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Improving Students' Creative Thinking Ability Through Problem Based Learning Models on Stoichiometric Materials

R B Rudibyani

Faculty of Teacher Training and Education, Lampung University, Road. Prof. Dr. Soemantri Brojonegoro No.1

ratu.betta.r@gmail.com

Abstract. This study aims to determine the improvement of students' creative thinking skills through the Problem Based Learning model on Stoichiometry material. The population in this study were all students of class XI IPA, Senior High School in Tulang Bawang Barat Regency, in the even semester of 2017/2018 school year. The sampling technique used was cluster random sampling and obtained a sample of class as the experimental class and the control class. This research method is quasi-experimental with Pretest-Posttest Control Group Design. The increase in students' creative thinking skills is measured based on the average n-Gain score of students. The results showed that in the experimental class, the average value of n-Gain students' creative thinking skills was 0.78 (high criteria) and the control class, the average value of n-Gain students' creative thinking skills was 0.52 (medium criteria). Based on the results of this study it can be concluded that students' creative thinking skills on Stoichiometry material, increased through the Problem Based Learning models

1. Introduction

In the 21st-century or known as the era of globalization as it is today, humans are faced with various complex challenges [1-3]. This is characterized by easy access to all types of information because it is available anywhere and can be accessed at any time [4-5]. natural face challenges of the 21st-century, at least people are required to master the what competencies among which creative thinking skills and innovative [6-7].

One of the thinking skills that can be developed in students is creative thinking skills. Creative thinking skills are thinking skills to generate new ideas, useful ideas, and alternative ideas that can be used to solve problems [8-10]. The ability to think creatively is the ability to generate new ideas by combining, changing or developing existing ideas, not the ability to create something out of nothing [11-12]. Provides a description of the ability to think creatively, namely the ability to think; (1) Current (Fluency); (2) Luwes (Flexibility); (3) Original (originality); (4) Detailing (Elaboration); and (5) Assessing (Elaboration) [13].

The importance of mastering these abilities is expected to be able to solve various problems and create new things such as concepts, theories, and so on that are needed for the real world life they will experience [14-15]. To deal with the issue of education can be believed as natural improving creative thinking and problem-solving nature builds d quality of human resources and of high quality [16-17].

The observation results in a class that 70% of students (preliminary study) do not have the ability to think creatively so that students have not been able to solve chemical problems well and smoothly. Stoichiometry is a chemical material that studies the structure, composition, properties, and changes of



matter, as well as the energy that accompanies material changes involving students' skills and reasoning [18].

Learning chemistry and assessing the results of learning chemistry must pay attention to the characteristics of chemistry as a process and product [19]. Chemistry as a process includes ways of thinking, attitudes, and steps of scientific activities to obtain chemical products. Chemistry as a product can be in the form of law, concepts, postulates, and theories. While the values of chemistry related to moral responsibility, social values, attitudes and actions of a person in learning or developing chemistry. These attitudes and actions, for example, curiosity, honesty, accuracy, perseverance, caution, tolerance, and thrift [20-21].

The implementation of the 2013 curriculum allows it to improve and create solutions to problem-solving, namely by training and developing students' thinking skills [22-24]. The problem -solving leads to questions and searches for answers by students who can then find solutions to problems in the context of learning using available information resources [25-26]. This can be seen from the implementation of the 2013 curriculum which explicitly mandates problem-based learning that demands high-level thinking skills such as creative thinking skills [27-28].

Problem based learning model (Problem Based Learning) is a learning model that develops the student's ability to solve problems, so that the knowledge and concepts by the students is the result of student's own thinking and is expected to build creative thinking skills as well so not only can solve the problem but also acquire new knowledge [29-32]. This learning model is designed based on real problems of life, which is based on problems that exist in everyday life that challenge students to learn and work together between group members in solving problems and finding solutions to existing problems [33-34]. Therefore, with this problem-based learning model (Problem Based Learning) is expected to produce quality human resources, able to solve challenging problems that exist in real life [31]. Based on this background, this study aims to determine improving students' creative thinking ability through the model Problem-Based Learning in the Stoichiometry.

2. Research Method

The method used in this study is quasi-experiment with non-equivalent pretest-posttest control group design [35].

