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The Influence of the Application of Discovery Learning and Problem Based Learning Models on Mathematical Creative Thinking Abilities Viewed from the Self-Directed Learning of SMK

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ABSTRACT

Mathematical creativity is still lacking in Revany Indra Putra Vocational School in Jambi City when it comes to solving mathematical puzzles. The purpose of this study is to ascertain the following: 1. How students' mathematical creative thinking abilities are affected when Discovery Learning, Problem Based Learning, and Direct Instruction models are applied; 2. How students' mathematical abilities are affected when they self-directed learn; and 3. How students' mathematical creative thinking abilities are impacted when learning models are applied and self-directed learning occurs. With an experimental group and a control group, this study is quasi-experimental in nature. Using the Simple Random Sampling method, samples were drawn at random. Mathematical creative thinking ability test questions, self-directed learning questionnaires, and observation sheets for learning models are the tools employed. Two-way ANOVA analysis was used to assess the data from this study. First hypothesis findings were 0.017 <0.05, second hypothesis results were 0.019 <0.05, and third hypothesis results were 0.000 <0.05. The following conclusions can be drawn: 1. The use of Discovery Learning, Problem Based Learning, and Direct Instruction models has an impact on students' mathematical creative thinking abilities; 2. Learning independence has an impact on students' mathematical creative thinking abilities; and 3. There is an interaction between the use of model learning and students' self-directed learning with regard to their capacity for mathematical creativity.

Keywords: discovery Learning, mathematical creative thinking ability; PBL; ; self-directed learning

INTRODUCTION

Fostering original thought, curiosity, prediction, and hypothesis are some of the ways that mathematics education aims to create creative behaviors involving intuition, creativity, and discovery. This highlights the value of using creative activities to foster quantitative thinking skills during the learning process. stated that the development of creative mathematical thinking abilities, namely the ability to solve mathematical problems creatively, is necessary in mathematics education (Bernard & Setiawan, 2020; Septian et al., 2021; Setiawan et al., 2021; Widodo et al., 2020).

However, in reality, students' mathematical creative thinking abilities are relatively low. The problem often encountered and addressed in mathematics education is the low level of students' mathematical creative thinking abilities. Only a few students succeed in achieving creativity, while the majority still fall short of expectations in creative mathematical thinking (Ndiung et al., 2020; Septian, 2022).

SMK Revany Indra Putra observations showed that pupils' comprehension, problem-solving, and ability to provide a variety of alternative answers are all lacking. Put differently, students frequently provide the same responses and occasionally only adhere to the directions in the textbook or accepted practices. Pupils don't seem to be coming up with fresh ideas; instead, they seem to be following teacher directions and showing little initiative to try solving problems on their own.

A model that puts students at the center of their education and gives them lots of chances to hone their creative thinking skills is required to address these problems. Teachers are required to choose the appropriate instructional model that can enhance an active and meaningful learning environment, where students have a better grasp and understanding of the subject matter, resulting in improved learning outcomes (Azmi & Sopiany, 2022; Rohmah et al., 2020). Some models that emphasize student-centered learning include Discovery Learning and Problem-Based Learning, where both models focus on students working collaboratively to solve problems. Students' creative mathematical thinking abilities are better when they receive problem-based learning compared to conventional learning. Students' creative mathematical thinking abilities with problem-based learning are classified as good, while those with conventional learning are classified as moderate (Faturohman & Afriansyah, 2020; Rohaendi & Laelasari, 2020). Thus, the main goal of Discovery Learning and Problem-Based Learning models is to develop intellectual skills, creative thinking, and the ability to solve problems scientifically.

Taking all of the above into account, the goals of this research are to ascertain whether the following are true: (1) Does the application of the Discovery Learning, Problem-Based Learning, and Direct Instruction models affect students' creative mathematical thinking abilities at SMK Revany Indra Putra in Jambi City; (2) Does learning independence affect the creative mathematical thinking abilities of students at Jambi City's SMK Revany Indra Putra; and (3) whether learning independence, problem-based learning, direct instruction, and discovery learning interact to foster students' capacity for creative mathematical thinking.

RESEARCH METHODS

This kind of study is known as quasi-experimental study. The 92 students in class X of Revany Indra Putra Vocational High School in Jambi City for the academic year 2022–2023 comprise the population under study. These students are split into four classes: TKJ I (22 students), TKJ II (21 students), Marketing (27 students), and Accounting (22 students).

