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Improving Mathematical Analogy Ability: An Exploration-Based Learning Model

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ABSTRACT

Mathematical analogy ability is the ability needed to solve mathematical problems. However, students' mathematical analogy abilities are still relatively low because of the difficulty of students finding similar problem solving patterns from two or more similar problems. This study aims to analyze the differences in the improvement of mathematical analogy abilities that received snow cube throwing based on exploration (SCTBE), exploratory and expository learning reviewed as a whole, and by school category. This study is a quasi-experimental study with a non-equivalent pretest and posttest control-group design. The research subjects were students of class VIII from three school levels in Cimahi City. Overall, the results showed that students who received SCTBE and expository learning improved mathematical analogy abilities and were better than students who received exploratory learning. Reviewed by school category, SCTBE learning is more suitable for middle category schools with active and independent characteristics. Research result shows that exploratory learning that is presented in a pleasant atmosphere will increase student engagement, so that it has an impact on increasing students' mathematical analogy abilities.

Keywords: *Exploratory Learning, Mathematical Analogy Ability, Snow Cube Throwing Learning.*

ABSTRAK

Kemampuan analogi matematis merupakan kemampuan yang dibutuhkan untuk menyelesaikan masalah-masalah matematika. Namun, kemampuan analogi matematis siswa masih tergolong rendah karena sulitnya siswa menemukan keserupaan pola penyelesaian masalah dari dua atau lebih masalah yang serupa. Penelitian ini bertujuan menganalisis perbedaan peningkatan kemampuan analogi matematis yang mendapat pembelajaran *snow cube throwing* berbasis eksplorasi (SCTBE), eksploratif dan ekspositori ditinjau secara keseluruhan dan berdasarkan kategori sekolah. Penelitian ini merupakan penelitian kuasi eksperimen dengan rancangan *non-equivalent pretest and posttest control-group design*. Subjek penelitian adalah siswa kelas VIII dari tiga level sekolah di Kota Cimahi. Hasil penelitian menunjukkan bahwa: Secara keseluruhan peningkatan kemampuan analogi matematis siswa yang memperoleh pembelajaran SCTBE dan ekspositori lebih baik dari siswa yang memperoleh pembelajaran eksploratif; ditinjau berdasarkan kategori sekolah, pembelajaran SCTBE lebih cocok digunakan pada sekolah kategori tengah yang memiliki karakteristik aktif dan mandiri. Penelitian menunjukkan bahwa pembelajaran eksploratif yang disajikan dalam suasana yang menyenangkan akan meningkatkan keterlibatan siswa, sehingga berdampak pada peningkatan kemampuan analogi matematis siswa.

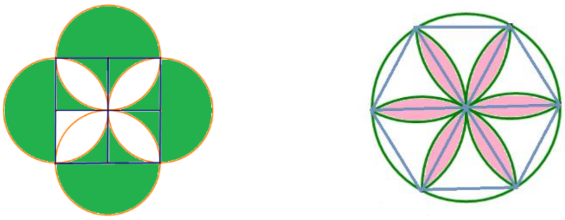
Kata Kunci: Pembelajaran Eksploratif, Analogi Matematis, Model Pembelajaran *Snow Cube Throwing.*

INTRODUCTION

The way we think, communicate, convince the other person and draw conclusions is often based on analogy (Azmi, 2017). The analogy is part of inductive reasoning, where the way to conclude is based on previously known facts. Goswami (2004) reveals that reasoning by analogy is widely accepted as a core component of human cognition. Analogous reasoning has long been believed to play an essential role in mathematics learning and problem-solving (Genter, Holyoak, & Kokinov, 2001). In addition, Hofstadter (Pearse & Walton, 2011) argues that analogy plays a vital role in problem-solving, decision making, perception, memory, creativity, emotion, explanation, and communication. Analogies in mathematics can help students understand another material by looking for similarities in properties between the material being compared. (Kariadinata, 2012). The explanation about the importance of analogy ability illustrates that students' mathematical analogy skills need to be developed in learning activities.

Analogy is part of inductive reasoning. Reasoning is usually defined as an activity, process or activity of thinking to draw a conclusion based on several statements that are known to be true. Based on this understanding, the analogy is part of the process of drawing conclusions. Thus, mathematical analogy ability is defined as the ability to draw conclusions by comparing two different things by only paying attention to the similarities, but not paying attention to the differences (Shadik, 2013). Mofidi (2012) argues that analogical reasoning makes learning deeper and mathematical concepts can be stored in long-term memory. Mathematical analogy skills have a significant role in solving mathematical problems, including the ability to use known problems that have identical structures in solving new problems (English, 2004). Research conducted (Sarina & Namukasa, 2010) shows that an abstract mathematical concept can be more easily understood by making analogies related to the real world.