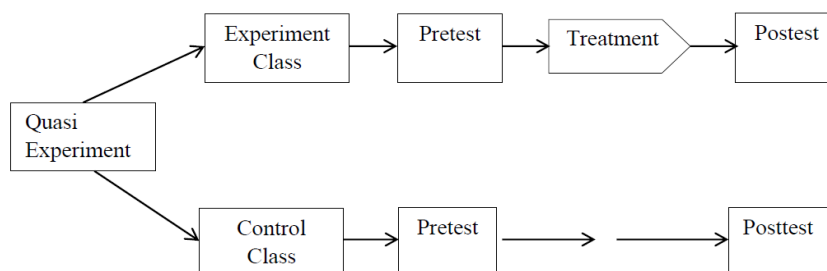


Figure 1 Method research is quasi-experiment with non-equivalent pretest-posttest control group design

The population in this study were all students of class XI IPA, Senior High School in Tulang Bawang Barat Regency, in the even semester of 2017/2018 school year. Sampling using cluster random sampling technique, the obtained samples are class XI IPA 3 as the experimental class and XI IPA 4 as the control class.

The instrument used in this study was a matter of pretest and posttest consisting of 5 description questions that represented students' creative thinking abilities and student worksheets based on the model problem-based learning. In addition, there is an assessment sheet used, namely the teacher's implementation sheet in managing classes problem-based learning.

The validity and reliability of the instrument were analyzed with SPSS version 17 for Windows software. The validity of the problem is determined from the comparison of the values r_{table} and r_{count} .

The criteria are if $r_{\text{table}} < r_{\text{count}}$ then the question is said to be valid. Reliability is determined using Cronbach's Alpha. Criteria for a degree of reliability (r_{11}) according to Guilford are shown in Table 1.

Table 1 Criteria for Degree of Reliability

Degree of reliability (r_{11})	Criteria
$0.80 < r_{11} \leq 1.00$	Very high
$0.60 < r_{11} \leq 0.80$	Height
$0.40 < r_{11} \leq 0.60$	Moderate
$0.20 < r_{11} \leq 0.40$	Low
$0.00 < r_{11} \leq 0.20$	Not reliable

Increased students' creative thinking ability on the stoichiometric material was obtained through pretest and posttest scores. The results of the research data obtained student scores, which were then converted into grades and then analyzed by calculating n-Gain. The value of n-Gain is the difference between the posttest and pretest scores to determine the increase in the value that occurs. Here is the Formulas n-Gain:

$$n - Gain = \frac{\% \text{ postes} - \% \text{ pretes}}{100 - \% \text{ pretes}}$$

With criteria n-Gain according to [36] is shown in Table 2.

Table 2. Criteria for n-Gain

Score n-Gain	Criteria
$n - Gain > 0.7$	Height
$0.3 < n - Gain \leq 0.7$	Medium
$n - Gain \leq 0.3$	Low

The Effect size of the use of learning models problem based learning in improving students' creative thinking skills on stoichiometric material determined by value test-t. Before the test is t carried out, the normality test and homogeneity test are performed on the pretest, posttest, and values n-Gain using SPSS version 17 for Windows software. The normality test is determined based on the value sig. in the column Kolmogorov-Smirnov, while the homogeneity test is seen from the value sig. in the column Test of Homogeneity of Variance.

The criteria for normality and homogeneity are that the sample is said to be normally distributed and has a homogeneous variance if the value of sig. > 0.05 . If the sample is normally distributed and homogeneous, then the parametric statistical test then uses SPSS version 17 for windows software which tests independent sample t-test on n-Gain both classes with criteria accept H_0 if the value is significant or sig. (2-tailed) > 0.05 , which means that the average n-Gain creative thinking skills use the model Problem Based Learning lower or equal to the average n-Gain creative thinking skills that use conventional learning models and reject H_0 if the opposite. Furthermore, the independent sample t-test tested was on pretest and posttest scores second class with criteria accept H_0 if the significant value or sig. (2-tailed) > 0.05 , which means that the value of the pretest is the same as the posttest value (there is no change) and reject H_0 if the opposite.

