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The Effect of Module-Assisted Direct Instruction on Problem-Solving Ability Based on Mathematical Resilience

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ABSTRACT

Mathematical resilience is necessary for learning mathematics because the nature and impression of mathematics is a complex subject for most students. This study aimed to determine the effect of the module-assisted Direct Instruction model and mathematical resilience on the problem-solving abilities of prospective teacher students at a private university in Yogyakarta. This research is a quantitative descriptive study with a quasi-experimental design of the nonequivalent control group design type. The sample used was 40 students divided into 19 students in the experimental class, namely the class that received the module-assisted Direct Instruction learning model, and 21 students in the control class, namely the class that received the Expository learning model. The data collection technique is done by giving a problem-solving ability test and mathematical resilience questionnaire. The data analysis technique used quantitative descriptive analysis techniques with the ANCOVA test. The results also show that the Direct Instruction learning model assisted by the module effectively supports problem-solving abilities controlled by the variable of mathematical resilience in discrete mathematics lectures.

Keywords: *Direct Instruction, Problem-Solving Ability, Mathematical Resilience*.

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INTRODUCTION

Discrete mathematics is one of the subjects that prospective teacher students must take. Discrete mathematics material that is loaded with proof (Mujib, 2019) apart from being able to train abstract thinking, discrete mathematics can also train higher-order thinking skills (HOTS) (Nopriana & Noto, 2017; Rahmawati et al., 2018).

One of the higher-order thinking skills that prospective teacher students must possess is problem-solving skills (Kuncoro et al., 2018; Sulistyowati et al., 2017). Not only problem solving through discrete mathematics learning, but the abilities expected to develop from prospective teachers students also understand concepts, and reasoning patterns, think creatively and flexibly and make mathematical connections in solving everyday problems (Oktaviana, 2017).

However, achieving all these discrete mathematics learning objectives is not easy (Mujib, 2019). Students must have a persistent, diligent, and unyielding attitude to stay focused in facing the challenges and difficulties they face. This attitude is called mathematical resilience (Attami et al., 2020; Hafiz & Dahlan, 2017).

Mathematical resilience is not instant to have but needs to be trained and developed. As for growing strong mathematical resilience, it starts with having an attitude of being ready to face risks, viewing challenges as opportunities to learn, and strengthening the attitude of a belief that through the learning process, students can develop better (Dilla et al., 2018; Zhanty, 2019).

Mathematical resilience is essential in learning mathematics because the nature and impression of mathematics is a challenging subject for most students due to a lack of learning and practicing solving mathematical problems (Fathonah et al., 2018; Istiqomah, 2016; Rofi'ah et al., 2019). The results of initial interviews with students revealed that high competitiveness with peers creates anxiety, so they tend to avoid anything related to challenges and difficulties in learning mathematics that can interfere with achievement. One way that can be done to overcome this is to provide assistance and guidance to students to stay motivated in learning (Iswara & Sundayana, 2021).

One learning model suitable for use is the Direct Instruction learning model. Through the Direct Instruction learning model, lecturers help students learn step by step, starting from simple concepts to more abstract and complex concepts (Salam et al., 2019). Likewise, examples and practice questions are made in stages to assist students in constructing knowledge. All these steps, the researchers combined with the module so that each level in the presentation of discrete mathematics material could be followed and understood by students better.

Based on this explanation, this study aimed to determine the effect of the module-assisted Direct Instruction model and mathematical resilience on the problem-solving abilities of prospective teacher students at a private university in Yogyakarta.

METHODS

This research is a quantitative descriptive study with a quasi-experimental design of the nonequivalent control group design (Sugiyono, 2014). The research subjects are even semester teacher candidates taking discrete mathematics courses at a private university in Yogyakarta. The sample used was 40 students divided into 19 students in the experimental class, namely the class that received the module-assisted Direct Instruction learning model, and 21 students in the control class, namely the class that received the expository learning model.

This study involved three variables, namely the independent variable, the dependent variable, and the covariate variable. The independent variables are Direct Instruction learning with module-assisted learning in the experimental class and expository learning in the control class. The dependent variable is a problem-solving ability, while the covariate variable is mathematical resilience. Indicators of problem-solving ability used in this study are Polya's four-step process for problem-solving: (1) understanding the problem; (2) Devising a plan (composing a strategy or settlement plan); (3) Carry out the plan (solve problems according to the plan that has been made), and (4) Look back (check and interpret) (Polya, 2004).