Through the use of a lottery and a basic random sampling technique, three classes were chosen at random from the population to serve as the experimental and control groups. The classes that were chosen are the Accounting class as experimental group 1, which uses the Discovery Learning model; the Marketing class as experimental group 2, which uses the Problem Based Learning model; and the TKJ I class as the control group, which uses the Direct Instruction model. These results are based on the lottery results of the sample classes from the population of class X of Revany Indra Putra Vocational High School in Jambi City for the academic year 2022/2023. The study's instruments will be validated using the TKJ II class in order to satisfy validity requirements.

The independent variables in this study are the problem-based learning and discovery learning models; the dependent variable is the students' capacity for mathematical creativity; the moderating variable is their self-directed learning. To ascertain the impact of the A test of students' mathematical creative thinking ability is administered, taking into consideration their self-directed learning, using the Discovery Learning (DL) and Problem Based Learning (PBL) models. The trigonometric ratios topic from Vocational High School's class X mathematics course in the even semester of the 2022–2023 academic year is the source of the test questions. The essay-style test questions used in this study to gauge students' aptitude for mathematical creativity were given to both the experimental and control groups. Pretest and posttest are the two components of the instrument used to measure creative thinking in mathematics. The purpose of the pretest is to evaluate the students' initial capacity for mathematical creativity, and the posttest is used to.

A two-way analysis of variance (ANOVA) is used in this study's hypothesis testing to see if the research groups' means differ from one another. The purpose of this study's first hypothesis is to determine how students' capacity for mathematical creativity is affected when the Discovery Learning (DL), Problem Based Learning (PBL), and Direct Instruction (DI) models are used. The purpose of Hypothesis 2 is to investigate how students' capacity for mathematical creativity is impacted by self-directed learning. The third hypothesis seeks to investigate how students' capacity for mathematical creativity is impacted by the application of the Discovery Learning (DL), Problem Based Learning (PBL), and Direct Instruction (DI) models.

A two-way analysis of variance is used to test the hypothesis results (ANOVA). An analysis of comparison for more than two variables or more than two means is called an ANOVA. Comparing more than two means is its goal.

RESULTS AND DISCUSSION

Table 1 displays the data for the creative thinking pretest results of the students, and Table 2 displays the data for the students' posttest results.

Table 1. Description of Pre-test Data Students' Creative Thinking Abilities

Pre-Test	N	Minimum	Maximum	Mean	Std. Deviation
Control	22	10	43	29.27	8.564
Experiment 1	22	19	50	30.73	8.680
Experiment 2	27	15	50	31	9.668

Tabel 2. Description of Post-test Data Students' Creative Thinking Abilities

Pre-Test	N	Minimum	Maximum	Mean	Std. Deviation
Control	22	41	79	59.73	11.132
Experiment 1	22	40	87	71.55	10.680
Experiment 2	27	55	85	68.22	8.206

Subsequently, to perform a two-way ANOVA, it is imperative to ascertain if the students' posttest scores exhibit a normal distribution and homogeneity. Tables 3 and 4 present the findings of the tests for homogeneity and normaly.

Tabel 3. Post-Test Data Normality Test Results: Students' Creative Thinking Ability

Class	Sig.	Information	Decision
Control	0.200	0.200 > 0.05	Normally Distributed Data
Experiment 1	0.200	0.200 > 0.05	Normally Distributed Data
Experiment 2	0.199	0.199 > 0.05	Normally Distributed Data

Tabel 4. Post-Test Data Homogeneity Test Results: Students' Creative Thinking Ability

Homogeneity Test	Sig.	Information	Decision
Levene Statictic	0.249	0.249 > 0.05	Homogen

The Analysis of Variance (ANOVA) test is used to test the hypothesis once the presumptions have been met. With a 95% confidence level, the hypotheses are tested using Univariate Analysis of Variance (ANOVA) or Two-Way ANOVA with support from SPSS 25 software. There is no significant difference found in the test results for the variables being tested if the significance level (p-value) is ≥ 0.05.

