IJAMESC, Vol. 3 No. 02, April 2025
DOI: https://doi.org/10.61990/ijamesc.v3i2.473 e-ISSN 2986-8645

STUDENTS' MATHEMATICAL CREATIVE THINKING ABILITY THROUGH GAMIFICATION-BASED CRBL LEARNING MODEL BASED ON DIFFERENCES IN LEARNING STYLES

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Abstract
This study aims to determine the influence of the gamification-based Creative Responsibility Based Learning (CRBL) learning model on students' mathematical creative thinking skills based on differences in learning styles. This study uses a quantitative approach with the type of research, namely quasi-experimental design and the design used, namely posttest only control group design. The population of this study is all grade VIII students of MTs Al-Hikmah Bandar Lampung for the 2024/2025 school year. The sampling technique uses cluster random sampling. The samples taken were three classes with experimental class 1 using the gamification-based CRBL learning model, experimental class 2 using the CRBL learning model and control class using the direct instruction learning model. The data collection technique uses tests and questionnaires. The hypothesis test uses a two-way anova test with the prerequisite tests, namely the normality and homogeneity test and the double comparison test using the scheffe test. The results of this study are that there is an influence of the gamification-based CRBL learning model on students' mathematical creative thinking ability, there is no influence of student learning style on students' mathematical creative thinking ability, and there is no interaction between the CRBL learning model and students' learning style on mathematical creative thinking ability.

Keywords: Creative Thinking, Creative Responsibility Based Learning (CRBL), Gamification, Learning Style

1. Introduction

Basic science that underlies the development of science and technology and can build critical and creative thinking, namely mathematics (Siti Adella Wahyuni et al., 2024). Mathematics is a science that studies how to calculate and measure an object using numbers and symbols (Widyastuti et al., 2020). Mathematics is divided into several levels in formal education, including elementary school, junior high school and college (Anggoro et al., 2021). The lack of mathematical creative thinking skills is one of the factors that can cause low mathematical skills of students (Sulhani et al., 2023). National Education Association (NEA) states that in the 21st century, communication, collaboration, critical thinking and creative thinking skills must be possessed by every student to be able to compete in the era of globalization (Roekel, n.d.). Students must have the ability to think critically, develop new ideas, and excel in presentation skills to succeed in education and the world of work (Syahrani, 2024). Creative thinking is the ability of a person to be able to achieve a goal by creating new ideas and ideas (Azizah et al., 2023). Creative thinking skills are very important in learning, including in the field of mathematics, but in reality the ability to think creatively in students is still relatively low.

Based on a TIMSS survey (Trends In International Mathematics And Sciens Study) related to mathematical achievements, it was stated that Indonesia's position was still low below the international (Syamsul Hadi, 2019). In addition, in the report Programme for International Student Assessment (PISA) stated that the mathematical ability of Indonesian students declined in 2022 (Adi Ahdiat, 2024).

Learning outcomes can be seen from the learning outcomes obtained during learning activities with high or low results (Septi Ayu Lestari Habeahan, 2024). Based on pre-research conducted at MTs Al-Hikmah Bandar Lampung, it was found that the results of the students' mathematical creative thinking ability test were still low. This is shown when given the mathematical creative thinking ability test questions, many students are still fixated on one way taught by the teacher even though there are other alternatives to solve the problem. This reality is evidenced by the results of the students' mathematical creative thinking ability test which states that as many as 87.5% of students have not met the Minimum Completeness Criteria (KKM). This assessment is based on creative thinking indicators. The indicators of creative thinking according to Filsaime include four indicators, including Fluency (smoothness), Flexibility (flexibility), Originality (authenticity), Elaboration (detail) (Filsaime DK, 2008).

The problems found by the author during the pre-research can be overcome in various ways, one of which is the selection of appropriate learning models to improve students' creative thinking skills. There are many learning models to improve students' creative thinking skills, one of which is Creative Responsibility Based Learning (CRBL). Although the CRBL learning model is believed to be effective in increasing students' creativity, to support the motivation and interest of students, the author includes gamification elements in the learning model. In addition, the characteristics of each student also need to be considered, such as how students absorb information optimally so that it is stored in memory for a long period of time. Such methods for each student are certainly different, so the author feels that it is necessary to review based on the difference in learning styles.

