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PROJECT-BASED LEARNING MODEL TO PROMOTE STUDENTS CRITICAL AND CREATIVE THINKING SKILLS

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Abstract: This study aimed to assess the worthiness of the project-based learning model in training critical and creative thinking skills on colloidal material. This research is a pre-experimental design with a one group pretest-posttest design. 31 students of XI MIPA 4 at MAN 1 Mojokerto were the targets studied in this study. The results of this study are: 1) The average percentage of the project-based learning treatment obtained is 78% in the good category (1st meeting) and 88% in the very good category (2nd meeting). 2) The activity of students is declared good with a percentage of 88%. 3) Critical and creative thinking skills have high criteria, as shown in the results of N-Gain 0.70, 0.73, and 0.73. 4) Student learning outcomes increase, which indicated from one complete student to 28 complete students. 5) A total of 95% positive responses were obtained from 31 students on the Project-Based Learning model. So the conclusion that can be drawn is that the project based learning model can train students' critical and creative thinking skills on colloidal material. project based learning model can be used as an alternative learning strategy to practice critical and creative thinking skills as the demands of 21st-century skills. It is more maximal and meaningful so that the desired learning activities and better results study can be achieved.

Keywords: *Project-Based Learning, Critical Thinking Skills, Creative Thinking Skills, Colloid.*

INTRODUCTION

Chemistry is a natural science that deals with what happens in everyday life. Chemistry learning in schools involves skills and reasoning that affect the interaction process between students and what is happening around them. In addition, chemistry is an experimental science, which means that in studying it, learning activities such as practicum are needed so that it can develop students' knowledge about the material being studied [1]. One of the chemicals that concern everyday life is colloids. A colloid is a chemical material in Basic Competency 3.15, where most of the material is in the form of concepts widely applied in various fields of daily life. In addition, colloidal material requires an analysis stage for several sub-materials, mainly in grouping colloid types and analyzing colloid properties, so that colloidal material can be used as a medium to develop thinking skills [2]. This research's 21st-century thinking skills training are skills to think critically and creatively. Critical thinking is a scientific skill that can build knowledge by analyzing information to solve a problem and draw conclusions so that students can understand the subject being studied in-depth [3]. Critical thinking has several indicators, including interpretation, explanation, analysis, evaluation, inference, and self-regulation [4]. Critical thinking skills in the learning process in the classroom are needed to help students have a high-level mindset. In addition, critical thinking skills are an important part of the chemistry learning process, where there are phenomena and other things that need to be analyzed in chemistry [5]. Cones et al. [6] also added that these skills are very appropriate to be emphasized in all aspects of learning because they are related to increasing learning activities, especially in teaching pharmacy and chemistry. Critical thinking skills are closely related to creativity [7]. Creativity is the capability to create new ideas or other great ideas which can be used to clear a problem [8]. An idea can be created after deep thought and reasoning. The idea or idea of innovation will also be better if it is re-analyzed before the idea is realized [9]. Indicators of creative thinking skills are (1) fluency, which means having various ideas which will be the solver of a problem; (2) flexibility, which is having various ideas or ideas; (3) originality, which means having new ideas or ideas that can be problem solvers; and (4) elaboration, which is to develop ideas to become a solver of problem in detail. Students with high creativity can get higher learning outcomes than those with low creativity [10].

Although these abilities are still not getting enough attention. From the results of chemistry teachers at MAN 1 Mojokerto interviews, information was obtained that learning chemistry in schools was dominated by the lecture method, memorizing concepts, and students receiving material without going deeper into it. In addition, the results of the pre-research conducted at MAN 1 Mojokerto also showed that students' critical and creative thinking skills on colloidal material were still low. So we should try the right strategy or learning model to improve this. One of the efforts that can be made is by applying Project Based Learning (PjBL) style.

