

The effects of E-learning based on a creatively cooperative method on student's self-regulation ability in mathematics

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Abstract

This study aims to determine the effect of the creatively cooperative learning method on students' self-regulation abilities in mathematics. This study employed quantitative research with a One-Group Posttest-only design. The research participants were 93 students from the seventh grade at a secondary school. The data were collected using a mathematical problem-solving test and a self-regulated ability questionnaire. The data were analyzed using linear regression analysis. This study indicates that the implementation of the creatively cooperative learning method positively influences students' self-regulated abilities in mathematics. This study informs educators about the importance of creatively cooperative learning methods to improve students' self-regulation abilities in mathematics and achievement. Thus, educators can combine the creatively cooperative learning method to make effective and suitable teaching materials or learning plans.

Keywords: mathematics learning; self-regulation ability; creative cooperative; learning methods; students' creativity

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1. Introduction

Students need self-regulation to increase their knowledge and learning achievement independently. Self-regulated ability refers to students' ability to regulate their thinking, control performance, and do self-reflection independently (Alten et al., 2020). However, every student finds it difficult to improve self-regulated abilities (Muwonge et al., 2020; Tsai & Shen, 2009). Low self-regulated learning abilities can be improved by providing appropriate and effective interventions. Self-regulated ability can maximize the improvement of students' learning and cognitive performance with effective and appropriate learning methods (Wong et al., 2021). Good self-regulated ability can lead to the discovery of new and original ideas. Discovering new and original ideas refers to students' creativity (Ge & Zeng, 2020; Yang & Zhao, 2021). The development of creative learning that can improve self-regulation abilities is the application of cooperative learning methods. Cooperative learning refers to forming study groups, creating a creative learning environment, and providing opportunities for students to develop their self-regulation skills (Zhu et al., 2019). Thus, this study aims to determine the effect of the creatively cooperative learning method on students' self-regulation abilities in mathematics.

1.1. Conceptual or Theoretical Framework

Self-regulation in the learning process can improve cognitive abilities independently (Alten et al., 2020). The self-regulation ability encourages students' learning motivation, cognition, and open-mindedness (Hooshyar et al., 2020). Moreover, self-regulation enables students to systematically regulate their behavior and cognition, integrate previous knowledge with new problems, and create new mindsets (Bai & Wang, 2021). Self-regulation can trigger new and flexible creative thinking processes (Panayiotou et al., 2021).

Several studies have shown that students have difficulty improving their self-regulation skills. Muwonge et al. (2020) have discovered that many students still have low self-regulation ability. They cannot apply self-regulated abilities in their learning process (Van Alten et al., 2021). Meanwhile, Tsai and Shen (2009) state that the application of low self-regulated abilities in students results in low achievement. Students cannot consider and synthesize previous knowledge with their new knowledge in this condition. The low self-regulation ability in learning mathematics positively decreases students' interest, motivation, and cognitive scores in mathematics (Xu et al., 2021). Moreover, their low self-regulation ability and self-confidence cause low motivation and cognitive mathematics because they cannot provide an original self-perception (Dicke et al., 2021).

Previous studies have examined the role of learning methods to improve students' low self-regulation abilities. Wong et al. (2021) deploy that self-regulation abilities using effective and appropriate learning methods can improve students' learning and cognitive performance. Moreover, students' self-regulation abilities can be developed longitudinally by designing appropriate learning methods (Li et al., 2020). The appropriate learning methods can serve as mediation to develop students' self-regulation abilities as well as increase flexibility and new thinking (Panayiotou et al., 2021). On the other hand, Leo and Muis (2020) state that learning models that can improve students' cognitive skills, open-mindedness, original thinking, and self-regulation abilities to solve mathematics problems independently should be considered.