Based on the description of the problem that has been explained earlier, the purpose of this study is (1) to find out the influence of the gamification-based CRBL learning model on mathematical creative thinking ability (2) to find out the influence of students' learning style on mathematical creative thinking ability (3) to find out the interaction between gamification-based CRBL learning model and students' learning style on mathematical creative thinking ability.

2. Theoretical Background

2.1 Creative Thinking

Creative thinking is the ability of a person to be able to achieve a goal by creating new ideas and ideas (Azizah et al., 2023). The ability to think creatively mathematically is a person's ability to be able to find many possible answers to a problem, where the emphasis is on the quantity, appropriateness, and variety of answers (Atika et al., 2020). To realize creative thinking skills, students need to get support from the environment as well as strong encouragement from within themselves (Fajrizal et al., 2019). The indicators of creative thinking according to Filsaime include four indicators, including Fluency, Flexibility, Originality, Elaboration (Filsaime DK, 2008).

2.2 Creative Responsibility Based Learning (CRBL)

In addition to gamification, the selection of learning models is also important to be adjusted to the goals to be achieved. The learning model is a plan that is used as a guideline for designing learning in the classroom and determining the learning tools that must be used by teachers and students to achieve learning goals (Harefa et al., 2020). One of the learning models to increase student creativity is Creative Responsibility Based Learning (CRBL). Creative Responsibility Based Learning (CRBL) is a student-centered learning model, educators facilitate students' responsibilities as well as skills to develop their scientific creativity (Suyidno et al., 2021). The CRBL learning syntax consists of five stages, namely generating students' creative responsibility, organising creative learning needs, guiding group investigations, assigning responsibilities in demonstrating scientific creativity, evaluation and reflection.

2.3 Gamification

In the modern learning era, various innovative approaches continue to be developed to improve student learning outcomes, one of which is gamification. Gamification is one of the learning techniques that utilizes aspects of games such as giving challenges, competitions, achievement satisfaction and prizes into the context of learning both to increase student engagement and to motivate students (Srimuliyani, 2023). Gamification is divided into two, namely structural gamification and content gamification. The type of gamification used in this study is structural gamification. Structural gamification is the concept of gamification by applying game elements to motivate students through game content without changing the learning material. For example, using game elements such as points, levels, badges, leaderboards, and achievements, and applying them to an educational context. (Elshiekh & Butgerit, 2017)

2.4 Learning Style

Learning style is a way for a person to be able to absorb information with cognitive, affective and physiological factors that are considered the most effective and efficient (Tri Ambarwati et al., 2020). Learning style can also be interpreted as an activity that a person does to make it easier to understand new ideas and knowledge (Anggoro et al., 2019). According to Syarif Hidayat, the types of learning styles include visual, audirori and kinesthetic. Visual namely the student's learning style by seeing, Auditory namely the student's learning style by listening, and Kinesthetic, that is, the student's learning style by involving physical activity (Hidayat S, 2012).

2.5 Previous Research and Research Gap

Suyidno (2019) in his research related to the CRBL model believes that this model is effective in increasing students' scientific responsibility and creativity in learning physics (Suyidno et al., 2019). Meanwhile, Yasmin Hadiyyana Fatin Hana (2024) showed the results of her research, namely that there was a significant increase in students' mathematics learning outcomes after using a gamification-based cooperative learning model (Yasmin Hadiyya Fatin Hana et al., 2024). However, there have not been many studies that examine how gamification in CRBL can affect students' mathematical creative thinking ability based on their learning style.

