Discovery learning for problem-solving ability and self-efficacy

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Abstract

Mastering problem-solving skills and fostering self-efficacy are crucial for student success as they equip individuals with the confidence and adaptability needed to navigate challenges effectively both academically and in real-life situations. However, the problem-solving skills of students and their self-efficacy are still relatively low. This study aims to assess the effectiveness of implementing the discovery learning model in enhancing students' problem-solving skills and self-efficacy. This study uses a mixed-method approach with high school students from one of the schools in Purwakarta. The sample is made up of two classes, one of which uses discovery learning and the other of which uses traditional classroom methods. with instruments including problem-solving ability test questions, self-efficacy questionnaires, observation sheets, and interviews. Data analysis is conducted using an independent sample t-test. The instruments used include tests and non-tests, namely problem-solving tests, self-efficacy scale questionnaires, observation sheets, and interviews. The research discovered notable variances in the mathematical problem-solving skills and self-efficacy of students who engaged in discovery learning versus those who engaged in conventional learning. It found that students in the discovery learning group exhibited better problem-solving skills and higher self-efficacy. Additionally, the study revealed a positive correlation between students' mathematical problem-solving abilities and their self-efficacy.
Keywords: discovery learning, problem-solving skill, conventional, mathematics, self-efficacy.

How To Cite: Faoziah, N., Virgianti, E., & Setiawan, D. (2024). Discovery Learning For Problem-Solving Ability And Self-Efficacy. *Journal on Mathematics Education, 14*(1), 35-44 http://doi.org/10.22342/jme.v13i1.13308

INTRODUCTION

Education is one of the key aspects in forming individuals who are qualified and able to compete in this era of globalization. In the educational context, the importance of developing students' problem-solving abilities and self-efficacy is the main focus (Mintasih, 2018). Problem-solving ability is a core skill needed to face the challenges of everyday life, both in academic and professional contexts (Afrilia, et al., 2023). On the other hand, self-efficacy, namely an individual's belief in his or her ability to overcome the tasks at hand, is a factor that influences student motivation and learning performance. (Priska, et al., 2020).

From existing data in Indonesia, the level of student self-efficacy in mathematics subjects is still low, especially in terms of understanding complex mathematical concepts. This low level of self-efficacy can also hinder students' ability to solve problems in mathematics (Nugraha & Wulansari, 2023).

The results of the 2018 PISA survey show that of the 79 countries assessed, the number of students aged 15 years, amounting to 600,000, has decreased compared to the results of the 2015 PISA survey (OECD, 2019). In the mathematics category, Indonesia is ranked 7th from the bottom with an average score. In the 2015 PISA survey, Indonesia was ranked 62nd out of 70 countries with an average mathematics ability score of 386 (Hermaini & Nurdin, 2020). In addition, the study conducted by Utami & Wutsqa, (2017) also concluded that students' mathematical problem-solving abilities were at a low level. This shows the need to improve students' mathematical abilities, including mathematical problem-solving

abilities. One effort to improve students' mathematical problem-solving abilities is to choose a learning model that suits learning needs so that problem-solving abilities can be improved.

Problem solving in mathematics learning is a key aspect of basic abilities in the learning process (Sariningsih & Purwasih, 2017). This problem-solving ability is closely related to the students' self-efficacy in solving problems because the confidence held by students will influence every step in solving problems (Utami & Wutsqa, 2017). Research by Bandura & Schunk (1981) shows that the higher the level of self-confidence, the faster students are in solving mathematics problems, are able to persist in solving problems, and are more careful in carrying out computations in mathematics learning. (Zakiyah & Yusritawati, 2023).

In an effort to improve students' problem solving abilities and self-efficacy, the learning approach is a key factor that needs to be considered. One learning model that is known to be effective in facilitating the active learning process and increasing student involvement is the Discovery Learning Learning Model (Salo, 2016). This model emphasizes the active role of students in discovering new knowledge through exploration, observation and reflection (Hutajulu, 2021).