The importance of the analogy ability is also shown from the preliminary study results: Look at the picture below, calculate the area of the green and pink colored areas if the radius of the circle in problems 1 and 2 is 7 cm.



Problem 1 Problem 2

Figure 1. Example-Example of Analogy Problem

One strategy to solve problem number 1 is to draw a square through the intersecting points. Then the square is divided into four smaller squares. One small square is divided into three areas: two green areas and one area not colored (leaf). The combination of the colorless area and 1 part of the colored area on the small square is equal to the area of a quarter circle. So the area of one colored area in a small square is equal to the area of a small square minus the area of a quarter circle.

Problem number 2 can be solved with the same analogy as problem number 1. The trick is to draw a regular hexagon, then divide the hexagon into six equal triangles. By the same analogy, we can determine that half of the leaf is equal to the area of an equilateral triangle minus the area of one-sixth of the circle. The preliminary study results show that most students who can guess the solution strategy in question number 1 cannot make assumptions about the solution strategy in question number 2. Even though question number 2 has the same completion pattern as problem number 1. students' mathematical analogy is still low. Students with good analogy abilities will more easily solve problem number 2 if they already know the problem-solving strategy from number 1. The case above shows the importance of analogy skills in solving mathematical problems. In addition to the results of the preliminary study, the low ability of analogy is also shown from several research results such as (Ningrum & Rosyidi, 2013; Azimi, 2016; Ridhoi et al., 2020).

So far, research related to analogy abilities has been carried out by several researchers such as: Analysis of mathematical analogy abilities on several mathematical topics such as: Trigonometry

(Basir, Ubaidah, & Aminudin, 2018), algebra (Daniarti & Nursangaji, 2015), pyramids (Nurhalimah & Haerudin, 2021), quadrilateral (Khotimah & Sutirna, 2021), and build a flat side space (Viniarsih, Sugiatno & Bistari, 2015). Students' mathematical analogy profiles were reviewed based on: gender (Ningrum & Rosyidi, 2013), visualizer and verbalizer cognitive style (Mawarni, 2020), Davis Keirsey personality type (Widiyatmoko, 2020). The use of geogebra software to improve analogy abilities (Salamah, Nuriadin, & Kurniasih, 2018; Setiawati, 2019; Sahadatina, 2018). Efforts to improve analogy skills through the discovery method (Sulhiah, 2019; Rahman & Maarif, 2014; Maarif, 2016; Irma, 2019).

An effective way to train students' mathematical analogy abilities is to solve math problems with similar patterns and strategies. For this reason, a learning approach that can develop students' analogy abilities is needed. A learning approach that can help students practice finding patterns of solving a problem is an explorative approach. The reason for choosing this approach is that the explorative approach trains students to analyze/search for a particular pattern or information and make hypotheses related to the pattern found.

Some relevant research related to explorative learning is research (Rohaeti, 2010; Anwar, 2012; Sari, 2015; Maryam, Atun & Aeni, 2016; and Huda, 2017). In this study, explorative teaching materials were presented on sheets of paper. Usually, in one lesson, students can only solve 5-6 math problems. Therefore, it is necessary to practice many math problems in every lesson to increase their learning achievement (Wahyuni, 2016; Kusumawati & Irwanto, 2016; Panggabean, & Sumardi, 2018). On this basis, the snow cube throwing learning was chosen, facilitating students to practice many problems (Sari, 2010). Based on the explanation above, the researcher suspects that students will have good analogy skills when they learn by using snow cube throwing based on exploration (SCTBE). Therefore, this study aims to analyze the increase in the mathematical analogy ability of students who receive SCTBE, exploratory (EF), and expository (EI) learning both as a whole and in terms of school categories.

METHOD

The method used in this study was a quasi-experimental method with a non-equivalent control group design. The selection of a quasi-experimental design in this study was based on the difficulty of artificially creating groups.This design was the same as the pretest-posttest control group design, except that the experimental and control groups were not chosen randomly in this design. Each research class was given a pretest and posttest to see the difference in the quality of improving their mathematical analogy abilities. This experimental activity was carried out for 5 weeks excluding pretest and posttest.

This study compares mathematical analogy abilities in three groups, namely two experimental groups and one control group. The comparison of the similarities and differences of the three learning models is described in Table 1.

