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An Analysis of Students' Mathematical Adaptive Reasoning: The Impact of Creative Problem-Solving (CPS) Learning Model and Entrepreneurial Character

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Abstract

This research aims to determine the effect of the CPS learning model on mathematical adaptive reasoning ability in terms of students' entrepreneurial character. This research is quantitative research of the quasi-experimental research design with a posttest-only control group design. The population was the eighth-grade students of SMP Negeri 1 Natar, consisting of 367 students. The sampling technique used was cluster random sampling. The data analysis technique employed was the two-way Anova test with a significance level of 0.05. The finding showed that there was an effect of the CPS learning model on students' mathematical adaptive reasoning ability. The CPS learning model provided higher results compared to the conventional learning model. Besides, the students' entrepreneurial character influenced their mathematical adaptive reasoning ability. Students with high entrepreneurial character had higher mathematical adaptive reasoning ability than those with low entrepreneurial character. However, the Tukey test result showed no interaction between the CPS learning model and entrepreneurial character on students' mathematical adaptive reasoning ability.

Kata Kunci:

Penalaran adaptif;
Model pembelajaran CPS;
Karakter entrepreneur

Abstrak

Penelitian ini bertujuan untuk mengetahui bagaimana pengaruh dari penerapan model pembelajaran CPS terhadap kemampuan penalaran adaptif matematis ditinjau dari karakter entrepreneur siswa. Penelitian ini merupakan penelitian kuantitatif dengan desain penelitian Quasi Experimental jenis posttest only control group design. Populasi dalam penelitian ini yaitu siswa

kelas VIII SMP Negeri 1 Natar berjumlah 367 orang. Teknik pengambilan sampel yang digunakan ialah Cluster Random Sampling. Teknik analisis data yang digunakan adalah uji two-way Anova dengan taraf sig. 0.05. Hasil penelitian menunjukkan bahwa terdapat pengaruh model pembelajaran CPS terhadap kemampuan penalaran adaptif matematis siswa. Penggunaan model pembelajaran CPS memberikan hasil yang lebih tinggi dibandingkan dengan pembelajaran yang menerapkan model pembelajaran konvensional. Selain itu, karakter entrepreneur siswa juga memiliki pengaruh terhadap kemampuan penalaran adaptif matematis. Siswa yang memiliki karakter entrepreneur tinggi memiliki kemampuan penalaran adaptif matematis yang lebih tinggi dibandingkan dengan siswa yang memiliki karakter entrepreneur rendah. Tetapi hasil uji lanjut menunjukkan bahwa tidak terdapat interaksi antara model pembelajaran CPS dengan karakter entrepreneur terhadap kemampuan penalaran adaptif matematis siswa.

INTRODUCTION

In the era of industrial revolution 4.0, digitization, robotization, intelligent automation, the internet of things, and artificial intelligence are improving rapidly (Martynov, Shavaleeva, & Zaytseva, 2019; Sima, Gheorghe, Subić, & Nancu, 2020). It can impact various sectors of life, such as education, economy, national and global, and society and individuals. Therefore, educational institutions should develop pedagogical knowledge, soft skills (Demchenko et al., 2022; Tee et al., 2022), and entrepreneurial character (Chang & Rieple, 2013; Salamzadeh, Tajpour, & Hosseini, 2022).

Mathematical adaptive reasoning is essential in learning. This ability is one of the most significant skills and competencies students need in mathematics learning today and in the future (Magfirah, Asfar, Asfar, Nurwijaya, & Fauziah, 2022; Suhanda, Lestari, & Rozak, 2023). Adaptive reasoning by students can help them find solutions to mathematical problems at hand (Wasiran & Andinasari, 2019) by connecting problems through ideas to obtain solutions to mathematical problems (Konita,

Asikin, Sri, & Asih, 2019) so that students with good reasoning ability will easily understand mathematics problems (Rachman & Rosnawati, 2021). Thus, adaptive reasoning is an essential part of supporting the process of mathematics learning because it can make learning mathematics more meaningful (Wasiran & Andinasari, 2019).