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This learning style is how to learn centered on a problem and its resolution, decision making, the process of finding sources, and working together to produce a final product [11]. Project-based learning helps students to enrich their great mindset and symbolize various skills [12]. The ideas obtained by students in groups will be developed into project planning plans and analyzed detailed data from existing data [13]. With the new knowledge that they have got, organizing and interpreting skills are expected to own by students well rather than just read and keep it in their memory [14]. Based on research conducted by Hikmah et al. [15], it is known that there are different results about how they think critically between students with Project-Based Learning strategies and who are learning with regular methods. Yamin et al. [16] also state this learning model can help students' creativity better. Research by Fahmi and Wuryandini [17] said that the project-based learning model could lead to students' creative thinking skills in learning electrolyte solutions. The average creative thinking skills is 86.8% (Good Category). It shows that the results obtained have reached the research success indicators set at 81% in the good category.

The characteristics of colloidal material are related to practicum, conceptual, group investigation, and related to everyday life, so this can be taken to expand students' critical and creative thinking skills. Creativity can be formed by training critical thinking skills using project-based learning. So that students are expected to get good learning outcomes. In connection with this, research is needed on the Project-based learning model to train students' critical and creative thinking skills on colloidal materials. The skills to think critically and creatively are needed for a better learning class and education in the future.

RESEARCH METHODS

Pre-experimental design is chosen for this research, which means the research is carried out in one class (Experimental class without a comparison). The form of the research design used is One Group Pretest-Posttest Design. The students that were chosen for the subjects were XI MIPA 4 of MAN 1 Mojokerto, which consisted of 31 students.

Research data were obtained through questionnaires, observations, and tests. The questionnaire used in this study was a pre-research questionnaire with 19 questions and a student response questionnaire to the learning treatment with five statements. Three observers did the observation method while the treatment was applied, namely one chemistry teacher at MAN 1 Mojokerto and two chemistry education students. The tests in this study were carried out before treatment (pretest) and after treatment (posttest). The following is an overview of the One Group Pretest-Posttest Design:

$$O_1 - X - O_2$$

Information:
O_1 : The result of the pretest score
X : Treatment of the learning model (Project-Based Learning)
O_2 : Posttest score results

The instruments used were (1) Questionnaire sheets for students, (2) student observation sheets, (3) the observation sheet for the treatment learning model, and (4) the pretest-posttest sheet. There are three types of pretest-posttest sheets, namely cognitive knowledge pretest-posttest sheets, critical thinking skills pretest-posttest sheets, and creative thinking pretest-posttest sheets. Pretest-posttest sheets of critical thinking skills are arranged according to critical thinking indicators, as well as pretest-posttest sheets of creative thinking skills, which are arranged according to creative thinking indicators. Learning was carried out in two meetings with two observations. All instruments and devices used have received validation from 2 experts with an average validation value of 94.65%, which states that they are valid to be used to collect research data.

The syntax treatment learning model and the activities of students can be known through the observer's observation sheet, which is then analyzed and the percentage calculated. The following formula is used to calculate the percentage of the treatment learning model syntax:

$$\% \text{ Implementation} = \frac{\text{Total Score}}{\text{Maximum Score}} 100\%$$

The results obtained are then guided into the group in Table 1.

Table 1. Learning Implementation Criteria

Percentage (%)	Criteria
0 – 20	Very Less
21 – 40	Less
41 – 60	Enough
61 – 80	Good
81 – 100	Very Good

[18]

The formula used to calculate the percentage of student activity:

$$\% \text{ activity} = \frac{\text{Frequency of activity appearing}}{\text{Total frequency of activity}} \text{ x } 100\%$$

Student activities can be declared good if the percentage of relevant activities is more dominant than irrelevant activities, reaching 61% [19].