Based on the value $t_{\text{calculated}}$ obtained from the independent sample t-test on pretest and posttest scores, then performed to determine the size of the effect. To determine the impact of learning effects on the improvement of students' creative thinking ability through the Problem Based Learning model in the Stoichiometry material, the effect size formula calculation was analyzed. Calculation of the test effect size according to [37] used the following formula:

$$\mu^2 = \frac{t^2}{t^2 + df}$$

with the criteria effect size according to Dincer as shown in Table 3 [38]:

Table 3 Criteria for Effect Size

Effect size (μ)	Criteria
$\mu \leq 0.15$	Very small
$0.15 < \mu \leq 0.40$	Small
$0.40 < \mu \leq 0.75$	Medium
$0.75 < \mu \leq 1.10$	Large
$\mu > 1, 10$	Very large

To prove that learning using the model problem-based learning has been implemented, it is necessary to assess the implementation of the model problem-based learning through observation sheets. The percentage of achievement is calculated by the formula:

$$\% Ji = \frac{\sum Ji}{N} \times 100\%$$

Table 4 Criteria Level Implementation

Percentage	Criteria
80.1% - 100.0%	Very high
60.1% - 80.0%	High
40.1% - 60.0%	Average
20.1% - 40.0%	Low
0.0% - 20.0%	Very low

3. Results and Discussion

This study describes the effectiveness of learning models problem based learning in improving students' creative thinking skills in buffer solution material. The effectiveness of the model problem-based learning is determined based on whether there is an increase in the average value n-Gain of students' creative thinking ability at the end of learning.

Characteristic of learning model problem-based learning is to raise problems related to everyday life then students are asked to find solutions in groups that are guided by the teacher. The results of students' learning abilities are then evaluated by the test instrument, in this study that is measuring students' creative thinking skills.

3.1 Validity and Reliability

Test the validity of test results are presented in Table 5.

Table 5 Results of Validity Grain Problem

Grain Problem	Coefficient correlation	r_{table}	Comments
1	0.578	0.4409	Valid
2	0.669	0.4409	Valid
3	0.763	0.4409	Invalid
4	0.692	0.4409	Valid
5	0.680	0.4409	Valid

Based on Table 5, Validation test using Correlation Pearson Product Moment method with the provisions. If $r_{count} > r_{table}$ then the item is valid, and if $r_{count} < r_{table}$ then the item is invalid and omitted. The validity test instrument obtained the lowest score of 0.578 and the highest 0.763 > r_{table} with 32 students with $r = 0.4409$ (r product moment value), the instrument used was valid. While

reliability is obtained by Cronbach, Alpha s $0.813 > 0.4409$ means that each item about reliability is implemented in the experimental class and control class. The five items are declared valid and reliable so that the test instrument can be used to measure students' creative thinking skills.