According to Huang & Yang, (2018), using the discovery learning model in mathematics learning can provide several benefits. One of them is helping students develop critical and creative thinking skills, as well as improving their skills in solving problems. One option to overcome challenges in learning mathematics is to use the discovery learning model. This learning model allows the development of students' understanding through direct experience in solving problems, which has the potential to increase students' learning achievement and level of self-efficacy (Nugraha & Wulansari, 2023).

However, although many studies have highlighted the benefits of the Discovery Learning Learning Model, not many studies have specifically focused on its effect on increasing students' problem-solving abilities and self-efficacy, especially in the context of formal education at the secondary school level. Several previous studies that discussed the discovery learning model include research conducted by Fazriansyah, (2023) discusses the benefits of the discovery learning model in improving students' communication skills, as well as evaluating the level of student self-efficacy during the application of this learning model. Meanwhile the study of Rahmi, et al.., (2020) researching students' understanding of mathematical concepts and the effect of self-efficacy on students' conceptual understanding after implementing the discovery learning model. Nugraha & Wulansari, (2023) through literature studies, exploring how the use of discovery learning models can improve students' learning achievement and self-efficacy in learning mathematics. Fajri, et al.., (2017) researched increasing students' spatial abilities and self-efficacy using a multimedia-based discovery learning model. In addition, research by Nurcahyo, et al., (2018) examines the application of the discovery learning model with a scientific learning approach to improve students' critical thinking skills in history learning. Considering the importance of these skills in helping students face future challenges, this research aims to determine the effectiveness of implementing the Discovery Learning Learning Model in improving students' problem-solving abilities and self-efficacy in a secondary school environment. By evaluating and understanding the positive impact of implementing this learning model, it is hoped that it can make a significant contribution to learning practices that are more effective and oriented toward the holistic development of student potential.

METHODS

This research uses a mixed method. This method was chosen because it provides additional support to a single method (in this case quantitative). A qualitative approach was integrated to strengthen and confirm the results of the quantitative analysis (Indrawan & Yaniawati, 2017). The research design chosen

was a non-equivalent pretest-posttest control group design which is explained in the following description (Sopari, et al., 2022):

O X O
O O

O : Pretest/posttest mathematical problem-solving abilities
X : Treatment given

This research was conducted at a high school in Purwakarta Regency in the 2023/2024 academic year. The research sample consisted of 11th-grade students, with two classes selected, consisting of one control group class with 34 students, and one experimental group class with 32 students. Previously, a pretest was carried out in both classes to measure students' initial abilities in solving mathematical problems. The pretest result data was analyzed by following the steps of normality test, homogeneity test, and t-test using the Independent Sample T-Test (Faoziyah, 2023).

After the treatment is given, a posttest is carried out to evaluate students' mathematical problem-solving abilities after receiving the treatment. The post-test data was then analyzed by following the steps of normality test, homogeneity test, and t-test using the Independent Sample T-Test. To find out the comparison of the increase in mathematical problem-solving abilities between the experimental class and the control class, the analysis was continued using the n-gain test from the pretest and posttest results. Analysis of the questionnaire was carried out by comparing the initial questionnaire and the final questionnaire. However, to measure the level of self-efficacy, observations, and interviews were also carried out with students to support the results of the questionnaire, which were then analyzed qualitatively. The normality test uses the Shapiro-Wilk test and the homogeneity test uses the Levene test with a significance level of 5% each. (Ismail, 2022).

To determine the increase in problem-solving ability and self-efficacy between the experimental class and the control class, use the n-gain test with the following formula:

Normalized Gain = $\frac{\%\ Posttest\ score - \%\ Pretest\ score}{100 - \%\ Pretest\ score}$, Hake (Hidayat, et al.., 2020). With interpretation by Table 1 below:

Table 1. Interpretation of gain values (g)

Mean of Normalized Gain	Classification
(g) ≥ 0,70	High
0,30 ≤ (g) > 0,70	Medium
(g) < 0,30	Low

RESULTS AND DISCUSSION

The results of descriptive statistical analysis of student pretest score data in the experimental class and control class are presented in Table 2.