Table 1. Comparison Among the Three Groups

Treatment	Learning		
	SCTBE	Explorative	Expository

Teaching materials	Five types of exploration-based teaching materials in 1 lesson	1 type of exploration-based teaching materials in 1 lesson	Ordinary Teaching Materials
Exercises	Problem-solving questions	Problem-solving questions	Problem-solving questions
Presentation of Teaching Materials	sticked on a snow cube.	Printed on HVS paper sheets	Printed on HVS paper sheets
Learning process	Group discussion about teaching materials. 1 group consists of 2 students.	Group discussion about teaching materials. 1 group consists of 5 students.	Students pay attention to the teacher's explanation, then work on the questions given by the teacher.

This study has three variables, namely the independent variable, the dependent variable, and the control variable. The independent variables are SCTBE (X_1), EF (X_2), and EI learning, while the dependent variable is mathematical analogy ability (MAA). The control variable in this study is the school category.

To examine more comprehensively the rationale for the relationship between research variables, the researcher examines in terms of the school category. The selected schools are divided into three categories: the high, middle, and lower school categories, based on the National Examination issued by the Ministry of Education and Culture. The grouping of students is intended to find out more deeply about the differences in the improvement of students' mathematical analogy abilities between students who use SCTBE, EF, and EI learning in each school category.

This research was conducted in three public junior high schools in Cimahi City. The sample selection in this study was based on stratified random sampling techniques and group-level random sampling techniques. Samples were selected from three schools, namely by taking three classes in each school. The three classes each received SCTBE learning, exploratory and expository learning, so that the total subjects selected were nine classes. The subjects in this study were 275 students of class VIII.

The instrument used in this study was a mathematical analogy ability test in the form of a description, which was arranged to measure the increase in students' mathematical analogy abilities before and after the learning process on circle material. Before being used, the instrument has been validated internally, rationally, externally empirically and by asking for expert opinion regarding the contents of the instrument, which must be following the program design to be carried out and based on existing theories. At the same time, external validity is done by comparing the existing criteria in the instrument with empirical facts in the field. The results of the validity test showed that the expert gave uniform consideration to the validity of the face and content of the mathematical analogy ability test. These results are shown from the value of sig. greater than 0.05. This means that the mathematical analogy ability instrument is included in the valid category.The quantitative data analysis technique compares the increase in the mathematical analogy ability of the experimental class and control class students by using the three-average difference test for the independent sample. Before the three-average difference test is carried out, the normality test and homogeneity test are carried out first as a condition for data analysis.

RESULTS AND DISCUSSION

To calculate the students' average N-Gain MAA, pretest and posttest MAA data were used. In Table 2, descriptive statistics of students' N-Gain MAA based on learning are presented.

Table 2. Description of MAA's N-Gain based on learning

Statistics	N-Gain MAA		
	SCTBE	Explorative	Expository
Average	0,36	0,29	0.34
Standard Deviation	0,15	0,13	0,13
Total students	93	88	94

Based on Table 2, the mean N-Gain of the SCTBE group was higher than the average N-Gain of the explorative and expository groups. Besides the gain classification, there are different classifications between the SCTBE, explorative and expository groups. The average N-Gain of the SCTBE and expository groups was in the medium category, while the exploratory group was in the low category. The increase in students' MAA is marked by an increase in the average N-Gain of each aspect of MAA. Sternberg (English, 2004) states that the components of the analogical reasoning process consist of (1) Encoding. Identify the source problem and the target problem by finding both; (2) Inferring characteristics. Determine some of the known couple's possible relationships; (3) Mapping. Connect A: B to pair to C : D; (4) Applying. Choose a suitable answer to complete the analogy. Table 3 below describes the average N-Gain for each aspect of MAA in the three learning groups.

Table 3. Description of N-Gain Aspects of MAA

Group	Aspects of MAA			
	Encoding	*Inferring*	*Mapping*	*Applying*
SCTBE	0,28	0,17	0,88	0,43
Explorative	0,34	0,02	0,78	0,28
Expository	0,41	0,04	0,85	0,29

Based on Table 3, the average N-Gain of the SCTBE group students was higher than the exploratory and expository groups in three aspects of MAA except encoding. In encoding, the average N-Gain of students in the expository group is higher than the other two groups. The average N-Gain of the SCTBE group students is in the low category in the encoding and inferring aspects, the medium category in the applying aspect, and the high category in the mapping aspect. On the other hand, the average N-Gain of the explorative group was lower than that of the SCTBE and expository groups in three aspects except for the encoding aspect.

When viewed in the four aspects of MAA, the mapping aspect of the three groups experienced a higher average increase than the increase in other aspects. This aspect improvement category is included in the high category. The inferring aspect of the three groups is the lowest increase compared to the other three aspects. The average increase in N-Gain in this aspect is included in the low category.