2.6 Research Hypothesis

Based on the theoretical review and previous research, the hypothesis in this study is that there is an influence of gamification in the CRBL learning model on mathematical creative thinking ability, there is an influence of student learning style on mathematical creative thinking ability, and there is an interaction between gamification in the CRBL learning model and student learning style on mathematical creative thinking ability

3. Methods

This study uses a type of Quasi Experimental Design research with the design used, namely Posttest Only Control Group Design. This study was designed with two experimental groups and one control group. In experimental class 1, a gamification-based CRBL learning model was given, in experimental class 2 a CRBL learning model was given, and in the control class, a direct instruction model was given with conventional methods. This study has three variables, namely gamification in the Creative Responsibility Based Learning (CRBL) learning model as an independent variable symbolized by (X_1), students' mathematical creative thinking ability as a bound variable symbolized by (Y) and students' learning style as a moderator variable symbolized by (X_2). The population in this study is all class VIII MTs Al-Hikmah Bandar Lampung which totals 104 students. The sampling technique used is Cluster Random Sampling by lottery. Meanwhile, the data collection technique is using tests and questionnaires. Tests are used to measure students' mathematical creative thinking skills and questionnaires are used to find out students' learning styles. The data analysis technique used in this study is two-way ANOVA with analysis prerequisite tests that must be met, namely normality test and homogeneity test. Furthermore, if the two-way ANOVA test proves the existence of an influence, a further test is needed. The advanced test used in this study is in the form of a scheffe test.

4. Results and Discussion

4.1 Descriptive Statistic

Before being given treatment, students are first given a questionnaire to find out the type of learning style. The results of the student learning style questionnaire are presented in the following table.

Table 1. Data Description Learning style questionnaire results

Class	Categorization of Learning Styles			Sum
	Visual	Auditory	Kinesthetics	
Experiment 1	16	9	7	32
Experiment 2	9	7	11	27
Control	5	8	12	25
Total	30	24	30	84

Based on table 1, it is known that in experimental class 1 there are 32 students who are divided into 3 categories of learning styles, namely 16 students in the visual category, 9 auditory students and 7 other students who are kinesthetic. Furthermore, in experimental class 2 there were 27 students, with 9 visual students, 7 auditory students, and 11 kinesthetic students. Meanwhile, in the control class there were 25 students, with 5 visual students, 8 auditory students, and 12 other students, namely kinesthetics.

After collecting the learning style questionnaire data, then the students of the sample class were given treatment. Then after the learning process is complete, students are given

a posttest to measure mathematical creative thinking skills. The data on student posttest results is presented in the following table.

Table 2. Description of Posttest Results Data

Group	X_{max}	X_{min}	Central Tendency Size			Group Variance Size	
			$\overline{X}$	M_e	M_o	R	SD
Experiment 1	100	56	84,47	84,50	94	44	11,291
Experiment 2	94	56	76,07	75	75	38	9,607
Control	81	50	67,56	69	63	31	9,332

Based on table 2, it is known that the average score of the creative thinking ability test of the experimental class 1 is $\overline{X} = 87,47$ while the experimental class 2 is and the control class is, so it can be concluded that the experimental class 1 has a higher average score of creative thinking ability than the experimental class 2 and the control class.$\overline{X} = 76,07\overline{X} = 67,56$

4.2 Normality Test

After all the data collection processes are completed, both questionnaires and questions, then the data is analyzed using a two-way ANOVA test. Before the two-way ANOVA test is carried out, the data must first meet the prerequisite tests for analysis, namely the normality test and the homogeneity test. The results of the normality test of students' mathematical creative thinking skills and learning styles are presented in the following table.

Table 3. Results of the Normality Test of Creative Thinking Ability

Tests of Normality							
	CLASS	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistics	Df	Sig.	Statistics	Df	Sig.
Creative Thinking	Experiment 1	,144	32	,088	,936	32	,058
	Experiment 2	,159	27	,077	,950	27	,212
	Control	,147	25	,169	,926	25	,072

a. Lilliefors Significance Correction

Based on table 3, the results of the normality test of creative thinking ability using the Kolmogorov Smirnov and Shapiro-wilk tests were obtained that the value $p - value \geq \alpha$ with a level of significance $\alpha = 0,05$. Thus, it can be concluded that the data on creative thinking ability comes from data that is normally distributed.