Table 2. Descriptive Statistical Analysis of Pretest Scores

	N	Minimum	Maximum	Mean	Std. Deviation
Control class	34	32	58	43,50	7,696
Experiment class	32	31	56	42,03	6,611
Valid N (listwise)	32				

Based on Table 2 above, the averages of the two classes are different, but the difference is not significant, only a difference of 1.47. This indicates that the initial abilities in solving mathematical problems between the control class and the experimental class are almost the same. The pretest data has been tested for normality, with the results showing that the significance value for the experimental class is 0.440 and for the control class is 0.135. Both classes have a significance value greater than 0.05, so the null hypothesis is accepted, indicating that the pretest data from both classes are normally distributed. (Zakiyah & Yusritawati, 2023). After ensuring that the data comes from a normally distributed population, the next step is to test the homogeneity of variance. The homogeneity test results show a significance value of 0.351, which is also greater than 0.05, so the null hypothesis is accepted, indicating that the data from the two classes have homogeneous variance. (Ismail, 2022). Because the data is normally distributed and homogeneous, an Independent Sample T-Test analysis was carried out, with the following results:

Table 3. Independent Sample T-Test Pretest Data

		Sig.	t	df	Sig. (2-tailed)
Pretest KPM	Equal variances assumed	,351	,829	64	,410
	Equal variances not assumed		,833	63,488	,408

Table 3 explains that the significance value is 0.410 and is greater than 0.05, so the null hypothesis is accepted. This shows that there is no significant difference in mathematical problem-solving abilities between the two classes at the pretest (Wijaya & Marpaung, 2023). Descriptive statistical analysis of posttest score data for experiment class and control class students is as follows:

Table 4. Descriptive Statistical Analysis of Posttest Scores

	N	Minimum	Maximum	Mean	Std. Deviation
Control class	34	50	82	67,82	9,437
Experiment class	32	60	90	77,81	8,098
Valid N (listwise)	32				

From table 4, it can be seen that the average posttest score in the experimental class is higher than the control class. A significant difference can be seen with a difference of 9.99. The next stage is to carry out statistical tests, including normality and homogeneity tests. The following are the results of the normality test:

Table 5. Posttest Results Normality Test

Class	Shapiro-Wilk		
	Statistic	df	Sig.
Control class	0,952	34	0,143
Experiment class	0,959	32	0,261

The normality test results in table 5 show a significance value for the experimental class of 0.261 and for the control class of 0.143. Because both significance values are greater than 0.05, it can be concluded that the two classes have normal data distribution (Sopari, et al., 2022). Meanwhile, the results of the homogeneity test show a significance value of 0.544, which is also greater than 0.05, so the null hypothesis is accepted, indicating that the data from the two classes are homogeneous (Faoziyah, 2023). With normal and homogeneous data, the next step is to analyze using the Independent Sample T-Test, with the following results:

Table 6. Independent Sample T-Test Posttest Data

	t	df	Sig. (2-tailed)
Equal variances assumed	-4,601	64	0,000
Equal variances not assumed	-4,623	63,475	0,000

From table 6, there is a significance value of 0.000, which indicates that the alternative hypothesis is accepted. This means that there is a significant difference in mathematical problem-solving abilities between the two classes (Zakiyah & Yusritawati, 2023). To determine the difference in improvement in mathematical problem-solving abilities between the two classes, an n-gain test was carried out. The n-gain test results can be seen in the following table:

Table 7. N-Gain test result of mathematical problem-solving

Class	Average score of Pretest	Average score of Prosttest	Average N-Gain score	Criteria
Control	43,50	67,82	0,43	Medium
Experiment	42,03	77,81	0,62	Medium

From the averages in table 7 that have been presented, it can be concluded that there is a significant increase between the two classes. The average increase in problem-solving abilities in the experimental class was 0.62, while in the control class it was 0.43. In terms of this increase, the experimental class showed better results than the control class, and both were in the medium level category according to the n-gain criterion (Hidayat, et al., 2020).