The most different improvement between SCTBE learning with exploratory and expository learning is inferring and applying aspects. This fact means that SCTBE learning makes students superior in inferring and applying aspects than the other two lessons. In SCTBE learning, students experience the stages of making conjectures. At this stage, students are asked to guess the pattern of solving the problems given. Even though explorative learning goes through the same stages, the answers of the explorative group students on the teaching materials given are still a lot wrong. According to Dane & Pratt (2009), the pattern matching process is often honed through training and repeated practice. The observations showed that the exploratory class students tended to be more passive in asking questions than the expository group. These results are in line with the research results (Tohir, 2019), which states that most teachers complain about the obstacles in using the scientific approach in the question section. This factor causes the ability of SCTBE students in the inferring aspect to be superior to other students. The active learning model can increase students' activeness in asking questions (Subhan, Fatmaryanti, & Nurhidayati, 2013). Although the SCTBE group is superior in these three aspects, the expository group students seem superior to SCTBE and exploratory learning in the encoding aspect.

There is a difference in the increase in MAA between the three groups of students, and it needs to be analyzed further whether the difference is significant. The first step to test the significance is to test the normality and homogeneity of the data being compared. From the analysis results, it was found that the three groups of data were not normally distributed. Considering that the data for the three groups were not normally distributed, the data homogeneity test was not needed, so the Kruskal Walis test was used to test the difference in average MAA of the three groups of students. The results of the Kruskal Walis test calculations are summarized in Table 4.

Table 4. Test of Mean Differences in Analogy Ability Improvement

Group	N	Average	Sig.	Conclusion
SCTBE	93	0,36		
Explorative	88	0,29	0,004	Reject H_o
Expository	94	0,34		

The results of data analysis in Table 4 conclude that Ho is rejected. Thus, it can be said that there is a difference in the average increase in MAA between students in the SCTBE, explorative and expository groups. Furthermore, to find out which learning is better, further different tests are needed. The test results of differences in the average increase in MAA between learning are summarized in Table 5.

Table 5. Further Difference Test of MAA between Learning

Hypothesis Test	Average Difference	Sig. (2-tailed)
SCTBE : EF (A)	0,072*	0,000
SCTBE : EI (B)	0,027	0,179
EF : EI (C)	0,045*	0,027

Based on data from Table 4, information is obtained that the results of data analysis conclude that Ho is rejected. Thus, it can be said that there is a difference in the average increase in MAA between students in the SCTBE, explorative and expository groups. Furthermore, to find out which learning is better, further different tests are needed. The test results of differences in the average increase in MAA between learning are summarized in Table 5.

The increase in MAA of students who received explorative learning was lower than the other two groups because students were conditioned to only learn from one type of teaching material to only learn one way to solve a problem. Therefore, when students in the explorative class are given similar questions, they lack experience solving them. In addition, the time factor is also one of the obstacles in explorative learning. Based on the results of the analysis of the responses of middle and high school teachers, it shows that explorative learning does require a relatively long time when compared to ordinary learning. Sari (2017) also reveals that the time required in explorative learning is relatively long compared to SCTBE learning and ordinary learning.

If students can learn to solve two to three similar questions in expository learning, in exploratory learning, students can only solve one question in one lesson. It is different from the SCTBE group; However, they use more teaching materials than explorative learning. Students can subconsciously solve many mathematical problems similar to the same analogy as solving the previous problem. Sari (2010) shows that through snow cube throwing learning, students can work on 120 questions in one lesson, wherein in the conventional approach, students can only work on 1-5 questions in one meeting. Therefore, the time factor is not an obstacle in learning SCTBE. As a result, SCTBE learning is superior to the other two groups in improving students' MAA.

In addition to comparing the MAA of three learning groups, this study also compares the MAA of three learning groups in terms of the school category. The description of the average N-Gain and the standard deviation of student MAA data from the three learning groups based on school category is presented in Table 6.

Table 6. Descriptive Statistics of MAA N-Gain by School Category

School Category	**Statistic**	**N-Gain**		
		SCTBE	**EF**	**EI**
high	Mean	0,36	0,31	0,34
	Standard Deviation	0,08	0,08	0,13
	Total students	30	32	27
middle	Mean	0,43	0,34	0,31
	Standard Deviation	0,18	0,13	0,13
	Total students	32	26	34
lower	Mean	0,30	0,22	0,36
	Standard Deviation	0,13	0,15	0,13
	Total students	31	30	33

From the data contained in Table 6, it shows that the average N-Gain MAA of students in the SCTBE group is higher than the average N-Gain MAA of students in the exploratory and expository groups in the high and middle school categories. In the lower category schools, the average N-Gain MAA of students in the expository group was higher than the other two groups. Although the average N-Gain of MAA students in the exploratory group was lower than SCTBE and the expository group in the upper and lower school categories, the average N-Gain of MAA students in the exploratory group was higher than the expository group in the middle school category. This fact shows that the increase in MAA students who receive SCTBE learning is higher than students who receive exploratory or expository learning in the high and middle school categories.

