic University (UIN) in Indonesia".

The main objective of this research is to describe and analyze the analogical reasoning abilities of UIN students in Indonesia. Specifically, this study aims to: 1) Describe and analyze the analogy reasoning ability of students of mathematics education at the State Islamic University (UIN) in Indonesia, 2) Know the differences in the analogical reasoning ability of students of mathematics education at several State Islamic Universities (UIN) in Indonesia.

B. Literature Review

The ability of mathematical reasoning is the ability to express arguments that are essential for understanding mathematics (Turmudi, 2008, p.7; Hali et al., 2016; Susanti & Rustam, 2018). Mathematical reasoning is a process that always takes place in the mind that must be developed consistently using a variety of contexts. This means that mathematical reasoning is the ability to analyze mathematical situations that occur, then the results of the analyzing process reach a concrete conclusion.

Reasoning is a thought process that connects known facts to a conclusion (Loc & Uyen, 2014, p. 2). Mofidi, et al (2012) defines reasoning as the process of drawing logical conclusions based on facts and available sources. Based on the two opinions above it can be concluded that the ability of reasoning is needed to obtain a conclusion based on the facts that exist before making a decision.

Analogy in the Indonesian dictionary is interpreted as an equation or agreement between two different things. According to the Arabic dictionary, the analogy is interpreted as case which contains the meaning of measuring or comparing. Kaymakci (2016) revealed that analogy is a special type of comparison where the second subject was introduced to show similarities that can explain old topics. Magdas (2015) explains that in analogy learning can contain new information that is more concrete and easier to imagine.

Ramos (2011) revealed that the analogy is the ability to see relationships, not only the relationship of objects but also the relationship between ideas, then use that relationship to obtain other objects or ideas. Richland, et al (2004) revealed that the analogy is talking about two different things, one not the other, but two different things compared to one another. Analogy means seeking the similarity of two different things, and drawing conclusions on the basis of the similarity, thus the analogy can be used as an explanation or as a basis for reasoning.

There are two kinds of analogical abilities, namely inductive analogy and declarative analogy. Inductive analogy is an analogy which is constructed based on the principal's similarities that exist in two phenomena. The conclusions are drawn based on what is found in the first phenomena. Whatever happens in the first case also occurs in the second phenomenon. Declarative analogy is a method to explain or confirm something abstract or unknown or still vague, using things that are already known before. According to English (1997), some indicators to measure the ability of analogical reasoning are like: a) students can observe patterns (from a picture or a number), b) students can determine the relationship between patterns of images or numbers, c) students can estimate the rules that shape the pattern.

The mathematical analogies in this study are the process of drawing conclusions on the basis of similarity by comparing two different things. From this similarity, conclusions can be drawn so that it can be used as an explanation or as a basis for reasoning. The analogical ability is meant to meet indicators such as students can observe patterns (from a picture or a number), students can determine the relationship between the pattern of images or numbers, and students can estimate the rules that shape the pattern.

The following is an example of students' mathematics analogical reasoning ability in mathematics covering different topics: The 4th term of sequence A is 17. The relationship between sequence A and 17 is similar to the relationship between sequence G and Y. A ball is dropped from a height of 36 m then bounces on the floor as high as $\frac{2}{3}$ of the previous height, and so on so as to form a row G. Determine the value of Y.

C. Methodology

1. Research Design

The method of research is descriptive qualitative, aiming to generalize the population based on sample data so that temporary conclusions can be made about the characteristics, behavior or attitudes of the population. The descriptive method was chosen to make it easier to obtain analogical reasoning ability and mathematical generalization reasoning ability for UIN Mathematics Education students in Indonesia (UIN Syarif Hidayatullah Jakarta, UIN Sunan Gunung Djati Bandung, UIN Sunan Kalijaga Yogyakarta, UIN Sunan Ampel Surabaya, UIN Alauddin Makassar, and UIN Sunan Ampel Makassar, UIN UIN Sultan Syarif Kasim Riau).