Table 4. Results of the Learning Style Normality Test

Tests of Normality							
	CLASS	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistics	Df	Sig.	Statistics	Df	Sig.
Value of Learning Styles	Experiment 1	,099	32	,200*	,956	32	,216
	Experiment 2	,105	27	,200*	,953	27	,257
	Control	,113	25	,200*	,945	25	,194

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on table 4, the results of the learning style normality test were obtained that the learning style data came from a normally distributed population, because p- with avalue $>$ α level of significance.$\alpha = 0,05$

4.3 Homogeneity Test

The prerequisite test for the analysis that follows the normality test is the homogeneity test. The homogeneity test in this study was carried out on data on creative thinking ability and learning style using SPSS software. The results of the homogeneity test are as presented in the following table.

Table 5. Results of the Homogeneity Test of Creative Thinking Ability

Tests of Homogeneity of Variances					
		Levene Statistic	df1	DF2	Sig.
Creative Thinking	Based on Mean	1,110	2	81	,334
	Based on Median	1,232	2	81	,297
	Based on Median and with adjusted df	1,232	2	80,008	,297
	Based on trimmed mean	1,102	2	81	,337

Table 5 is the result of the homogeneity test of mathematical creative thinking ability obtained from the calculation of SPSS software. In the table, the type of homogeneity test displayed is the statistical levene test with a level of significance$\alpha = 0{,}05$. The decision-making in this test is that if p-value >, the data is said to be homogeneous. Because αp-valuegreater than 0.05, it is concluded that the data of the creative thinking test is from a homogeneous population.

Table 6. Results of the Learning Style Homogeneity Test

Tests of Homogeneity of Variances					
		Levene Statistic	df1	DF2	Sig.
Learning Style	Based on Mean	1,372	2	81	,259
	Based on Median	1,365	2	81	,261
	Based on Median and with adjusted df	1,365	2	78,846	,261
	Based on trimmed mean	1,370	2	81	,260

Table 6 is the result of the learning style homogeneity test obtained from the calculation of SPSS software. In the table, the type of homogeneity test displayed is the statistical levene test with a level of significance$\alpha = 0{,}05$. Because p- valuegreater than 0.05, it is concluded that the learning style data is from a homogeneous population.

After the prerequisite test of the analysis is fulfilled with the results of data coming from a population that is normally distributed and homogeneous, then the next is the hypothesis test. The hypothesis test used in this study is a parametric test in the form of an ANOVA (Analysis Of Variance) two-way classification test using SPSS software. The results of the two-way ANOVA test calculation obtained from SPSS are presented in the following table:

4.4 Anova Test

Table 7. Two-Way Anova Test Results

Tests Of Between-Subjects Effects					
Dependent Variable: Berpikir_Kreatif					
Source	Type III Sum Of Squares	Df	Mean Square	F	Sig.
Corrected Model	4901,369A	8	612,671	6,069	,000
Intercept	433769,065	1	433769,065	4297,086	,000

Learning Model	3459,498	2	1729,749	17,136	,000
Learning Style	219,297	2	109,648	1,086	,343
Learning Model * Learning Style	700,184	4	175,046	1,734	,151
Error	7570,869	75	100,945		
Total	507126,000	84			
Corrected Total	12472,238	83			
A. R Squared = ,393 (Adjusted R Squared = ,328)					

Based on the results of the two-way anova analysis in table 7, it can be seen that the first hypothesis was H_{0A} rejected, because the result was obtained that the value - in the learning model was less than the significance level. This means that there is an influence between the gamification-based CRBL learning model, CRBL, and pvalueDirect Instruction on students' mathematical creative thinking skills. Furthermore, for the second hypothesis, the result was obtained that there was not enough evidence to reject, based on the table, the result was obtained that the value - learning style was greater than the level of significance, so it was concluded that there was no influence between students with H_{0B}pvaluevisual, auditory, and kinesthetic learning styles on mathematical creative thinking skills. Then for the third hypothesis, the result was obtained that there was not enough evidence to reject, based on the table, the result was obtained that the value between the learning model and the student's learning style was greater than the significance level, so it was concluded that there was no interaction between the gamification-based CRBL learning model and the student's learning style on the mathematical creative thinking ability.H_{0AB}pvalue

Based on the previous two-way ANOVA test, the result was obtained that the first hypothesis rejected while the second and third hypotheses did not have enough evidence to reject. Therefore, a double comparison test needs to be carried out on the first hypothesis, namely the learning model. The following are the results of the double comparison test with $H_0H_0$the Scheffe' method.