Even so, the increase needs to be tested whether the difference is significant or not. The Normality Test results show that the N-Gain MAA data for the learning group in the high and middle school categories are normally distributed. The N-Gain MAA data for one of the learning groups in the lower school category is not normally distributed. Next, the homogeneity test of the data in the middle school category is not needed. Given that the N-Gain data for the three learning groups in the high and middle school categories are normally distributed proceed with the data's homogeneity test. The results of the homogeneity test of the data in the high and middle school categories showed that the variance of the two data groups was not homogeneous, so the statistical test used was the Kruskal Walis test. The results of the Kruskal Wallis test calculations are summarized in Table 7.

Table 7. Test Results of Differences in MAA Improvement by School Category

School Category	Learning Comparison	Chi-Square	*Sig.*
High	SCTBE :EF :EI	4,063	0,131
Middle	SCTBE :EF:EI	8,139	0,017
Lower	SCTBE :EF:EI	15,010	0,001

Based on Table 7, the analysis of the mean difference test between the three learning groups in the high school category concluded that Ho was accepted. Thus, there is no significant difference in the average increase in MAA between students in the SCTBE, exploratory and expository groups in the high school category. Another result of the Kruskal Walis test analysis in the middle and lower school categories shows that Ho is rejected. Thus, it can be said that there is a significant difference in the average increase in MAA between students in the SCTBE, exploratory and expository groups in the middle and lower school categories. Furthermore, to determine which learning is better in the middle and lower school categories, it is necessary to further test the difference by looking back at the results of the normality and homogeneity test of the data. The test results of differences in the average increase in MAA between learning are summarized in Table 8.

Table 8. Further Difference Test of MAA between Learning in terms of School Category

School Category	Hypothesis test	Average Difference	Sig. (2-tailed)
Middle	A	0,090	0,075
	B	0,120*	0,008
	C	0,030	0,649
School Category	Hypothesis test	Average Difference	Sig. (2-tailed)
Lower	A	0,072*	0,043
	B	-0,067	0,053
	C	-0,139*	0,000

The results of the further difference test in the middle category schools show that hypothesis testing A indicates that Ho is accepted. There is no significant difference in the average increase in MAA between students who receive SCTBE learning and students who receive explorative learning. The conclusion of testing hypothesis B shows that Ho is rejected. The average increase in MAA of students who receive SCTBE learning is significantly better than the increase in MAA students who receive expository learning. The conclusion of hypothesis testing C shows that Ho is accepted. There is no significant difference in the average increase in MAA between students who receive exploratory learning and students who receive expository learning. Meaning, SCTBE learning is superior to expository learning in improving students' MAA in middle category schools.

The conclusion above shows that SCTBE learning is more suitable to be applied to middle-category schools. In the middle school category, SCTBE learning can become effective because it is supported by the good initial abilities of students so that in this school category, SCTBE learning can be superior to the other two lessons in improving students' MAA. In line with research (Lestari, 2017), which states that early mathematics ability on mathematics learning outcomes is an influence. In the lower category schools, SCTBE learning did not give optimal results in improving students' mathematical analogy abilities due to the lack of early mathematical abilities compared to the other two schools. The study results (Kurniadi & Purwaningrum, 2018) show that students with low initial mathematical abilities are not good at problem-solving because they cannot understand problems and identify elements.

Several previous research results state that high-level schools are more supportive of improving students' mathematical abilities compared to middle and lower level schools (Shodikin, 2015; Arista & Mahmudi 2020; Sugiman & Kusumah, 2010). Contrary to the results of these studies, in this study, middle-level schools in SCTBE learning are actually superior to upper-level schools which both receive SCTBE learning. That is, the high school level does not guarantee that the application of a lesson will have a better impact on students' mathematical abilities when compared to other school levels. Therefore, the characteristics of students need to be considered in choosing a learning model.

In lower-level schools, the results of testing hypothesis A indicate that Ho is rejected. The average increase in MAA of students who receive SCTBE learning is significantly better than the increase in MAA students who receive explorative learning. The results of testing hypothesis B indicate that Ho is accepted. There is no significant difference in the average increase in MAA between students who receive SCTBE learning and students who receive expository learning. The results of testing hypothesis C show that Ho is rejected. The average increase in the MAA of students who receive expository learning is significantly better than the increase in MAA of students who receive explorative learning. The conclusion of hypothesis testing A, B, and C shows that SCTBE and expository learning are superior to exploratory learning in improving students' MAA in lower category schools. The initial ability factor of students and the student's learning independence factor is thought to be one of the causes. The study results (Rusmiyati, 2017) state a positive correlation between learning independence and student achievement. Students with characteristics such as lower category schools are easier to learn analogy problems through the examples given by the teacher.