After the treatment learning model is applied, the student's cognitive knowledge, skill to think critically, and creative skills can be analyzed through the pretest and posttest scores. Pretest and posttest values can be determined using the following formula:

$$\%Score = \frac{\text{Value Obtained}}{\text{Maximum Score}} \times 100\%$$

After the data is obtained, a normality test is carried out using the SPSS 21 data processing program. The purpose of the normality test is to find out whether the data is normally distributed or not. If the result of the data's significance value is > 0.05, it is classified as normally distributed, and if the result is < 0.05, it is classified as not normally distributed [20]. The normality test used was the Shapiro-Wilk normality test because the sample studied was less than 50 people [21]. In addition, the data was also tested using the Paired Sample T-test with the SPSS 21 program. The Paired Sample T-test is classified as a parametric statistical test. The purpose of the Paired Sample T-test is to find out whether there are interconnected differences in the samples [22]. Furthermore, N-Gain is a formula to know the increase in cognitive knowledge and skill to think a critical and creative thing, using the following formula:

$$\%\text{N-Gain Score} = \frac{Posttest - Pretest}{Maximum\ Score - Pretest} \times 100\%$$

The N-Gain results obtained are then interpreted into categories in Table 2.

Table 1. N-Gain Score Criteria

Percentage (%)	Criteria
G ≥ 0,7	High
0,3 ≤ G ≥ 0,7	Medium
G < 0,3	Low

[23]

Students learning outcomes in the realm of knowledge can be said to be complete if they reach the KKM score of 76.

RESULTS AND DISCUSSION

This researh results as regards the Project-Based Learning model at MAN 1 Mojokerto, East Java, are described below:

Project-Based Learning Implementation

Observations made by observers aim to observe how the teacher applies Project-Based Learning treatment during chemistry class. Observers observe learning activities with an observation paper on the treatment of the Project-Based Learning model. The results of the observation of the model of Project-Based Learning can be shown in the following graph.

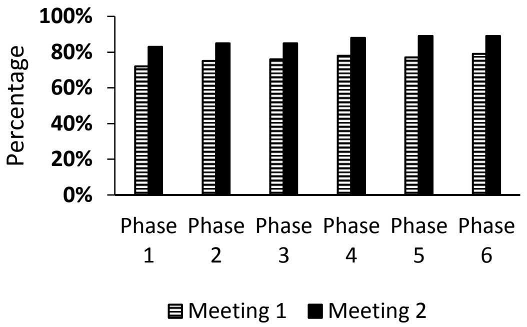

Figure 1. Percentage of Implementation of Project-Based Learning Model

Figure 1 shows the quality of the Project-Based Learning model for two meetings. Six Project-Based Learning syntaxes were observed, namely: Phase 1. Determining the Fundamental Questions (Start With The Essential Question), Phase 2. Designing a Project Plan (Design A Plan For The Project), Phase 3. Creating a Schedule (Create Schedule), Phase 4. Monitoring Project Class Progress (Monitoring), Phase 5. Testing Results (Assess The Outcome) [4]. The 1st and 2nd meetings resulted in an average of 81%, and the resulting percentage was 81%-100%. It indicates that the treatment of Project-Based Learning in this study has a very good category. In line with the increase in the implementation of Adam and Hendra's Project-Based Learning model [24], the implementation of the Project-Based learning model increased from 82.08% at the 1st meeting to 83.33% at the 2nd meeting and 84.12% at the 1st meeting. 3rd meeting. It gets an average percentage of 82.99%, which is in the 81%-100% interval with a very good category.

Student Activities

Student activities were analyzed through student activity observation sheets which three observers observed. Observations are made by observers every three minutes of student activities during the learning process. The results obtained can be used as a benchmark for whether or not learning in the classroom is good [25]. The results of the analysis of student activities obtained can be described in Figure 2.

Based on the graph of student activity above, the percentage of relevant activities is 89%, while the percentage of irrelevant activities is 11%. The percentage of relevant activities obtained is 61%, which is 89%, which means that the activities of students during the learning process can be declared good. It is in line with Saputri et al. finding [26], which states that the

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Project-Based Learning style can help students learn more and achieve more. Sastrika et al. [27] also stated that students could participate well in learning activities as part of the process of project-based learning during class.