To answer the problem question, whether students' self-efficacy decreased after learning mathematics using the discovery learning model, student self-efficacy data was collected through a self-efficacy scale questionnaire given to the experimental class and control class after learning or after treatment was given. However, first you need to know the student's initial self-efficacy abilities. The initial data from the questionnaire was analyzed first by testing its normality and homogeneity. The normality test results show a significance value for the experimental class of 0.735 and for the control class of 0.488. Both classes have a significance value greater than 0.05, indicating that both come from a normally distributed population (Sopari, et al., 2022). Meanwhile, the results of the homogeneity test show a significance value of 0.856, which is also greater than 0.05, so the null hypothesis is accepted, indicating that the data from the two classes are homogeneous. (Faoziyah, 2023). Therefore, an Independent Sample T-Test analysis was carried out with the following results:

Table 8. Independent Sample T-Test initial questionnaire data

		Sig.	t	df	Sig. (2-tailed)
initial questionnaire	Equal variances assumed	,856	,187	64	,852
	Equal variances not assumed		,187	63,648	,852

From Table 8, it can be seen that the significance value is more than 0.05, which indicates that the null hypothesis is accepted. This means that there is no significant difference in student self-efficacy between the two classes (Wijaya & Marpaung, 2023).

Data from students' self-efficacy questionnaires after the research were analyzed to evaluate students' self-efficacy after the research. Data from the questionnaire was analyzed first by testing normality and homogeneity. The results of the normality test showed that the significance value for the experimental class is 0.078 and for the control class is 0.064, with both significance values being greater than 0.05, indicating that both classes come from populations that have normal data distribution. (Sopari, et al., 2022). Furthermore, the significance value of the homogeneity test is 0.543, which is also greater than 0.05, so the null hypothesis is accepted, indicating that the data from the two classes are homogeneous (Ismail, 2022). Therefore, an Independent Sample T-Test was carried out with the following results:

Table 9. Independent Sample T-Test final questionnaire data

		Sig.	t	df	Sig. (2-tailed)
final questionnaire	Equal variances assumed	,543	-2,345	64	,022
	Equal variances not assumed		-2,339	62,747	,023

In Table 9, it can be seen that the significance value is less than 0.05, which indicates that the alternative hypothesis is accepted. This shows that there is a significant difference in student self-efficacy between the two classes (Zakiyah & Yusritawati, 2023). To determine which class is better, an n-gain test was carried out, and the results can be seen in the following table:

Table 10. N-Gain test Result of self-efficacy

Class	Average score of Pretest	Average score of Prosttest	Average N-Gain score	Criteria
Control	62,24	72,09	0,26	Low
Experiment	61,81	78,00	0,42	Medium

In Table 10, the experimental class shows better results than the control class. The criteria for the control class are low while the experimental class is medium (Hidayat, et al., 2020).

Correlation analysis is used to test the relationship between mathematical problem-solving abilities and students' self-efficacy.

Table 11. Correlation analysis result

		KPM Posttest	Final questionaire
KPM Posttest	Pearson Correlation	1	,655**
	Sig. (2-tailed)		,000
	N	32	32
Final questionnaire	Pearson Correlation	,655**	1
	Sig. (2-tailed)	,000	
	N	32	32

From Table 11, the significance value is less than 0.05, the null hypothesis is rejected and the alternative hypothesis is accepted. This indicates that there is a significant correlation between mathematical problem-solving abilities and the results of students' self-efficacy questionnaires (Utami & Wutsqa, 2017).