SCTBE learning has a positive impact on student involvement during the learning process. Student involvement during learning activities is considered important mainly because of its relationship with students' academic achievement (Reyes et al., 2012; Karabiyik, 2019; Lei, Cui, & Zhou, 2018; Uludag, 2016). Students become more involved in learning activities because students can learn mathematics in a pleasant atmosphere. The activity of throwing cubes in this learning makes students motivated to solve many problems through problem solving exploration. Through these activities students can have a lot of experience in solving similar mathematical problems. Of course it has an impact on increasing students' analogy abilities.

CONCLUSION

The results showed a significant difference in mathematical analogy skills between students who received the snow cube throwing based on exploration, exploratory and expository learning. The results of the further difference test showed that SCTBE and expository learning were superior to exploratory learning in improving students' MAA. The increase in MAA of students who received explorative learning was lower than the other two groups because students were conditioned to only learn from one type of teaching material. In practice, students only learned one way to solve a problem. These problems cause students to lack experience in solving the problems given. Therefore, to improve students' analogy abilities, they have to practice a lot in solving math problems that have similar patterns and solving strategies.

On the other hand, the results of this study in terms of school categories indicate that SCTBE learning is more suitable to be applied to middle category schools that have active and independent characteristics. Students who are active and independent will have no difficulty in the problem exploration process. They will tend to enjoy the learning process because they have independent characteristics. The SCTBE learning model is an active learning model where students must practice exploring problems, finding patterns, and drawing conclusions. This superiority factor causes this learning model to improve students' mathematical analogy abilities in the middle school category.

REFERENCES

Anwar, V. N. (2012). *Pengaruh Pembelajaran Eksploratif Terhadap Peningkatan Kemampuan Penalaran, Kemampuan Komunikasi, Dan Karakter Matematis Siswa Sekolah Menengah Pertama* (Tesis, Universitas Pendidikan Indonesia Bandung).

Arista, E. D. W., & Mahmudi, A. (2020). Kemampuan Berpikir Kreatif Matematis Dalam Penyelesaian Soal Open-Ended Jenis PISA Berdasarkan Level Sekolah. *Pythagoras: Jurnal Pendidikan Matematika*, *15*(1), 87-99.

Azimi, S. N. (2016). *Penalaran Analogi Siswa SMP dalam Menyelesaikan Masalah Geometri* (Tesis, Universitas Negeri Malang).

Azmi, M. P. (2017). Asosiasi Antara Kemampuan Analogi Dengan Komunikasi Matematik Siswa SMP. *Al-Jabar: Jurnal Pendidikan Matematika*, *8*(1), 91-100.

Basir, M. A., Ubaidah, N., & Aminudin, M. (2018). Penalaran Analogi Siswa dalam Menyelesaikan Masalah Trigonometri. *Wacana Akademika: Majalah Ilmiah Kependidikan*, *2*(2), 198-210.

Dane, E., & Pratt, M. G. (2009). Conceptualizing And Measuring Intuition: A Review Of Recent Trends. *International review of industrial and organizational psychology*, *24*(1), 1-40.

Daniarti, E., & Nursangaji, A. (2015). Kemampuan Penalaran Matematis Ditinjau Dari Analogi Siswa Dalam Materi Aljabar di SMP. *Jurnal Pendidikan Dan Pembelajaran Khatulistiwa*, *4*(4).

English, L. D. (Ed.). (2004). *Mathematical and Analogical Reasoning of Young Learners*. London: Lawrence Erlbaum Associates.

Gentner, D., Holyoak, K. J., & Kokinov, B. (2001). *The Analogical Mind: Perspectives from Cognitive Science.* Cambridge, MA: MIT Press.

Goswami, U. (2004). Commentary: Analogical Reasoning and Mathematical Development. In English, L. D, *Mathematical and Analogical Reasoning of Young Learners*. London: Lawrence Erlbaum Associates.

Huda, M. (2017). Meningkatkan Kemampuan Memecahkan Masalah Matematis Siswa MAN Babat Melalui Strategi Pembelajaran Eksploratif. *Prisma Prosiding Seminar Nasional Matematika*, 114-123.

Irma, I. M. (2019). Efektivitas Model Pembelajaran Discovery Dengan Setting Kooperatif Ditinjau Dari Kemampuan Analogi Dan Generalisasi Matematis Siswa Kelas Vii Mts Al-Fakhriyah Makassar. *Pedamath Journal on Pedagogical Mathematics*, *2*(1), 42-55.