This research was conducted to determine the effectiveness of the Direct Instruction learning model assisted by the module and the expository learning model on problem-solving abilities controlled by mathematical resilience variables in discrete mathematics lectures. The effectiveness indicators in this study are based on the results of Ancova's statistical testing.

Data collection techniques were carried out by giving mathematical resilience questionnaires to prospective teacher students who were carried out before the treatment was given and a problem-solving ability test after being given treatment. Problem-solving ability questions are essay questions for discrete mathematics courses with as many as six questions that three material experts have validated.

The data analysis technique uses quantitative descriptive analysis techniques assisted by exposure to the parametric analysis prerequisite test results (Arikunto, 2012). The description was carried out on the results of the hypothesis analysis test in the form of covariance analysis (ANCOVA) to determine the difference in problem-solving abilities between classes that received the Direct Instruction learning model assisted by modules and classes that received the expository learning model.

FINDINGS AND DISCUSSION

FINDINGS

Prerequisite tests (normality test, homogeneity test, and linearity test) must be met before carrying out the ANCOVA test. The normality test results using the Kolmogorov-Smirnov Test showed the Asymp value. Sig. (2-tailed) of 0.315 > 0.05 as shown in Table 1 for the variable problem-solving ability of classes receiving module-assisted Direct Instruction learning and classes receiving expository learning. These results interpret that all data comes from a normally distributed population.

Table 1. Normality test

		Problem Solving
N		54
Normal Parameters[a,b]	Mean	67.22
	Std. Deviation	15.068
Kolmogorov-Smirnov Z		.960
Asymp. Sig. (2-tailed)		.315

a. Test distribution is Normal.
b. Calculated from data.

The homogeneity test results of the problem-solving ability test data in the Direct Instruction class and the Expository class in Table 2 showed a sig value of 0.052 > 0.05. This interprets that the variance between groups is homogeneous. Then the ANCOVA analysis can be continued (Howitt & Cramer, 2017).

Table 2. Homogeneity test

Levene Statistic	df1	df2	Sig.
4.952	1	38	.052

Furthermore, the results of the linearity test in Table 3 show the sig value of deviation from linearity of 0.767 > 0.05. This means a linear relationship exists between mathematical resilience data and problem-solving ability data.

Table 3. Linearity test

		F	Sig.
Problem-solving * Resilience (Between Groups)	(Combined)	.422	.850
	Linearity	.005	.945
	Deviation from Linearity	.506	.767

Mathematical resilience needs to be controlled and used as a covariate variable. This is done so that the mathematical resilience variable does not affect the results of problem-solving abilities. After all the prerequisite tests are met, the ANCOVA test is continued. The results of the one-way ANCOVA hypothesis test are presented in Table 4.

Tabel 4. One-way ANCOVA Test

Source	df	F	Sig.
Corrected Model	2	13.696	.000
Intercept	1	.538	.468
Resiliensi	1	17.840	.000
Kelas	1	8.026	.007

The analysis results show that the value of Sig is 0.007 less than 0.05. Thus H1 is accepted, which means that after being controlled by the mathematical resilience covariable, there are differences in the problem-solving abilities of students in the experimental class and control classes. The difference in problem-solving abilities between the Direct Instruction and Expository classes can also be seen from the mean between the two classes in Table 5.

Table 5. Descriptive Statistics
Dependent Variable: Problem Solving

Kelas	Mean	Std. Deviation	N
Expository	60.5263	18.40099	19
Direct Instruction	72.6190	10.67931	21
Total	66.8750	15.87966	40

The average value of the Direct Instruction class is 72.62, and the mean of the Expository class is 60.53. This shows that the average value of the Direct Instruction class is higher than the average value of the Expository class. Furthermore, to find out whether the module-assisted Direct Instruction learning model is effective or not can be seen in the output of Table 6. The value of Sig = 0.007 < 0.05, which means that the module-assisted Direct Instruction learning model is effective in problem-solving abilities.