2. Instruments

The population in this study was all students of 5th semester of UIN Mathematics Education in 6 cities. Placement of 5th semester students of UIN Mathematics Education in 6 cities is carried out randomly by the campus without being based on rank and grades. Students are not grouped with several criteria and the curriculum provided is the same. Thus, it is assumed that each class in the 5th-semester students of UIN Mathematics Education in 6 cities is a relatively homogeneous class with students' characteristics in a fairly heterogeneous class, meaning that there are students who have high, medium and low abilities. Data obtained from the results of the six groups of samples by providing analogical reasoning ability tests. The analogical reasoning ability test is given consists of 3 questions with the main discussion of number theory.

3. The technique of Data Analysis

Data obtained from the test result of the six sample groups in which all students have given similar questions on mathematical generalization reasoning ability. There were two questions administered, each question consists of 2 parts with the subject matter of discussion of number theory. The validity of the instrument was tested for their content validity.

D. Findings and Discussion

Research conducted at UIN Syarif Hidayatullah Jakarta, UIN Sunan Gunung Djati Bandung, UIN Sunan Kalijaga Yogyakarta, UIN Sunan Ampel Surabaya, UIN Alauddin Makassar, and UIN Sultan Syarif Kasim Riau. This aims to see differences in analogical reasoning abilities of Mathematics Education students by taking each - one group to be used as a research sample. Samples were 203 5th semester students that consist of 35 Mathematics Education students of UIN Syarif Hidayatullah Jakarta, 34 Mathematics Education students of Sunan Gunung Djati Bandung, 35 Mathematics Education students of Sunan Kalijaga UIN Yogyakarta, 35 Mathematics Education students of UIN Sunan Ampel Surabaya, 33 Mathematics Education students of UIN Alauddin Makassar and 31 students of Mathematics Education Sultan Syarif Kasim Riau.

To find out the differences in analogical reasoning abilities of the six groups of Mathematics Education students, a descriptive test was given consisting of 3 items. The analogical reasoning ability test has been tested on Mathematics Education students in semester 7 of UIN Syarif Hidayatullah Jakarta, and its characteristics have been analyzed in the form of validity test, reliability test, level of difficulty test and test for distinguishing test questions.

The data used in this study are the results of analogical reasoning ability tests of Mathematics Education students. After the six groups of samples are given the analogical reasoning ability test,

the results of the six groups are obtained followed by prerequisite analysis testing calculations and hypothesis testing.

Based on the results of analogical reasoning ability tests of Mathematics Education students consisting of 6 UINs in Indonesia, it is seen that there are differences in the average value, median, mode, variance, standard deviation, slope level and sharpness. A comparative description of analogical reasoning ability comparison data is presented in table 1 below.

Table 1. Comparison of Analogical Reasoning Abilities of Mathematics Education Students

	UIN Ja- karta	UIN Ban- dung	UIN Yogya- karta	UIN Sura- baya	UIN Makas- sar	UIN Riau	
N	Valid Missing	35 0	34 1	35 0	35 0	33 2	31 4
Mean		65	64.97	61.14	62.63	53.27	54
Std. Error of Mean		2.714	2.815	2.792	2.277	2.564	2.704
Median		67	67	58	67	50	58
Mode		58 ^a	67	50 ^a	67	50 ^a	58
Std. Deviation		16.055	16.414	16.518	13.469	14.727	15.053
Variance		257.765	269.423	272.832	181.417	216.892	226.6
Skewness		-0.197	-0.204	-0.035	-0.029	-0.072	-0.21
Std. Error of Skew- ness		0.398	0.403	0.398	0.398	0.409	0.421
Kurtosis		-0.548	-0.678	-1.028	-0.271	-0.501	-0.535
Std. Error of Kurtosis		0.778	0.788	0.778	0.778	0.798	0.821
Range		59	59	59	59	58	58
Minimum		33	33	33	33	25	25
Maximum		92	92	92	92	83	83

Table 1 shows the comparison of analogical reasoning abilities of Mathematics Education students consisting of 6 UINs in Indonesia. The average acquisition of UIN Syarif Hidayatullah Jakarta students is highest compared to the other 5 UINs with the average value 65. The average value of students of UIN Alauddin Makassar's analogical reasoning ability is the lowest compared to the 5 other UINs with an average value 53.27. The difference between the highest and the lowest average value is 11.73. The median value of analogical reasoning ability of UIN students Syarif Hidayatullah Jakarta, UIN Sunan Gunung Djati Bandung, and UIN Sunan Ampel Surabaya is the highest compared to the other 3 UINs with the value 67. The median value of analogical reasoning ability of UIN Alauddin students Makassar is the lowest compared to 5 other UINs with a median value 50. The difference between the highest median value with the lowest is 17.