Karabiyik, C. (2019). The Relationship Between Student Engagement And Teriary Level English Language Learners' Achievement. *International Online Journal of Education and Teaching*, 6 (2), 281-293.

Kariadinata, R. (2012). Menumbuhkan Daya Nalar (Power of Reason) Siswa melalui Pembelajaran Analogi Matematika. *Infinity Journal*, *1*(1), 10-18.

Khotimah, K., & Sutirna, S. (2021). Analisis Kemampuan Analogi Matematis Siswa Pada Materi Segiempat. *Maju: Jurnal Ilmiah Pendidikan Matematika*, *8*(1).

Kurniadi, G., & Purwaningrum, J. P. (2018). Kesalahan Siswa Pada Kategori Kemampuan Awal Matematis Rendah Dalam Penyelesaian Tes Kemampuan Pemecahan Masalah Matematis. *JPPM (Jurnal Penelitian dan Pembelajaran Matematika)*, *11*(2).

Kusumawati, E., & Irwanto, R. A. (2016). Penerapan Metode Pembelajaran Drill Untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis Siswa Kelas VIII SMP. *EDU-MAT: Jurnal Pendidikan Matematika*, *4*(1).

Lestari, W. (2017). Pengaruh Kemampuan Awal Matematika Dan Motivasi Belajar Terhadap Hasil Belajar Matematika. *Jurnal Analisa*, *3*(1), 76-84.

Lei, H., Cui, Y., & Zhou, W. (2018). Relationships Between Student Engagement And Academic Achievement: A Meta-Analysis. *Social Behavior And Personality: An International Journal*, 46(3), 517-528

Maryam, S., & Aeni, A. N. (2016). Pendekatan Eksploratif Untuk Meningkatkan Kemampuan Representasi Matematis Dan Kepercayaan Diri Siswa. *Jurnal Pena Ilmiah*, *1*(1), 551-560.

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).

Maarif, S. (2016). Improving Junior High School Students' Mathematical Analogical Ability Using Discovery Learning Method. *International Journal of Research in Education and Science*, *2*(1), 114-124.

Mofidi, S.A., & Parvaneh A. 2012. Instruction of Mathematical Concept Through Analogical Reasoning Skills. *Indian Journal of Science and Technology*, 5(6).

Ningrum, R. K. (2013). Profil Penalaran Permasalahan Analogi Siswa Sekolah Menengah Pertama Ditinjuau Dari Perbedaan Gender. *MATHEdunesa*, *2*(3).

Ningrum, R. K., & Rosyidi, A. H. (2013). Profil Penalaran Permasalahan Analogi Siswa Sekolah Menengah Pertama Ditinjuau Dari Perbedaan Gender. *Jurnal Mahasiswa Teknologi Pendidikan*, *3*(2), 1-8.

Nurhalimah, H., & Haerudin, H. (2021). Analisis Kemampuan Berpikir Analogi Matematis Siswa Smp Dalam Menyelesaikan Soal Limas. *Maju: Jurnal Ilmiah Pendidikan Matematika*, *8*(1).

Panggabean, S., & Sumardi, H. (2018). Pengaruh Metode Drill Terhadap Hasil Belajar Matematika Siswa SMP Pertiwi Medan. *Jurnal MathEducation Nusantara*, *1*(1), 89-96.

Pearse, M., & Walton, K. M. (2011). *Teaching Numeracy: 9 Critical Habits to Ignite Mathematical Thinking*. Corwin Press.

Rahman, R., & Maarif, S. (2014). Pengaruh Penggunaan Metode Discovery Terhadap Kemampuan Analogi Matematis Siswa SMK Al-Ikhsan Pamarican Kabupaten Ciamis Jawa Barat. *Infinity Journal*, *3*(1), 33-58.

Reyes, M. R., Brackett, M. A., Rivers, S. E., White, M., & Salovey, P. (2012). Classroom Emotional Climate, Student Engagement, And Academic Achievement. *Journal of Educational Psychology*, 104(3), 700-712.

Ridhoi, M., Sulandra, I. M., Sukoryanto, S., & Nusantara, T. (2020). Analisis Kemampuan Penalaran Analogis Siswa SMP dalam Menyelesaikan Masalah Matematika. *Jurnal Pendidikan Matematika dan Sains*, *8*(1), 21-25.

Rohaeti, E. E. (2008). *Pembelajaran Dengan Pendekatan Eksplorasi Untuk Mengembangkan Kemampuan Berfikir Kritis Dan Kreatif Matematika Siswa SMP* (Doctoral dissertation, Universitas Pendidikan Indonesia Bandung).