Efforts to improve students' abilities need to be made that are oriented towards providing knowledge and other characteristics needed by students in facing the times, such as entrepreneurial character. Cultivating entrepreneurial character in education makes students more skillful, brave, independent, and unyielding (Hidayat & Pradesa, 2022; Muliadi, Sarjan, & Rokhmat, 2022). Learning that relates to entrepreneurial character is not only intended to make students an entrepreneur but also focuses on entrepreneurial character, which is seen as one trait that can face future problems.

Individuals with entrepreneurial character have several characteristics: having a leadership spirit, being creative and innovative, being good at seeing opportunities, liking challenges, and taking risks (Polindi, 2019). Students are said to have adaptive reasoning when they can think logically related to the problem-solving solutions they face, estimate and reflect, and be able to give reasons for the procedures used in solving problems (Oktaviana & Haryadi, 2020). This is in line with one of the characteristics of the entrepreneurial character, which is creative and good at seeing opportunities. Creativity in students will lead them to get innovation from every unique idea or idea they come up with so that this idea can later be used as the best solution to existing problems. Meanwhile, being good at looking for opportunities describes individuals who can think critically and creatively so that they can observe every opportunity that arises.

But ironically, amid the importance of adaptive reasoning skills, the facts in the field show that mathematical adaptive reasoning skills are still low. This statement is reinforced by previous research (Permana, Setiani, & Nurcahyono, 2020, Oktaviana & Haryadi, 2020). Research by Fatati and Illah also provides information that students' average adaptive reasoning ability in schools has yet to be achieved optimally (Saniyyah & Triyana,

2020). Based on these problems, improving students' mathematical adaptive reasoning ability is needed. One of the efforts to improve students' mathematical adaptive reasoning ability is by choosing and applying a learning model that can involve all students to be active in the learning process. One alternative learning model that is expected to train and improve students' mathematical adaptive reasoning is the Creative Problem-Solving (CPS) learning model (Ansari, Taufiq, & Saminan, 2020; Muin, Hanifah, & Diwidian, 2018).

In the CPS learning model, students are directed to participate in group learning (Rachman & Rosnawati, 2021). The CPS learning model process can train mathematical problem-solving skills (Malisa, Bakti, & Iriani, 2018). This research is strengthened by the results of previous studies, which state that the use of the CPS learning model can improve students' problem-solving skills (Muhammad et al., 2018), can improve students' mathematical reasoning and communication (Tambunan, 2021), can improve students' creative thinking skills (Malisa et al., 2018), and can also improve adaptive reasoning improve creative thinking and adaptive reasoning (Wasiran & Andinasari, 2019).

Based on several previous studies, research has yet to be conducted that aims to see the impact of applying the CPS learning model and entrepreneurial character on students' mathematical adaptive reasoning skills.

RESEARCH METHODS

This research employed the quantitative approach. The type of research used was a quasi-experimental design with two groups: the experimental group (using the CPS learning model) and the control group (using a conventional learning model). The research was conducted at SMP Negeri 1 Natar in the 2022/2023 academic year, comprising 367 students. The sampling technique used was Cluster Random Sampling, which obtained class VIII F as the experimental class with 31 students and VIII E as the control class with 31 students. The researchers taught the Cartesian Coordinates material. Data collection techniques employed were tests and questionnaires. The test was used to measure mathematical adaptive

reasoning ability, while the questionnaire was used to measure students' entrepreneurial character. The hypothesis was tested after the prerequisite analysis test, namely normality and homogeneity tests using SPSS 26 software. Hypothesis testing was carried out using two-way Anova, then continued with the Tukey test using SPSS 26 software.

RESULTS AND DISCUSSION

Two-way Anova Test

Hypothesis testing with two-way ANOVA was performed to determine the impact of the CPS learning model and entrepreneurial character on students' mathematical adaptive reasoning skills. The results of the two-way ANOVA are described below:

Table 1. Two-Way Anova Test Result

Dependent Variable: Mathematics Adaptive Reasoning Score

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2725.177[a]	5	545.035	6.944	.000	.383
Intercept	95670.691	1	95670.691	1218.941	.000	.956
Class	417.172	1	417.172	5.315	.025	.087
Category	783.815	2	391.908	4.993	.010	.151
Class* Category	234.317	2	117.159	1.493	.234	.051
Error	4395.256	56	78.487			
Total	229699.265	62				
Corrected Total	7120.432	61				

a. R Squared = .383 (Adjusted R Squared = .328)