Table 8. Double Comparison Test Results

Multiple Comparisons						
Dependent Variable: BERPIKIR_KREATIF						
Scheffe						
(I) Learning Model	(J) Learning Model	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Gamification-Based CRBL	CRBL	8.39*	2,625	,008	1,84	14,95
	Direct Instructions	16.91*	2,682	,000	10,21	23,61
CRBL	Gamification-Based CRBL	-8,39*	2,625	,008	-14,95	-1,84
	Direct Instructions	8.51*	2,789	,012	1,55	15,48
Direct Instructions	Gamification-Based CRBL	-16.91*	2,682	,000	-23,61	-10,21
	CRBL	-8.51*	2,789	,012	-15,48	-1,55
Based on observed means. The error term is Mean Square(Error) = 100,945.						
*. The mean difference is significant at the 0,05 level.						

Based on table 8 of the results of the double comparison test, it can be seen that $H_0: a_1 \neq a_2$ it was rejected, because a score was obtained - which means that there is a difference between students who are given the gamification-based CRBL learning model and students who are given the CRBL learning model. Based on the pvalue $< 0{,}05$mean difference (I-J) column, a positive value of 8.39 was obtained, which means that the average value of the gamification-based CRBL column I learning model was higher at 8.39 compared to the J column learning model, namely CRBL. Furthermore, it was rejected, because scores were obtained - which means that there is a difference between students who are given the gamification-based CRBL learning model and students who are given $H_0: a_1 \neq a_3$pvalue $< 0{,}05$ the Direct Instructions learning model. Based on the mean difference (I-J) column, a positive value of 16.91 was obtained, which means that the average value of the gamification-based CRBL learning model was higher at 16.91 compared to the J column learning model, namely Direct Instructions. Then, $H_0: a_2 \neq a_3$ it was rejected, because scores were obtained - which means that there is a difference between students who are given the CRBL learning model and students who are given pvalue $< 0{,}05$ the Direct Instructions learning model. Based on the mean difference (I-J) column, a positive value of 8.51 was obtained, which means that the average value of the learning model of column I, namely CRBL, was higher at 8.51 compared to the learning model of column J, namely Direct Instructions. Based on data collection and data processing results using SPSS, the following is a discussion of the three hypotheses tested.

Based on the data that has been obtained and tested using statistical tests, it can be known that the first hypothesis is that it is rejected, this result is in accordance with the theoretical hypothesis that H_{0A} This means that there is an influence between students who get the gamification-based CRBL learning model, CRBL, and Direct Instruction to the ability to think creatively mathematically. Data analysis showed significant average differences from the three learning models. The mathematical creative thinking skills of students who use the gamification-based CRBL learning model are better than those of students who use the CRBL learning model and Direct Instruction with conventional methods. This is likely to happen because students' interest and motivation in learning increase with the presence of gamification elements that cause their learning outcomes to also increase, so that the gamification-based CRBL learning model is better in improving students' mathematical creative thinking skills. The results of this study support Suyidno's findings, namely that CRBL is believed to be effective in increasing students' scientific responsibility and creativity (Suyidno et al., 2019). In addition, the research conducted by Yasmin Hadiyyana Fatin Hana also strengthens the results of this study by showing a significant improvement in students' mathematics learning outcomes after using a gamification-based cooperative learning model (Yasmin Hadiyya Fatin Hana et al., 2024). Although this gamification-based CRBL learning model is effective to implement, researchers still find several weaknesses in the field, namely with the application of gamification methods, students' enthusiasm in learning solely to get prizes or awards. In addition, the competitive spirit of students who emerge to compete for points makes the class less conducive and for educators who want to implement this model requires careful preparation, sufficient finances and being able to manage time well.