Tabel 6. Parameter Estimates

Parameter	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Intercept	.268	-12.448	43.437
Resiliensi	.000	.263	.748
[Kelas=1.00]	.007	-19.048	-3.163
[Kelas=2.00]	.	.	.

The results of the ANCOVA test in Tables 4 and 6 show that the module-assisted Direct Instruction learning model affects students' problem-solving abilities. The magnitude of the influence of the module-assisted Direct Instruction learning model on students' problem-solving abilities can be seen in Table 7. The problem-solving ability variable is 0.178 or 17.8% in the Partial Eta Squared part. The influence of the module-assisted Direct Instruction learning model on students' problem-solving abilities is 17.8%.

Table 7. Univariate Tests
Dependent Variable: Problem Solving

	df	F	Sig.	Partial Eta Squared
Contrast	1	8.026	.007	.178
Error	37			

Furthermore, correlation analysis and simple regression can be known to see the relationship and effect of resilience on problem-solving ability. The test results for the two variables can be seen in Table 8.

Table 8. The correlation test of mathematical resilience on problem-solving ability

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.548[a]	.301	.282	13.45243

a. Predictors: (Constant), Resiliensi

Based upon Table 8, it can be seen that the coefficient of determination (R2) is 0.301, which means that mathematical resilience has an effect of 30.1%, while other variables influence the rest.

DISSCUSSION

The results of data analysis using the ANCOVA test showed differences in problem-solving abilities between the experimental class that was taught using Direct Instruction with the help of a module and the control class that was given expository learning controlled by the mathematical resilience variable.

The effect of module-assisted Direct Instruction on the problem-solving ability of prospective teacher-students is 17.8%. The average value of the experimental class is higher than the average value of the control class. This shows that module-assisted Direct Instruction can affect the problem-solving ability of prospective teacher students, although not too significantly.

While resilience itself affects the ability to solve problems by 30.1%, the results showed that the effect of resilience on students' problem-solving abilities was not too significant. One of the causes of the low influence of mathematical resilience on problem-solving abilities is that the lecture process is still carried out online.

Although online learning has many advantages, there are still many shortcomings in its implementation. Some of the obstacles encountered during the research were the lack of opportunities for direct discussions. Therefore, students in the lecture process are required to develop mathematical resilience in addressing this problem. This in line with research that has been done previously that in online learning there are still many obstacles, such as unstable internet network connections, disturbances/distractions from the home environment, difficulty understanding the material is delivered online, and difficulty discussing with colleagues. (Hutauruk, 2020; Huzaimah & Amelia, 2021; Sunarto & Al Ghifari, 2021).

Mathematical resilience can be formed because of a disciplined and independent attitude (Suparni et al., 2021) to produce a positive student character in discrete mathematics lectures. Students do not give up easily in facing challenges and even failures. They can solve problems well, look for new strategies and try their best in the problem-solving process.

Mathematical resilience is categorized as one of the soft skills that someone must possess, especially student teacher candidates. When facing a challenge and difficulty, they can fight harder and not give up quickly in providing mathematics learning at school later. Several studies state that one of the factors of low mathematical resilience is the fear of being wrong, which then affects students' emotions.

Anxiety about the fear of being wrong in doing mathematics in this study was overcome by providing the Direct Instruction learning model with the help of the module. According to research conducted by (Sitompul & Hayati, 2019) Direct Instruction can increase interest and motivation in learning, so that enthusiasm and mathematical resilience can also increase.

The module-assisted Direct Instruction learning model is suitable for applied to discrete mathematics lectures because discrete mathematics courses are subjects with procedural knowledge properties (Iswara & Sundayana, 2021) and mathematical proof (Mujib, 2019). Students who have high resilience will be able to do problem-solving well (Juniasani et al., 2022), able to carry out the evidentiary process appropriately, structured and systematic.

CONCLUSION

Module assisted Direct Instruction has been shown to positively affect the problem-solving abilities of prospective teacher students, especially in discrete mathematics lectures. This can be seen from the average value of students' problem-solving abilities in the experimental class, which is higher than that of students' problem-solving abilities in the control class. The results also show that the Direct Instruction learning model assisted by the module effectively controls problem-solving abilities controlled by the variable of mathematical resilience in discrete mathematics lectures.

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