New and original ideas, especially in mathematics, can be improved by creative learning. Creative mathematics learning can increase students' self-regulated learning (Lengetti et al., 2020; Wechsler et al., 2018). Creative learning enables students to build self-confidence and increase self-regulation abilities (Kümmel et al., 2020; Lin et al., 2019). Meanwhile, creatively designed learning can construct students' self-regulation abilities (Yoon et al., 2014). Creative learning affects students' superior creative thinking, understanding, and psychomotor abilities (Huang, 2020; Neng-tang Huang et al., 2020). Thus, teachers should consider the development of creative learning methods so that they

more independently determine their original ideas (Amponsah et al., 2019). The creative learning method that increases self-regulation abilities is cooperative learning.

Previous studies have examined the role of the cooperative learning method to increase students' self-regulated learning abilities. Zhu et al. (2019) have discovered that cooperative learning by involving study groups mediates teachers to create creative learning spaces and enable students to develop self-regulation abilities. Learning that involves group work activities provides a space for students to flexibly exercise self-regulation abilities and form new ideas in learning (Ge & Zeng, 2020; Yang & Zhao, 2021). Meanwhile, collaborative learning in digital spaces can create creative interactives and develop the ability to independently organize and find new ideas (Cybulski et al., 2015). Collaborative learning involves cooperative group work to solve problems and facilitate creative mathematics learning (Bray & Tangney, 2017).

1.2. Related research

Previous literature mentions that the cooperative learning method can improve students' self-regulation abilities and creativity (Cybulski et al., 2015; Ge & Zeng, 2020; Yang & Zhao, 2021; Zhu et al., 2019). However, this literature does not statistically examine the effect of the cooperative learning method on Improving students' SRL abilities. In addition, this study wants to integrate the cooperative learning method with creative learning from Runco (2020) to identify students' self-regulation abilities in mathematics through statistical regression testing. This study is essential and original because previous studies have not examined the effect of the creatively cooperative learning method on students' self-regulation abilities in mathematics.

1.3. Purpose of the study

This research aims to determine the effect of the creatively cooperative learning method on students' self-regulation abilities in mathematics. This study is expected to become a reflective material for educators and provide a creatively cooperative learning method to improve students' self-regulation abilities in mathematics. Therefore, this study formulates three research questions.

1. What is the correlation between the application of the creatively cooperative learning method and students' self-regulation abilities in mathematics?
2. How is the contribution of the application of the creatively cooperative learning method to students' self-regulation abilities in mathematics?
3. How does the creatively cooperative learning method affect students' self-regulation abilities in mathematics?

2. Method and materials

2.1. Research Method

This research employed a quantitative research method because this research involves the process of collecting, analyzing, interpreting, and writing research results in the form of statistical analysis (Creswell & Creswell, 2018). Moreover, this research employed a one-group posttest only design because the design of this research did not involve a pre-test and a control group because all participants received the creatively cooperative learning method design.

2.2. Participants

Participants in this study were 93 students from the seventh grade of a secondary school in Malang, Indonesia. All participants were a combination of two classes in one school. The two classes were selected using the purposive sample method. In addition, this study selected a school implementing

online learning because this study was conducted online using the Zoom application.

2.3. Data Collection tools

The research instruments were the mathematical problem-solving test and the self-regulation ability questionnaire. The self-regulation ability questionnaire was adapted from Barnard et al. (2009) to determine students' self-regulation abilities in mathematics. The questionnaire consisted of 24 items with seven indicators: environment structuring, goal setting, self-evaluation, task structuring, task strategies, help-seeking, dan time management. This questionnaire used the four-point of Likert scale.

The validated mathematical problem-solving test was analyzed using the Kaiser-Meyer-Olkin's (KMO) and Bartlett's tests. The results of the KMO's and Bartlett's tests are shown in Table 1. The results show that the values of the KMO's and Bartlett's tests are $0.965 > 0.5$. This shows that the mathematical problem-solving test is valid for the study.