Furthermore, the second theoretical hypothesis states that there is an influence of students' learning style on mathematical creative thinking ability, however, the results of the second hypothesis test based on the data of the research results can be found that there is not enough evidence to reject H_{0B} That is, even though learning styles can affect students' mathematical creative thinking abilities but the effect is so small that statistical

tests do not detect any evidence strong enough to state that There is an influence between students and learning styles visual, auditory and Kinesthetics to the ability to think creatively mathematically. The results of this second hypothesis test are in line with Ela Nurlaela's research entitled "The Influence of Learning Style and Emotional Intelligence on the Creative Thinking Ability of Science" with the results of the hypothesis test, namely that there is no significant influence of learning style on the creative thinking ability of science (Nurlaela, 2022). This indicates that different learning styles of students do not have a significant influence on students' ability to generate new ideas or solve problems. Factors that may be the cause of the absence of this influence are, students do not adapt their learning styles according to their characteristics optimally so that the difference in learning outcomes between students with visual, auditory, and kinesthetic learning styles is not significant. Furthermore, it is likely to come from external factors such as interest, motivation or the learning environment. If the learning environment makes students uncomfortable or students do not have the interest and motivation to think creatively, even though their learning style has been optimized, their creative thinking ability can still be limited. Another possibility is the limitation of time in the learning process. Limited time to apply various learning styles in mathematics learning can be an inhibiting factor. This is strengthened by the research of Ihfa Indira Nurnaifah et al, entitled "The Influence of Learning Style on Student Physics Learning Outcomes" which states that there is no influence of the independent variable (X) on the bound variable (Y), meaning that the student's learning style does not affect the learning outcomes (Ihfa Indira Nurnaifah et al., 2022)

Then the third theoretical hypothesis is to state that there is an interaction between the gamification-based CRBL learning model and students' learning styles on mathematical creative thinking skills. But The results of the third hypothesis test based on the data of the research results are known that there is not enough evidence to reject the H_{0AB} Means, there is no evidence strong enough to state that There is an interaction between learning models Creative Responsibility Based Learning (CRBL) based on gamification with students' learning styles on mathematical creative thinking skills. The results of this third hypothesis test are in line with the research of Pita Suliawati et al., entitled "Improving Mathematical Creative Thinking Skills; Impact Flipped Classroom Assisted by Audio Visual and Learning Styles" with the results of his research that there was no interaction between Flipped Classroom and the category of learning styles on mathematical creative thinking skills (Pita Suliawati, Jamal Fakhri, 2020). This is also strengthened by Widya Wanelly's research which states that there is no interaction between learning approaches and learning styles in influencing students' creative thinking skills (Wanelly & Fauzan, 2020) Another research was conducted by Anisa Nurjanah et al., who also stated that there was no interaction between learning models and learning styles on students' mathematical problem-solving skills (Nurjanah et al., 2022). The absence of interaction between the learning model and this style can be interpreted as the superiority of the learning model does not depend on the learning style visual, auditory, And Kinesthetics in influencing their creative thinking skills. The factor that may be the cause of this lack of interaction is the effectiveness of the gamification-based CRBL learning model, which is quite adaptive and able to accommodate various learning styles such as visual, auditory and Kinesthetics evenly so that no particular learning style benefits more from the application of this learning model. Another factor is the imbalance in the number of samples between groups. With an unbalanced sample size, the statistical power to detect interactions is reduced. An imbalance in the number of samples can affect the assumption

of homogeneity Variance. Therefore, although the effect of the interaction may exist, it cannot be detected by statistical tests due to this imbalance in the number of samples. So the researcher believes that there is no interaction between the learning model and the learning style on the ability to think creatively mathematically.

5. Conclusion

Based on the analysis of the data of the research results and the testing of the hypothesis regarding the influence of gamification in the Creative Responsibility Based Learning (CRBL) learning model on the ability to think creatively mathematically based on the learning style of MTs Al-Hikmah Bandar Lampung students, it is known that there is an influence of gamification in the Creative Responsibility Based Learning learning model (CRBL) on students' mathematical creative thinking skills. Furthermore, there was no influence between students with visual, auditory, and kinesthetic learning styles on mathematical creative thinking skills. Then there was no interaction between the gamification-based Creative Responsibility Based Learning (CRBL) learning model and students' learning styles on mathematical creative thinking skills.

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