From observations in class at each meeting, there was significant improvement. Observation results will be presented as a percentage (%) at each meeting. The following are the results of observations during the learning process:

Table 12. Observation Results of Students Activities During the Learning Process

Kelas	1st meeting	2nd meeting	3rd meeting	Average
Control	60 %	67 %	73 %	67 %
Experiment	78 %	83 %	92 %	84 %

From the data listed in Table 12, there was a significant increase in the control class and experimental class at each meeting. This difference can be seen in the average percentage of student activity during the learning process, where the experimental class was higher than the control class from the first to the third meeting. The increase in student activity began from the second meeting because they began to adapt to the new learning model. At the second meeting, students were also actively involved in independent learning both individually and in groups. The presentations made by students also showed significant improvement starting from the second meeting.

The results of interviews with students, which involved questions related to activities during learning, both in the experimental and control classes, showed that students experienced changes in the

way they learned. One significant change was an increase in self-confidence, which resulted in an increase in the generation of ideas for solving mathematical problems. Apart from that, interest in learning also increases, especially after forming groups and discussion activities where students have the opportunity to share, ask questions, and provide responses both in groups and in class discussions.Adanya perubahan kebiasaan belajar yang lebih positif juga diamati, serta peningkatan kerjasama antara teman sekelompok, terutama dalam konteks pembelajaran kelompok. Hal ini memberikan kontribusi positif terhadap pengembangan rasa kebersamaan dan tanggung jawab siswa. Dengan demikian, hasil wawancara dan observasi memberikan informasi tentang empat domain yang terdapat dalam angket *self efficacy*, yaitu motivasi, kognisi, perilaku, dan emosi.

Data analysis shows that the application of discovery learning in learning can improve problem-solving abilities. This is in line with the findings of Huang & Yang (2018), which states that the use of discovery learning in mathematics learning provides a number of benefits, including assistance in developing critical and creative thinking skills and improving students' problem-solving skills. The study of Jana & Fahmawati (2020) and Ramadhani (2017) also emphasized that the discovery learning method can improve students' mathematical problem-solving abilities. Harianti (2018) also found that the discovery learning method was effective in improving students' mathematical problem-solving abilities, even more effective than conventional methods. The study of Ulfa, et al.., (2017) also shows that students who take part in discovery learning have better problem solving abilities compared to students who take part in direct learning.

The results of data analysis also show that the application of the discovery learning model can increase Self-Efficacy. This finding is in line with research by Nugraha & Wulansari (2023). Research by Fajri, et al., (2017) also revealed that students' Self-Efficacy increased after participating in learning using the discovery learning model. The study by Nahdi (2018) also found that the effectiveness of discovery learning significantly influenced increasing student self-efficacy. The study by Nursa'ban & Ewisahrani (2021) also supports that the discovery learning model has a positive impact on student self-efficacy. In addition, research by Rahmi, et al. (2020) also emphasized that student self-efficacy can be increased through the discovery learning learning model.

The results of the correlation analysis show that there is a positive correlation between mathematical problem-solving abilities and students' mathematical self-efficacy, in accordance with research from Mudzakin, et al. (2022). The research by Amalia, et al. (2018) and Yuliyani, et al. (2017) also confirmed that there is a positive relationship between problem-solving ability and self-efficacy. Research from Septhiani (2022) also notes that there is a very strong correlation between self-efficacy and mathematical problem-solving abilities. Apart from that, Zakiyah & Yusritawati (2023) also concluded that there is a correlation between mathematical problem-solving abilities and students' self-efficacy.

CONCLUSION

The results of the analysis show that there are differences between mathematical problem solving abilities and self-efficacy of students who receive learning through discovery learning models and conventional learning. Students who receive discovery learning show better mathematical problem-solving abilities and self-efficacy compared to students who receive conventional learning. Apart from that, there is a significant correlation between mathematical problem solving abilities and students' self-efficacy. Observations and interviews also indicated that students experienced positive changes in their learning activities and interests.

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