Rusmiyati, F. (2017). Pengaruh Kemandirian Dan Kebiasaan Belajar Terhadap Prestasi Belajar Metematika Siswa Kelas X SMA Negeri 1 Rongkop. *Union: Jurnal Pendidikan Matematik*, *5*(1), 77-85.

Sahadatina, D. D. N. (2018). *Pembelajaran Geometri dengan Pendekatan SAVI Berbantuan GeoGebra untuk Meningkatkan Analogi Matematis Siswa Kelas VII IT 1 MTs Negeri Probolinggo* (Doctoral dissertation, Universitas Negeri Malang).

Salamah, A., Nuriadin, I., & Kurniasih, M. D. (2018). Pengaruh Strategi Knowledge Sharing Berbantu Software Geogebra terhadap Kemampuan Analogi Matematis Siswa di SMA Negeri 5 Jakarta. *Prosiding Senamku*, *1*, 153-167.

Sari, N. M. (2010). *Pengaruh Model Pembelajaran Snow Cube Throwing Terhadap Hasil Belajar Dan Minat Siswa* (Skripsi, Universitas Pasundan Bandung).

Sari, N. M. (2015). Meningkatkan Kemampuan Pemecahan Masalah Matematis Dengan Metode Eksplorasi. *AlphaMath: Journal of Mathematics Education*, *1*(1).

Sari, N. M. (2017). The Effectiveness Of Snow Cube Throwing Learning Model Based On Exploration. *AIP Conference Proceedings*, 1868(1), 050016. AIP Publishing LLC.

Sarina, V., & Namukasa, I. K. (2010). Nonmath Analogies In Teaching Mathematics. *Procedia-Social and Behavioral Sciences*, *2*(2), 5738-5743.

Setiawati, F. (2019). *Penerapan Model Pembelajaran Sinektik Berbasis Software Geogebra Untuk Meningkatkan Kemampuan Analogi Matematis Dan Self Confidence Siswa* (Doctoral dissertation, UIN Sunan Gunung Djati Bandung).

Shadiq, F. (2013). Penalaran dengan Analogi? Pengertiannya dan Mengapa Penting. *Widyaiswara PPPPTK Matematika*, 1-7.

Shodikin, A. (2015). Interaksi Kemampuan Awal Matematis Siswa dan Pembelajaran Dengan Strategi Abduktif-Deduktif Terhadap Peningkatan Kemampuan Penalaran dan Disposisi Matematis Siswa. *Inspiramatika*, *1*(1), 61-72.

Subhan, A., Fatmaryanti, S. D., & Nurhidayati, N. (2013). Keaktifan Bertanya Siswa Dengan Menggunakan Model Pembelajaran Aktif Tipe Card Sort Pada Kelas X Madrasah Aliyah Wathoniyah Islamiyah Karangduwur. *Radiasi: Jurnal Berkala Pendidikan Fisika*, *2*(1), 18-20.

Sulhiah, S. (2019). Pengaruh Metode Discovery terhadap Prestasi Analogi Matematis Peserta Didik SMKN 1 Sakra. *Fondatia*, *3*(2), 74-88.

Sugiman, S., & Kusumah, Y. S. (2010). Dampak pendidikan matematika realistik terhadap peningkatan kemampuan pemecahan masalah siswa SMP. *Indonesian Mathematical Society Journal on Mathematics Education*, *1*(1), 41-52.

Tohir, M. (2019). Menjadikan Para Siswa Aktif Bertanya dalam Kelas Matematika Berdasarkan Kurikulum 2013.

Uludag, O. (2016). The Mediating Role Of Positive Affectivity On Testing The Relationship Of Engagement To Academic Achievement: An Empirical Investigation Of Tourism Students. *Journal of Teaching in Travel & Tourism*, 16(3), 163-177.

Xu, B., Chen, N. S., & Chen, G. Effects Of Teacher Role On Student Engagement In Wechat-Based Online Discussion Learning. *Computers & Education*. 157(2020) pp. 103956.

Viniarsih, Sugiatno & Bistari. (2015). Kemampuan Koneksi Siswa Ditinjau Dari Kemampuan Analogi Matematis Dalam Materi Bangun Ruang Sisi Datar. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa*, 4(4), 1-13.

Wahyuni, N. (2016). Penggunaan Metode Drill Dalam Pembelajaran Matematika. *Prosiding Seminar Nasional Cokroaminoto Palopo*, *2*(1).

Widiyatmoko, S. (2020). Deskripsi Penalaran Analogi Ditinjau dari Tipe Kepribadian David Keirsey Siswa SMP Negeri 1 Ajibarang. *AlphaMath: Journal of Mathematics Education*, *4*(2), 9-14.