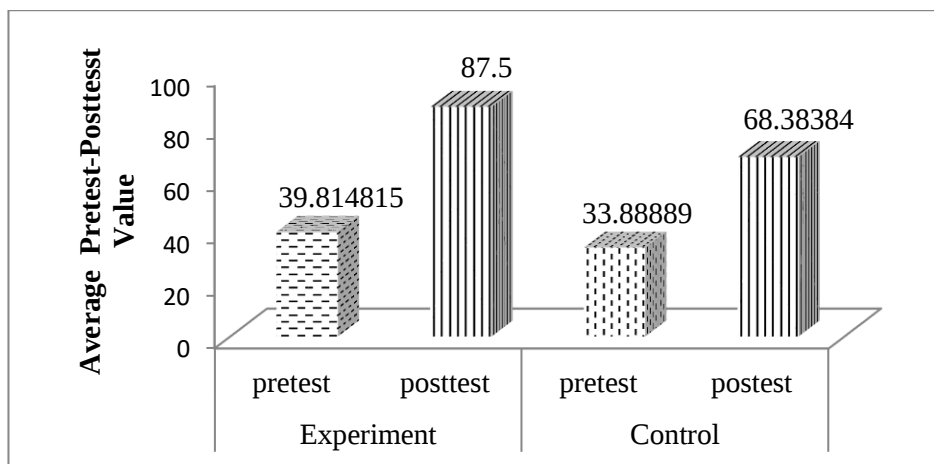


Figure 2 Average pretest posttest value

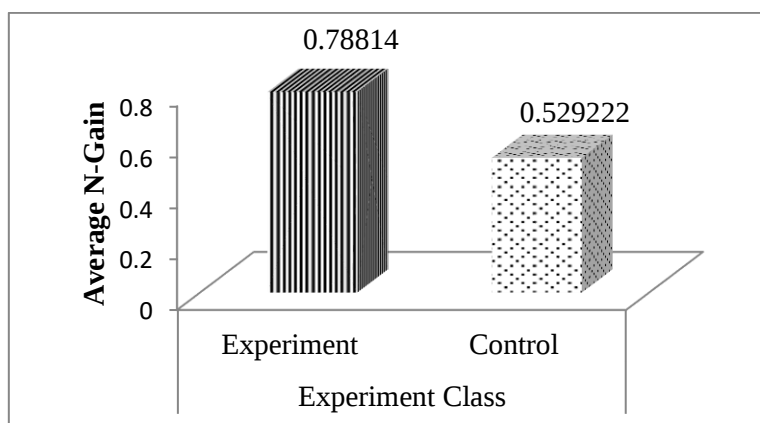


Figure 3 Average n-Gain value

Figure 1 shows that there is an average difference between the pretest and posttest scores in the experimental class and the control class. The average pretest score of the experimental class was 39.81 and the average pretest score of the control class was 33.88. While the average posttest score of the experimental class was 87.50 and the average pretest score of the control class was 68.38. This proves that the experimental class obtained a higher score higher than the control class.

Based on Figure 2 shows that the results of the acquisition of an increase in the average N-gain the biggest score occur in the experimental class 0.78 with a high criterion compared to the 0.52 control class with medium criteria. Implementation through the Problem Based Learning model in the Stoichiometry material contributes effectively can improve students' creative thinking skills.

3.2 Normality Test Results and Homogeneity Test

Results test for normality and homogeneity of students' creative thinking in the experimental class and control class can be seen in the following table.

Table 6 Test results for Normality

Class	observed Aspects of	Significant Value of Creative Thinking Skills	Explanation
Eksperimen	pretest	0.200	Normal
	posttest	0.500	Normal

Control	n-Gain	0.670	Normal
	pretest	0.940	Normal
	posttest	0.187	Normal
	n-Gain	0.200	Normal

Table 7 Test results for Homogeneity

observed Aspects of	Significant Value of Creative Thinking Skills	Explanation
pretest	0.463	Homogeneous
posttest	0.053	Homogeneous
n-Gain	0.563	Homogeneous

Based on Table 6 The results of the homogeneity score test of the students' creative thinking skills in the experimental class and the excitement class. This showed that the significance level obtained by the pretest, posttest and n-gain experimental classes was greater > 0.05 , it is $0.200 > 0.05$, $0.500 > 0.05$, $0.670 > 0.05$. H_0 accepted and this shows that the data is normally distributed. While the pretest control class was $0.940 > 0.05$, posttest was $0.187 > 0.05$, and n-gain was $0.200 > 0.05$. H_0 is accepted and this shows that all three data are normally distributed.

Table 7 The results of the homogeneity test scores of students' creative thinking skills in the experimental class and the excitement class. This showed that the level of significance of the pretest students' creative thinking skills scores of $p = 0.463$ and posttest of $p = 0.053$ whereas n-gain is $p = 0.563$. This shows that the significance level obtained is greater than 0.05 . So H_0 is accepted, both classes have homogeneous variance.

3.3 Difference Test of Two Average n-Gain

Test of two average differences was carried out using independent samples t-test in the program SPSS 17.0 with a significant level of 5%. Test criteria accept H_1 if sig. (2-tailed) from t-test for equality of means < 0.05 and accept H_0 if sig. (2-tailed) from t-test for equality of means > 0.05 . The results of the two average difference test n-Gain students' creative thinking skills in the experimental class and the control class showed that the value sig. (2-tailed) < 0.05 so that the decision to accept H_1 means that the average value of n-Gain critical thinking skills of students using a problem-based learning model is higher than conventional learning models [38].