The students of UIN Sunan Gunung Djati Bandung and UIN Sunan Ampel Surabaya's mode value is the highest compared to the other 4 UINs with the value 67. Sunan Kalijaga UIN Yogyakarta and UIN Alauddin Makassar are the lowest compared to the other 4 UIN with 50 mode values. The difference between the highest analogical reasoning mode values with the lowest is 17.

To find out the differences in the average analogical reasoning ability of Mathematics Education students consisting of 6 UIN in Indonesia, a hypothesis test is held. The results of hypothesis testing can be seen by looking at the significance value obtained. If the significance value <0.05 , then H1 is accepted. From the one-way ANOVA test results, it can be seen that the significance value is $0.002 < 0.05$. So, it can be concluded that there are differences in the analogical reasoning ability of students of mathematics education at the State Islamic University (UIN) in Indonesia. This is in line with the previous description regarding the differences in analogical reasoning ability of students of mathematics education courses at the State Islamic University (UIN) in Indonesia.

Based on the acquisition of the average value, the average value of the analogical reasoning ability of UIN Jakarta, UIN Bandung, UIN Yogyakarta and UIN Surabaya is above 60 while the average value of UIN Makassar and UIN Riau is above 50. This finding drew the attention of researchers considering the fact that UIN Jakarta, UIN Bandung, UIN Yogyakarta and UIN Surabaya are located on the island of Java while UIN Makassar and UIN Riau are located outside the island of Java. Based on the average value, there is a difference in the average acquisition between UIN located on Java, and UIN located outside Java so further investigation on the learning process carried out at each university is needed to find out those differences.

E. Conclusion

Based on the results of research and discussion of analogical reasoning ability in Mathematics Education at the State Islamic University (UIN) in Indonesia, the following conclusions can be

drawn: (1) Analogical reasoning ability in Mathematics Education students consisting of 6 UINs in Indonesia can be seen from the average value in each sample. The average value of UIN Syarif Hidayatullah Jakarta Mathematics Education students' analogical reasoning ability is the highest compared to the other 5 UINs, with an average value was 65. At the same time, UIN Alauddin Makassar got the lowest position with an average value was 53.27. The difference in average value between the highest and the lowest was 11.73. (2) There is a difference in students' analogical reasoning ability at the State Islamic University (UIN) in Indonesia. This conclusion was drawn referring to the results of empirical tests using one-way ANOVA. The test results show a significant value of the difference in mathematical analogy reasoning abilities of $0.002 < 0.05$. This shows a significant difference in the mathematical analogy reasoning ability of students of mathematics education at the State Islamic University (UIN) in Indonesia. With the results, students of mathematics education at UIN Syarif Hidayatullah Jakarta have an average analogical reasoning score higher than the other 5 UIN mathematics education students.