Table 5. The Study's Hypothesis Testing

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	4133.453a	8	516.682	7.514	0.000
Intercept	200538.974	1	200538.974	2916.398	0.000
Model	597.852	2	298.908	4.347	0.017
Kemandirian	582,852	2	291.426	4.238	0.019
Model*Kemandirian	1714.124	4	428.331	6.232	0.000
Error	4263.279	62	68.763		
Total	323508.00	71			
Corrected Total	8396.732	70			

The significance value of the learning models on the test results of creative thinking ability is 0.017, which is less than 0.05, according to the results of the hypothesis testing. As a result, using the Discovery Learning, Problem Based Learning, and Direct Instruction models has an impact on students' capacity for original thought. The test results of creative thinking ability show a significant relationship between self-directed learning and a significance value of 0.019, which is less than 0.05. This suggests that there is a relationship between the degree of self-directed learning and students' creative thinking ability. Furthermore, the importance value of On the test results of creative thinking ability, the interaction between the learning strategies and the degree of self-directed learning is 0.000, which is less than 0.05. This suggests that the degree to which students engage in self-directed learning and apply creative thinking when learning trigonometric ratios interacts with the learning models that are employed.

The Tukey test is then used in the analysis to ascertain the degree of influence on each variable. Table 6 displays the outcomes of the Tukey post test.

Table 6. Tukey Post Test

(I) Model Pembelajaran	(J) Model Pembelajaran	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
DL	PBL	3.32	2.382	0.350	-2,40	9.04
	Kontrol	11.82*	2.500	0.000	5,81	17.82
PBL	DL	-3.32	2.382	0.350	-9.04	2.40
	Kontrol	8.49*	2.382	0.002	2.78	14.21
Kontrol	DL	-11.82*	2.500	0.000	-17.82	-5.81
	PBL	-8.49*	2.382	0.002	-14.21	-2.78

A number of conclusions can be made from the Tukey test results in Table 6, including:

a. There is an 11.82 percent difference in the average posttest scores between students taught using the Discovery Learning and Direct Instruction models. Students from the control group who received instruction using the Direct Instruction model scored 11.82 points lower on the average than those who received instruction using the Discovery Learning model in their creative thinking ability.
b. There is an 8.49 difference in the average posttest scores between students taught using the PBL model and those taught using the traditional model. The creative thinking ability of students taught using the PBL model has an average test score 8.49 points higher than that of students taught using the Direct Instruction model.
c. There is a 3.32 difference in the average posttest scores between students who were taught using PBL and Discovery Learning. When using Discovery Learning, the average test score of students' creative thinking ability was 3.32 points higher than when using the PBL model. The distinction between these models, though, is not very noticeable in this instance.

The Tukey test was administered based on the degree of students' self-directed learning as well as the impact of the learning models that were employed. Table 7 displays the Tukey test results according to the degree of self-directed learning.

Table 7. Tukey Test Results According to The Degree of Self-Directed Learning

(I) Self-Directed Learning	(J) Self-Directed Learning	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
High	Medium	4.91	2.466	0.123	-1.01	10.83
	Low	8.50*	3.385	0.038	0.37	16.63
Medium	Low	3.59	2.893	0.435	-3.36	10.53
	High	-4.91	2.466	0.123	-10.83	1.01
Low	Medium	-3.59	2.893	0.435	-10.53	3.36
	High	-8.50*	3.385	0.038	-16.63	-0.37

It is clear from the Tukey test results in table 7 that students' capacity for creative thought is influenced by their degree of self-directed learning. In comparison to students who have a low or moderate level of self-directed learning, those who have a high level of self-directed learning tend to have higher average posttest scores for creative thinking. This indicates that there is an 8.50 point difference in the average posttest score of creative thinking ability between students who demonstrate a high level of self-directed learning and those who do not.

The learning model's significance value on the post-test scores of mathematical creative thinking ability is 0.017 < 0.05, as determined by the two-way ANOVA test results. Thus, H1 is approved, indicating that students' capacity for mathematical creativity is impacted by the application of Discovery Learning, Problem Based Learning, and Direct Instruction models.

S. Bruner's Learning Theory states that problem-based learning and discovery learning are two learning models that are connected to cognitive learning theory. In contrast to passively receiving information, students will be more engaged, enthusiastic, and gain a deeper understanding through the process of self-discovery, according to the discovery learning model, which integrates S. Bruner's learning theory.

Students are divided into five groups, each with four to five heterogeneous students, for the Discovery Learning process. Each group receives a worksheet that they must complete with the other members of their group. Students then report to the class on what they discussed in their groups.