3.4 Effect Size

Table 8. Test results of pretest-posttest scores and size of influence creative thinking skills

Class	Treatment	N	Mean	Std. Deviation	Sig (2-tailed)	Df	t	μ	Effect Size
Experiment	Pretest	34	30.2415	13.60463	0,000	66	-15,521	0,89	Large
	Posttest	34	78.8629	12.18868					
Control	Pretest	34	28.5865	14.20913	0,000	66	-8,747	0,73	Average
	Posttest	34	57.6288	13.15014					

After the test the difference two averages of the value of n-Gain, then test the difference between two average of the value of pretest and posttest in the experimental class and control class. The value obtained from the test of the difference between two average pretest-posttest then used to calculate the effect size the ability to think creatively.

Based on Table 8 above that the Sig. (2-tailed) in the second class of less than 0.05 so thank H_1 , which is the average value of creative thinking ability of students there is a difference. The size of the effect (effect size) in the experimental class is 0.89 or has a "big effect" according to the Dincer criteria (2015), compared to the control class which is 0.73 or that has "moderate effect". this shows students in the experimental class are able to think creatively.

The results of the conclusions obtained are supported by the implementation of model problem-based learning that was assessed by observers, namely partner teachers. The results of the assessment show that compliance increases at each meeting with the "very high" implementation criteria. The results of the learning outcomes can be seen in the following table 9.

Table 9. Results of PBL Implementation

Aspects of Observation	% Implementation		
	Meeting 1	Meeting 2	Meeting 3
Introduction	75 %	81%	88 %
Orienting students to problems	71%	79%	88%
Organizing students to learn	57%	63%	75 %
Assisting investigations independent and group	63%	70%	83%
Developing and promising (work) and presenting	58%	75 %	80%
Analysis and evaluation of the problem-solving process	56%	63%	81%
teacher assessment	70%	83%	85%
Score -rata	66.0%	73.4%	82.8%

Based learning model of problem-based learning is an instructional model that requires students active. The average percentage of achievement of all aspects of observation assessed by the two observers at the first meeting was 66%. This percentage is lower than the second meeting. In the first meeting, the class atmosphere tends to be less conducive so that it will have an impact on the management of unfavorable time during the learning process. The average percentage of all aspects of observation at the second meeting increased to 73.4%. At this second meeting, several aspects of observation have increased. At the third meeting, there was a better improvement of 82.8%. This is because students are getting used to what is taught by the teacher and the teacher begins to condition students to be more active in the teaching and learning process. This increase is because the condition of students in the class is more controlled and students become more active in finding information from relevant sources regarding the problems they find, students become more active in group discussions, answering questions, conducting experiments and also interacting with teachers. Based on the average percentage of all aspects of observation from the three meetings, the average percentage of teachers' ability to manage to learn is 74.1% with the criteria of "very good".

The implementation of the syntax of the learning process at each meeting conducted by the teacher and students has increased with the criteria of very good [40]. Increased scores in the learning process used by teachers and students who understand are able to understand the PBL syntax learning model [41]. Problem Based Learning (PBL) directly facilitates students' reasoning and problems that can be raised, critical questions and answers and derived from learning activities to be the center of students. students are more active in learning [42-43]. Their sharpness and imagination to think creatively and selectively [44]. Creative thinking is needed to train children in solving the problems they face [45]. People who are able to choose ideas that are more creative, more original, and more useful [46].

Learning with the model problem-based learning (PBL) is new things and new experiences for students. Students are not familiar with the use of learning models problem-based learning (PBL) so that at the beginning of the learning process, having difficulties in finding problems and determining hypotheses, so that teacher assistance is needed. Students are required to be active and follow the syntax in learning. These things cause additional needs time in the learning process.

4. Conclusion

Based on the results of research and discussion, it can be concluded Improving Students' Creative Thinking Ability Through Problem Based Learning Models in Stoichiometric Materials. The results showed that in the experimental class, the average value of n-Gain students' creative thinking skills was 0.78 (high criteria) and the control class, the average value of n-Gain students' creative thinking skills

was 0.52 (medium criteria). It can be concluded that students' creative thinking skills on Stoichiometry material, increased through the Problem Based Learning models.

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