Table 1. KMO and Bartlett's test for validity test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.965
Bartlett's Test of Sphericity	Approx. Chi-Square	21863.839
	Df	435
	Sig.	0.000

The questionnaire was validated by expert judgment. Furthermore, the questionnaire was validated using the Aiken-V index method (Gregory, 2015). The value of the Aiken-V index is $0.89 > 0.8$. This finding indicates that the questionnaire is valid for this study. The reliability test was analyzed using Cronbach's Alpha method. The Cronbach's Alpha values for 24 items are shown in Table 2. The results show that Cronbach's Alpha value is $0.891 > 0.6$. This score shows that the questionnaire is reliable to measure the students' self-regulation abilities in mathematics.

Table 2. The reliability test for self-regulation ability questionnaire

Cronbach's Alpha	N of Items
0.891	24

2.4. Data analysis

The data analysis technique used statistical linear regression analysis. The linear regression test was conducted to determine the effect of the creatively cooperative learning method on students' self-regulation abilities in mathematics. Meanwhile, the data were analyzed using the IBM SPSS Statistics-23 application.

The normality test had employed the prerequisite test before the data were analyzed by the linear regression test. The normality test of the data employed three methods: the Kolmogorov-Smirnov method, the histogram method, and the probability plot method. The normality test results using the Kolmogorov-Smirnov method are shown in Table 3.

Table 3. Kolmogorov-Smirnov test

		Unstandardized Residual
N		93
Normal Parameters ^{a,b}	Mean	0.0000000
	Std. Deviation	0.35454235
Most Extreme Differences	Absolute	0.295
	Positive	0.295
	Negative	- 0.232
Test Statistic		0.295
Asymp. Sig. (2-tailed)		0.000 ^c

Table 3 shows that the Sig. (2-tailed) is 0.908 > 0.05, or the significance value is more than 0.05. This finding shows that the residual data are normally distributed. The normality of the data is also shown in the probability plot method (Figure 1) and the histogram method (Figure 2). Figure 4 shows that the data points tend to spread out between the diagonal lines. Meanwhile, Figure 2 shows that the curve forms a symmetrical pattern. Therefore, the data are normally distributed.