The Discovery Learning model consists of the following steps: problem formulation, stimulation, data gathering, processing, verification, and generalization. Students' capacity for creative thought will grow as a result of the Discovery Learning model (Khofifah et al., 2021; Ririn et al., 2021).

The Problem Based Learning model, on the other hand, consists of five steps: introducing students to the issue, setting up the class for learning, directing both individual and group investigations, creating and presenting the work products, and assessing and evaluating the problem-solving procedure. Julyanasari et al. (2019) claim that because students solve the problems during the Problem Based Learning process, they are conditioned to comprehend concepts more fully. The instructor can require higher-order thinking from the class and actively involve them in problem-solving. As a result, students learn in a meaningful way using their preexisting schemas.

In contrast, the learning process in direct instruction centers on the teacher giving the students the material. This can be classified as a teacher-centered learning strategy. That students should only learn from their teachers and that in order for them to become proficient in the material they are being taught, they should listen to and watch all of their activities.

The teacher prepares the students for learning at the outset of the Direct Instruction process. After that, the instructor presents the content by outlining it on the whiteboard. The instructor concludes by summarizing and assigning homework. The results show that the experimental group's level of creative thinking ability is higher than the control group's, suggesting that the Discovery Learning and Problem Based Learning models have a stronger influence on students' mathematical creative thinking ability than the Direct Instruction model.

This is demonstrated by additional analysis using the Tukey test, which shows that students in the experimental group—taught using the Discovery Learning and Problem Based Learning models—have higher average scores on post-tests measuring their capacity for mathematical creativity than students in the control group, which was taught using the Direct Instruction model. The average scores for the experimental and control groups differ significantly from one another, as shown in the Tukey test results table. The difference in the average scores between the group with the Discovery Learning model and the Direct Instruction model is 11.82. Then, the difference in the average scores between the group taught with the Problem Based Learning model and the Direct Instruction model is 8.49. Meanwhile, in the group taught with the Discovery Learning and Problem Based Learning models, there is also a difference in the average scores, but it is not significant, namely 3.32, where the average score in the group with the Discovery Learning model is higher than the group taught with the Problem Based Learning model.

Students' mathematical creative thinking skills can be enhanced by using the Discovery Learning model. Furthermore, Problem Based Learning (PBL) is an instructional approach that can help students investigate mathematical ideas, include them in the process, and increase their level of engagement. Additionally, students can base their learning process on the presentation of real-world problems. The aforementioned research suggests that using PBL and Discovery Learning models in the classroom is a suitable way to help students develop their creative thinking skills in mathematics.

For the variable of students' self-directed learning toward the post-test results of their mathematical creative thinking ability, the hypothesis test using a two-way ANOVA obtained a significance value of 0.019, which is smaller than 0.05. This suggests that the degree of students' self-directed learning influences the differences in the test results of mathematical creative thinking ability; hence, the hypothesis is either accepted or rejected. In summary, students' degree of self-directed learning affects their capacity for creative thought.

According to the analysis's findings, students who practice self-directed learning at a high level outperform those who practice it at a moderate or low level in terms of their capacity for creative thought. This variation in the capacity for creative thought is also evident throughout the learning process in the three classes the researcher teaches. The study discovered that pupils who exhibit strong levels of self-directed learning also frequently possess strong creative thinking skills in mathematics. This is demonstrated by the differences in average scores for mathematical creative thinking ability between students who have high, moderate, and low levels of self-directed learning when it comes to answering the post-test questions on trigonometric ratio material.

There is a significant difference in the test results of mathematical creative thinking ability between students with high and low levels of self-directed learning, according to the Tukey test results for the variable of students' self-directed learning. Students who exhibit high levels of self-directed learning typically outperform students who exhibit low levels of self-directed learning by an average of 8.50 points. The degree of students' self-directed learning determines the division of the average creative thinking ability scores into highest and lowest categories. However, the difference in average scores obtained is not significant for students with moderate and low or moderate and high levels of self-directed learning.

A significance value of $0.000 < 0.05$ was obtained based on the hypothesis test results of the two-way ANOVA conducted on the students' creative thinking abilities post-test, indicating that H0 is rejected or H1 is accepted. Put another way, it can be said that there is a relationship between students' mathematical creative thinking abilities and the Discovery Learning, Problem Based Learning, and Direct Instruction models at high, moderate, and low levels of self-directed learning.