If the $p-value$ is lower than 0.05, H_0 is rejected. H_0 is accepted if the $p-value$ is higher than 0.05. Based on the table above, H_{0A} is rejected. The hypothesis test shows that the p-value is 0.025, lower than 0.05. Therefore, there is an influence between students who learn using the CPS learning model and the conventional learning model on mathematical adaptive reasoning skills. H_{0B} is rejected because the hypothesis test obtained a p-value of 0.010, lower than 0.05. Therefore, there is an influence between students who have high, medium, and low categories of entrepreneurial character on mathematical adaptive reasoning ability. H_{0AB} is accepted based on the hypothesis test with a p-value of 0.234, which is

higher than 0.05. Thus, no interaction exists between the CPS learning model and entrepreneurial character on students' mathematical adaptive reasoning ability.

Post-Anova Test

Based on the calculation of the hypothesis, the post-Anova test was needed by classifying the entrepreneurial character into three categories. Tukey test was performed because the research samples had the same number. The following are the Tukey test results with SPSS 26.

Table 2. Tukey Test Result

Multiple Comparisons

Dependent Variable: Mathematics Adaptive Reasoning Score Tukey HSD						
Category (I)	Category (J)	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
High	Moderate	13.4636*	3.59865	.001	4.7997	22.1276
	Low	17.6719*	3.53798	.000	9.1540	26.1898
Moderate	High	-13.4636*	3.59865	.001	-22.1276	-4.7997
	Low	4.2083	2.41783	.199	-1.6128	10.0294
Low	High	-17.6719*	3.53798	.000	-26.1898	-9.1540
	Moderate	-4.2083	2.41783	.199	-10.0294	1.6128

Based on observed means.
The error term is Mean Square (Error) = 78.487.
*. The mean difference is significant at the .05 level.

Table 2 shows the test results for students with high and low entrepreneurial character obtained the Sig. Value of 0.00, which is lower than 0.05. It means a significant average difference in mathematical adaptive reasoning ability between students with high and low entrepreneurial character. The test results for students with medium and high entrepreneurship obtained the Sig. Value of 0.01, which is lower than 0.05. Thus, there is a significant average difference in mathematical adaptive reasoning ability between students with medium and high entrepreneurial character. The test results on students with low and medium entrepreneurship obtained the Sig. Value of 0.199, which is higher than 0.05. Therefore, there is no significant average difference in mathematical

adaptive reasoning ability between students with low and medium entrepreneurial character.

The First Hypothesis

Based on the two-way Anova test, H_{0A} was rejected. Thus, there is an influence between the CPS learning model and the conventional learning model on students' mathematical adaptive reasoning ability with a Sig. Value of .025, which is lower than 0.05. The results showed that the students' mathematical adaptive reasoning ability that applied the CPS learning model was higher than students whose learning process used conventional models.

The CPS learning model can train students to solve mathematical problems by emphasizing discovering various ideas through divergent and convergent thinking processes (Wasiran & Andinasari, 2019). It can help students' reasoning process and find the most efficient solution to the problem. Since mathematics is a science that contains contextual problems, training creativity in learning will certainly teach students to be more capable and creative in solving problem-based problems. This statement is in line with previous research by Puspita, Supriadi, & Pangestika (2018) that there is an influence of the CPS model accompanied by the Vee technique on the student's creative thinking skills. Besides, research by Lois Oinike Tambunan explains that the CPS learning model can improve students' mathematical reasoning and communication (Tambunan, 2021).

Further research by Wasiran & Andinasari (2019) on CPS-based instructional packages found that there is a potential effect in improving students' creative thinking skills and adaptive reasoning skills. These findings may be caused by the learning stages of CPS, where the students involve divergent and convergent thinking processes. The divergent thinking process trains students' intuition, while the convergent thinking process trains their reasoning skills. Furthermore, the CPS model requires student activeness in discussing, expressing opinions, and being enthusiastic in solving existing problems so that it can affect mathematical adaptive reasoning ability.