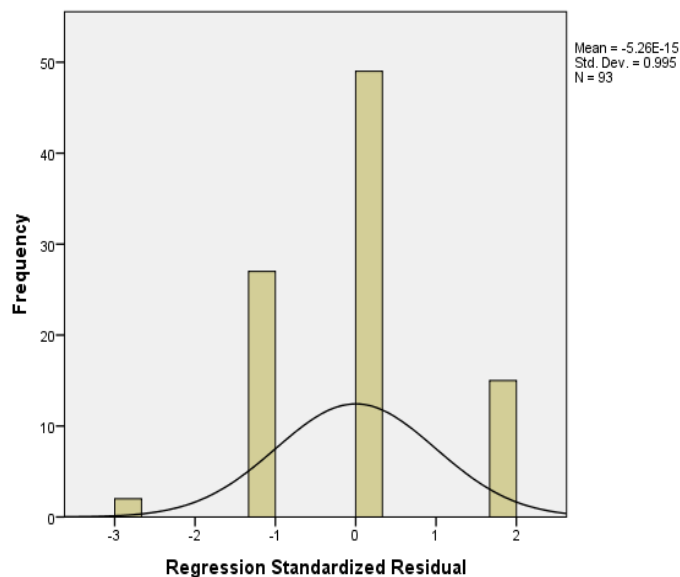


Figure 1. Histogram Method

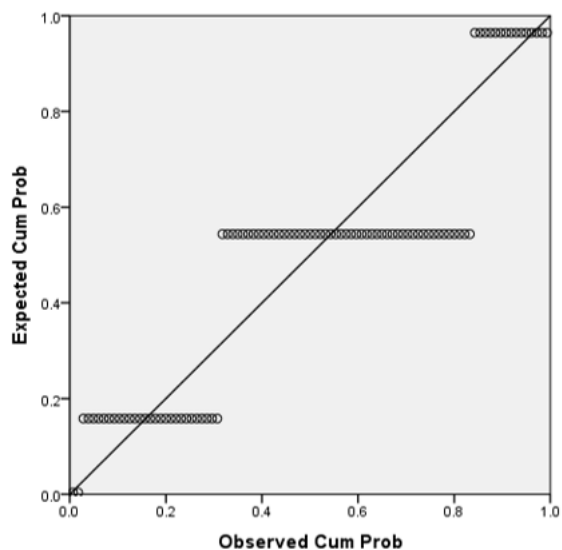


Figure 2. Probability Plot Method

3. Findings

3.1. The Correlation between Application of Creatively Cooperative Learning Methods and Students' Mathematical Self-Regulation Abilities

This section analyzes the correlation between the creatively cooperative learning method and students' self-regulated abilities in mathematics. The values (R) of the correlation test is shown in Table 4.

Table 4. Correlation Test (R)

Model	R	Std. Error of the Estimate
1	0.648 ^a	0.35649

Table 4 shows that the Std. Errors of the Estimate is 0.35649 and the correlation value (R) is $0.648 > 0.6$. These findings show a strong correlation between the creatively cooperative learning method and students' self-regulation abilities in mathematics.

3.2. The Contribution of the Creatively Cooperative Learning Methods to Students' Self-Regulation Abilities in Mathematics

The contribution of cooperative learning methods to students' self-regulation abilities to mathematical is indicated by the coefficient value of determination (R^2), as described in Table 5.

Table 5. Coefficient of Determination Test (R^2)

Model	R Square	Adjusted R Square
1	0.821	0.914

Table 5 shows that the coefficient of determination (R^2) is 0.821 and the adjusted r-square value is 0.914. If the r-square value (R^2) is 0.821, the percentage is 82.1%. Meanwhile, if the r-square value (R^2) is 0.821, the percentage is 82.1%. These findings show that the contribution of cooperative learning methods to students' self-regulation abilities in mathematics is 82.1%. On the other hand, 17.9% (100% - 82.1%) is the contribution of other variables, which are not examined in this study.

3.3. Partial Effects of Creatively Cooperative Learning Method on Students' Self-Regulation Abilities in Mathematics

This section analyzes the partial effects of the creatively cooperative learning method on students' self-regulation abilities in mathematics using the linear regression analysis. The partial effects were identified using the t-distribution test and the linear regression analysis. These effects are presented in Table 6.

Table 6. T-Test for Partial Effect Test

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-47.556	6.429		-7.397	0.000
Creatively Cooperative Learning Method	0.604	0.074	0.648	8.127	0.000

Table 6 shows that the value of $t_{statistic}$ for the creative cooperative learning method is 8.127 and the Sig. is $0.000 < 0.005$. The partial test has discovered that the creative cooperative learning method has a significant effect on students' self-regulation abilities in mathematics. On the other hand, the value of $t_{statistic}$ for the constant is -7.397 , and the Sig. value is $0.000 < 0.005$. The partial test also shows that learning without the creatively cooperative learning method has a significantly negative effect on students' self-regulation abilities in mathematics..

3.4. Simultaneous Effects of Creatively Cooperative Learning Method on Students' Self-Regulation Abilities in Mathematics

This section analyzes the simultaneous effects of the creatively cooperative learning method on students' self-regulation abilities in mathematics using the linear regression analysis. The simultaneous effects were gained by the ANOVA test through the linear regression analysis. These effects are shown in Table 7.

Table 7. ANOVA Test to Identify Simultaneous Effects

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	8.393	1	8.393	66.041	0.000
Residual	11.564	91	0.127		
Total	19.957	92			

Table 7 shows the $F_{statistic}$ value is 66,041 and the Sig. value is $0.000 < 0.05$. These findings show that the creatively cooperative learning method significantly affects students' self-regulation abilities in mathematics.