As seen in Figure 1 below, the graph displays the estimated marginal mean post-test values for each learning model according to the degree of self-directed learning.

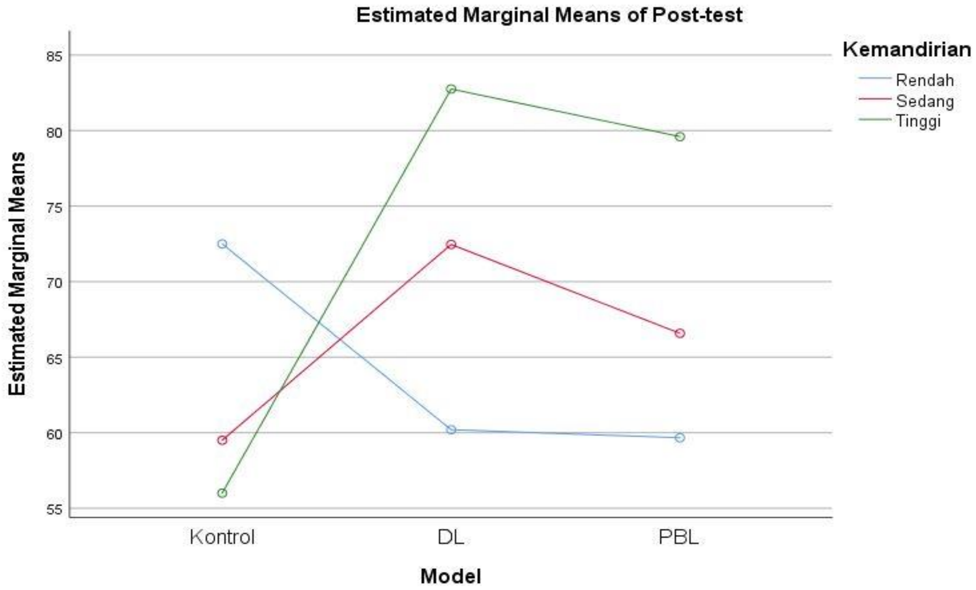

Figure 1. The Estimated Marginal Mean Post-Test Values for Each Learning Model According to The Degree of Self-Directed Learning

There is an interaction between the degree of learner autonomy and the learning model, as seen in the above image. The graph shows that learners with high levels of autonomy outperform those with moderate or low levels of autonomy in the experimental classes using the Discovery Learning and Problem Based Learning models. In contrast to students with moderate and high levels of autonomy, those in the control class who have low levels of autonomy actually receive higher average scores.

Investigative Education and Problem-Based Learning models are those that are focused on helping students solve problems. After being presented with a problem to research, students use their own abilities to build concepts and principles of a subject, incorporating prior knowledge and skills. These learning models also necessitate learners' active participation, giving them chances to find and use their own solutions to problems, which fosters the development of creative thinking skills. In order to assess the precision of newly acquired knowledge or the problem-solving methodology, students must go over the developed problem-solving procedures, thereby refining their critical thinking abilities.

The application of learning processes utilizing the Discovery Learning and Problem Based Learning models can be supported by effective learner autonomy. Analyzing, assessing, and planning their learning processes well are characteristics of independent learners. They don't need assistance from others to guide and control their own thoughts and behaviors. On the other hand, in Direct Instruction, students who possess a high degree of autonomy merely sit and pay attention to the teacher's presentation in front of the class.

Teachers assist students in the learning process in the problem-based learning and discovery learning models, while highly autonomous learners look for pertinent materials on their own to hone their creative problem-solving skills. Students who possess a high degree of autonomy are capable of finishing the tasks they are given. As a result, students who have a high degree of autonomy when learning mathematics are more likely to use problem-based learning and discovery learning approaches to their advantage. The ability of students to participate in educational activities freely and independently, allowing them to express their own creativity, is referred to as learner autonomy (Khofifah et al., 2021; Tanjung et al., 2020).

Therefore, in influencing learners' learning creativity, the use of direct instruction, problem-based learning, and discovery learning interacts with the degree of learner autonomy.

CONCLUSION

The following conclusions can be made in light of the research findings and discussions that have been presented:

a. Students at Smk Revany Indra Putra in Jambi City have stronger mathematical creative thinking skills when it comes to trigonometric ratios because of the impact of problem-based learning and discovery learning models.
b. Learner autonomy affects students' capacity for mathematical creativity at Smk Revany Indra Putra in Jambi City, particularly when it comes to the study of trigonometric ratios.
c. At SMK Revany Indra Putra in Jambi City, there is a relationship between learner autonomy and the Discovery Learning and Problem Based Learning models with regard to students' capacity for creative thought.