F. References

- Angraini, L. M., Kartasasmita, B., & Dasari, D. (2017). The effect of concept attainment model on mathematically critical thinking ability of the university students. *JPhCS*, *812*(1), 012010. DOI: 10.1088/1742-6596/812/1/012010
- Ansjar, M. & Sembiring. (2000). *Hakikat Pembelajaran MIPA dan Kiat Pembelajaran Matematika di Perguruan Tinggi*. Jakarta: Dirjen Dikti Departemen Pendidikan Nasional.
- English, L. D. (1997). *Analogies, Metaphora, and Images: Vehicles for Mathematical Reasoning*. In *Mathematical Reasoning analogies, Metaphora and Images* edited by English, Lyn D: Lawrence Erlbaum Associates, Inc.
- Hali, F. (2016). The effect of application of problem based learning against proportional reasoning ability based on vocational students' achievement motivation. *Journal of Mathematics Education*, *1*(2), 15–21. <http://usnsj.com/index.php/JME/article/download/JME003/pdf>
- Kaymakci, Y. (2016). Embedding analogical reasoning into 5E learning model: a study of the solar system. *Eurasia Journal of Mathematics, Science & Technology Education*, *12*(4), 881-911.
- Loc, N. P., & Uyen, B. P. (2014). Using Analogy in Teaching Mathematics: An Investigation of Mathematics Education Students in School of Education-Can Tho University. *International Journal of Education and Research*, *2*(7), 91-98. Retrieved from <https://www.ijern.com/journal/July-2014/08.pdf>
- Magdas, I. (2015). Analogical Reasoning in Geometry Education. *Acta Didactica Napocensia*, *8*(1), 57-65. Retrieved from <https://files.eric.ed.gov/fulltext/EJ1064450.pdf>
- MAA. (2004). *Undergraduate Programs and Courses in the Mathematical Sciences: CUPM Curriculum Guide 2004*. Washington DC: The Mathematics Association of America Published.
- Matlin, M.W. & Geneseo, S. (2003). *Cognition (5th Ed)*. New Jersey: John Wiley & Sons Inc.
- Mawarni, T. A. T. (2020). Kemampuan Penalaran Analogi Matematis Melalui Model Pembelajaran Hands on Mathematics dengan Media Benda Konkret Ditinjau dari Gaya Kognitif Visualizer dan Verbalizer. *Jurnal Penelitian, Pendidikan, dan Pembelajaran*, *15*(19). Retrieved from <http://riset.unisma.ac.id/index.php/jp3/article/viewFile/4933/5035>
- Amir-Mofidi, S., Amiripour, P., & Bijan-Zadeh, M. H. (2012). Instruction of mathematical concepts through analogical reasoning skills. *Indian Journal of Science and Technology*, *5*(6), 2916-2922.
- NCTM. (2000). *Principles and Standards for School Mathematics*. Reston, VA: NCTM.
- Ramos. (2011). Analogies as tools for meaning making in elementary science education: how do they work in classroom settings? *Eurasia Journal of Mathematics, Science & Technology Education*, *7*(1), 29-39.
- Rahmawati, D. I. & Pala, R. H. (2017). Kemampuan Penalaran Analogi dalam Pembelajaran Matematika. *Jurnal Euclid*, *4*(2), 689-798.
- Ramdhani, S. (2017). Analisis Kemampuan Penalaran Analogis Mahasiswa Pendidikan Matematika dalam Persamaan Diferensial Ordo Satu. *Jurnal Prisma*: *6*(2), 162-172.
- Richland, L. E., Holyoak, K. J., & Stigler, J. W. (2004). *Analogy use in eighth-grade mathematics classrooms*. *Cognition and Instruction*, *22*(1), 37–60. Retrieved from http://reasoninglab.psych.ucla.edu/KH%20pdfs/Richand_etal.2004.pdf

- Sumartini, T. S. (2015). Peningkatan Kemampuan Penalaran Matematis Siswa Melalui Pembelajaran Berbasis Masalah. *Jurnal Pendidikan Matematika*, 5(1), 1-10.
- Susanti, G., & Rustam, A. (2018). The effectiveness of learning models realistic mathematics education and problem based learning toward mathematical reasoning skills at students of junior high school. *Journal of Mathematics Education*, 3(1), 33-39. DOI: 10.31327/jomedu.v3i1.534
- Turmudi. (2008). *Landasan Filsafat dan Teori Pembelajaran Matematika (Berparadigma Eksploratif dan Investigatif)*. Jakarta: Leuser Cita Pustaka.
- Wahyudin. (2008). *Pembelajaran dan Model-model Pembelajaran: Pelengkap untuk Meningkatkan Kompetensi Pedagogis Para Guru dan Calon Guru Profesional*. Bandung: IPA Abong.