3.5. Empirical Model Identification of Effects of Creatively Cooperative Learning Method on Students' Self-Regulation Abilities in Mathematics

Table 6 shows that the unstandardized coefficient value in column B for the constant variable is -47.556. This score shows that learning without the creatively cooperative learning method has a negative effect on students' self-regulation abilities in mathematics. Learning that does not implement the creatively cooperative learning method reduces students' self-regulation abilities in mathematics. On the other hand, the unstandardized coefficient value in column B for the variable of the Creatively cooperative learning method is 0.604. Thus, this method positively affects students' self-regulation abilities in mathematics. In other words, the creatively cooperative learning method has increased students' self-regulation abilities in mathematics.

4. Discussion

This study has discovered a strong correlation between the creatively cooperative learning method and students' self-regulation abilities in mathematics. This finding is supported by Huang (2020), who has discovered that learning that supports students' creativity can strengthen the correlation between knowledge acquisition, sharing, and self-regulation in their learning process. Cooperative learning becomes a scaffold for students, supports their cognitive development, and provides original learning experiences (Chan, 2020). This strong correlation encourages the researchers to measure the contribution of the creatively cooperative learning method to the students' self-regulation abilities in mathematics.

Furthermore, this study has discovered that the cooperative learning method contributes to 82.1% of the students' self-regulation abilities in mathematics. This finding agrees with Lengetti et al. (2020), who define innovative-based learning as a learning approach that encourages students' self-regulation abilities in learning to obtain better results. Creativity performance in groups accounts for most of the students' learning performance and increases their confidence to manage the learning process independently (Pesout & Nietfeld, 2021).

The result also shows that the creatively cooperative learning method significantly affects students' self-regulation abilities in mathematics. This is in line with Huang et al. (2019) who opine that creativity has a significant effect on behavioral processes, self-efficacy, and self-regulation to improve students' competence. On the other hand, learning that does not use the creatively cooperative learning method has a significantly negative effect on students' self-regulation abilities in mathematics. Cooperative learning is superior to conventional learning because cooperative learning is correlated with academic optimization, learning adaptation, self-regulation, and students' cognitive enhancement (Peña-Ayala, 2021).

In this case, the creatively cooperative learning method is an effective learning alternative to improve students' self-regulation abilities in mathematics. Aziz and Hossain (2010) state that cooperative learning is a preferable alternative for students to the conventional learning because cooperative learning helps them improve their achievement. The cooperative learning in this study is designed creatively by referring to Runco's (2020) creativity indicators, namely flexible, fluent, and original. Yang and Zhao (2021) mention that creative learning involving heterogeneous groups for cooperative learning could improve students' skills in managing independent learning, academic performance, and achievement.

5. Limitation

This study has several limitations due to the small number of participants. In addition, the backgrounds of the participants do not represent Malang City, Indonesia as they only came from one school. This study measures the effects of the creatively cooperative learning method on students' self-regulation abilities in mathematics but has not explained the profile of students' self-regulation abilities in mathematics.

6. The Future of Research

Based on the limitations of this study, further research is suggested to increase the number of participants from different backgrounds, for example, high school students and college students. Participants can also come from more than one school. Further research can more comprehensively explain the profile of students' self-regulation abilities in mathematics. The profile of students' self-regulation abilities in mathematics is a continuation of this research. Thus, this study also provides research questions for the development of further research, which will investigate students' self-regulation and creativity.

7. Conclusion

The implementation of the creatively cooperative learning method has significantly increased students' self-regulation abilities in mathematics. This study has answered three major research questions.

1. The correlation between the creatively cooperative learning method and students' self-regulation abilities in mathematics is strong ($R = 0.648 > 0.6$).
2. The contribution of the creatively cooperative learning method to students' self-regulation abilities in mathematics is substantial ($R^2 = 0.821 > 0.8$).
3. The creatively cooperative learning method positively affects students' self-regulation abilities in mathematics. Thus, this method can improve their self-regulation abilities in mathematics.

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