REFERENCES

Azmi, S. N., & Sopiany, H. N. (2022). Respon Peserta Didik SMP terhadap Penggunaan Google Classroom dalam Pembelajaran Matematika Secara Online. *Prisma*, *11*(2), 339. https://doi.org/10.35194/jp.v11i2.2377

Bernard, M., & Setiawan, W. (2020). Development of Geometry Analysis Using Geogebra Scripting in terms of Student Cognitive Capabilities. *Journal of Physics: Conference Series*, *1521*(3). https://doi.org/10.1088/1742-6596/1521/3/032103

Faturohman, I., & Afriansyah, E. A. (2020). Peningkatan Kemampuan Berpikir Kreatif Matematis Siswa melalui Creative Problem Solving. *Mosharafa: Jurnal Pendidikan Matematika*, *9*(1), 107–118. https://doi.org/10.31980/MOSHARAFA.V9I1.562

Julyanasari, N., Praja, E. S., Noto, M. V., Sunan, U., & Djati, G. (2019). Problem Based Learning Model on The Ability of Students Mathematical Connection. *PRISMA*, *8*(2), 167–172. https://doi.org/10.35194/jp.v8i2.400

Khofifah, L., Supriadi, N., & Syazali, M. (2021). Model Flipped Classroom dan Discovery Learning terhadap Kemampuan Pemahaman Konsep dan Pemecahan Masalah Matematis. *PRISMA*, *10*(1), 17–29. https://doi.org/10.35194/jp.v10i1.1098

Ndiung, S., Sennen, E., Helmon, A., & Jediut, M. (2020). Efektivitas Model Pembelajaran Treffinger dalam Menumbuhkan Keterampilan Berpikir Kreatif Peserta Didik Sekolah Dasar. *PRISMA*, *9*(2), 167–178.

Ririn, R., Budiman, H., & Muhammad, G. M. (2021). Peningkatan Kemampuan Berpikir Kritis Matematis dan Kemandirian Belajar Siswa melalui Model Pembelajaran Problem Solving. *MATHEMA: JURNAL PENDIDIKAN MATEMATIKA*, *3*(1), 1. https://doi.org/10.33365/jm.v3i1.772

Rohaendi, S., & Laelasari, N. I. (2020). Penerapan Teori Piaget dan Vygotsky Ruang Lingkup Bilangan dan Aljabar pada Siswa Mts Plus Karangwangi. *Prisma*, *9*(1), 65. https://doi.org/10.35194/jp.v9i1.886

Rohmah, W. N., Septian, A., & Inayah, S. (2020). Analisis Kemampuan Penalaran Matematis pada Materi Bangun Ruang Ditinjau dari Gaya Kognitif Siswa. *Prisma*, *9*(2), 179–191.

Septian, A. (2022). Student’s mathematical connection ability through GeoGebra assisted project-based learning model. *Jurnal Elemen*, *8*(1), 89–98. https://doi.org/10.29408/jel.v8i1.4323

Septian, A., Ramadhanty, C. L., Darhim, D., & Prabawanto, S. (2021). Mathematical Problem Solving Ability and Student Interest in Learning using Google Classroom. *Prosiding International Conference on Education of Suryakancana*, *1*(1), 155–161.

Setiawan, E., Jusniani, N., & Sutandi, A. (2021). Analisis Kesalahan Mahasiswa Dalam Menyelesaikan Soal Interpolasi Berdasarkan Analisis Kesalahan Newman. *Prisma*, *10*(2), 221. https://doi.org/10.35194/jp.v10i2.1596

Tanjung, D. F., Syahputra, E., & Irvan, I. (2020). Problem Based Learning, Discovery Learning, and Open Ended Models: An experiment On Mathematical Problem Solving Ability. *JTAM | Jurnal Teori Dan Aplikasi Matematika*, *4*(1), 9–16. https://doi.org/10.31764/jtam.v4i1.1736

Widodo, S., Septianiady, & Rahayu, P. (2020). Kemampuan Pemecahan Masalah Matematika Bermuatan Nilai Islam. *Prisma*, *9*(2), 192–195.