Learning in the experimental class was carried out by dividing students into groups of 5 to 6 members. The teacher explained the material to be studied, then continued with the distribution of worksheets for each group. Before students work, the teacher first provides an explanation related to the mathematical tasks or problems proposed. CPS cooperative learning offered a great opportunity to train responsibility and required students to learn to express their ideas in finding the most effective and efficient problem-solving. After discussing with their group mates, the solutions were evaluated. The next step was for each group to provide answers on the blackboard and explain them to their friends. In the CPS learning process, the teacher helped students with difficulties and directed them so that learning could run smoothly.

Meanwhile, learning in the control class emphasized the lecture method with teacher-centered learning. The teacher explained the Cartesian coordinate material in the control class by giving several examples and continuing with questions and answers. The question-and- answer process in the control class at the first meeting tended to be passive. However, the next meeting experienced a slight difference that was better than the previous meeting. At the fourth meeting, students already looked enthusiastic in responding to learning, although it was not uncommon to find some students who tended to be passive.

Applying the CPS learning model can present a good effect on increasing students' activeness. In CPS learning, the learning is centered on students so that they can develop mathematical adaptive reasoning abilities.

The Second Hypothesis

Based on the results of the two-way Anova hypothesis test, it was found that H_{0B} was rejected, with a Sig. Value of 0.01, which is lower than 0.05. Therefore, there is an effect of the high, medium, and low entrepreneurial character of students on mathematical adaptive reasoning ability. The Tukey test results found significant differences between students with high and low entrepreneurial character. Students with high entrepreneurial character and students with moderate entrepreneurial

character turned out to have a significant average difference in mathematical adaptive reasoning ability because the indicators contained in entrepreneurial characters, such as self-confidence and optimism, task and result-oriented, and other indicators are considered capable of influencing students' mathematical adaptive reasoning ability. Students with good self-confidence and optimism will encourage themselves to never give up on challenges (Fransisca, Wulan, & Supena, 2020). Indicators regarding task-oriented and results that make achievement a necessity so that students with high entrepreneurial character will have better adaptive reasoning skills when compared to students with moderate and low entrepreneurial character.

This finding aligns with Endramawati, Mastur, & Mariani (2019), the results showed that students with high entrepreneurial character achieved more indicators contained in the mathematical literacy component compared to students with moderate or low entrepreneurial character. Furthermore, the results of previous research show that HOTS-based mathematics learning can increase the potential of students' entrepreneurial spirit (Turmuzi, Sudiarta, & Sutajaya, 2022).

The Third Hypothesis

Based on previous calculations, hypothesis testing results show no interaction between the CPS learning model and entrepreneurial character on students' mathematical adaptive reasoning ability. The resulting hypothesis test has a Sig. Value of 0.234, which is higher than 0.05. Therefore, it can be concluded that H_{0AB} is accepted. The results of the first and second hypothesis tests show that the CPS learning model and entrepreneurial character affect students' mathematical adaptive reasoning ability. However, the third hypothesis test concludes that the CPS learning model and entrepreneurial character have their respective effects or influences on mathematical adaptive reasoning ability. In other words, no interaction exists between the CPS learning model and entrepreneurial character on mathematical adaptive reasoning ability.

Previous research by Juniati, Siagian, & Mursid (2021), found an interaction between cooperative learning models and learning interests on entrepreneurship learning outcomes. However, hypothesis testing results found no interaction between the CPS learning model and entrepreneurial character on mathematical adaptive reasoning ability. In this study, there are several obstacles or weaknesses, including (a) the application of the CPS learning model, which requires a long time to be more effective to get maximum results; (b) optimal class conditioning is still needed in the discussion process, expressing opinions, and in understanding learning materials.

CONCLUSION

Based on the analysis, there is an effect of the CPS learning model on students' mathematical adaptive reasoning ability. The CPS learning model provides higher results compared to conventional learning models. Also, the students' entrepreneurial character influences their mathematical adaptive reasoning ability. Students with high entrepreneurial character have higher mathematical adaptive reasoning ability than those with low entrepreneurial character. However, further test results showed no interaction between the CPS learning model and entrepreneurial character on students' mathematical adaptive reasoning ability.

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