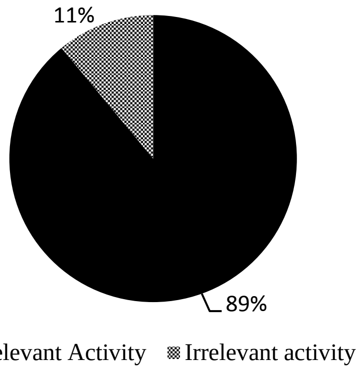

Figure 2. Students Activity

Critical Thinking Skills

The following are the critical thinking skills indicators used in this research: (1) interpretation, (2) inference, (3) analysis, (4) explanation, (5) evaluation, and (6) self-regulation [4]. By the results of the pretest and posttest, critical thinking skills can be analyzed. Table 4 shows the results of the normality test of the pretest and postest of critical thinking skills.

Table 4. Results of the Pretest-Posttest Normality Test for Critical Thinking Skills

	Shapiro-Wilk		
	Statistic	df	Sig.
Pretest	.950	31	.160
Posttest	.939	31	.078

Pretest and posttest significant values in table 4 are 0.160 and 0.078. The pretest and posttest significance values are greater than 0.05, indicating the research data is regularly distributed. Furthermore, the test was carried out using the Paired Sample T-test. The Paired Sample T-test is used to know the difference between students' pretest and posttest scores. Here are the results in table 5 below.

Table 5. Results of Paired Sample T-test

Paired Samples Test				
Paired Differences				
		t	Df	Sig. (2-tailed)
Pair 1	Pretest – Posttest	-32.978	30	.000

The results show that the 2-tailed significance value obtained is 0.000, which means <0.05. It demonstrates that scores of students' critical thinking abilities fluctuate between the pretest and posttest. The data was then evaluated with N-Gain. The results of the analysis of each indicator are shown in Table 6.

Table 6. Results of Analysis of Critical Thinking Skills Indicators

Critical Thinking Skills Indicators	Pretest	Post-test	N-Gain	Criteria
Interpretation	43.01	88.17	0.68	Medium
Inference	37.63	88.17	0.79	High
Analysis	33.33	87.10	0.76	High
Explain	34.41	89.24	0.79	High
Evaluate	32.26	87.10	0.66	Medium
Self Regulated	32.26	83.87	0.69	Medium
Average			0.73	High

The findings show that the Project-Based Learning approach can aid in the development of critical thinking skills in pupils. According to Kabatiah et al. [28], the Project-Based Learning approach can develop critical thinking skills as indicated by improving scores for each critical thinking indicator. It is equal to 81.86 at the 1st meeting with the the the the the the good category; 83.12 at the 2nd meeting with the the the the the the good category; and 86.00 at the 3rd meeting with very good category. In addition, Astri et al. [23] also said that the Project-Based Learning treatment improves students' skills to think critical things by 71.41 in the high category (Experimental Class) compared to 39.52 in the medium category (Control class with traditional learning). The stages of the Project-Based Learning model can train students' critical thinking skills. It can be seen in stages 1) Determining Fundamental Questions, where students are required to understand and interpret or formulate problems based on the phenomena or information presented [3], and 2) Design Project Planning, which leads students to explain (explanation) what is the uniqueness or characteristic of the project made, 3) Prepare a schedule, where students can self-regulate in designing a schedule for completing the project that is made. They are required to re-check whether the schedule compiled is correct. By the division of tasks and the time specified [29], 4) Monitoring Students and Project Progress, monitoring carried out is when students and teachers evaluate working groups regarding implementation discussion of project completion to the implementation of project presentations, 5) Testing the results, at this stage students can analyze what causes the project that was made to

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be successful or has advantages. However, when the project fails, they are also able to find the cause of the failure and be able to conclude the strengths and weaknesses of the project.

Creative Thinking Skills

Four indications of creative thinking talents were looked at 1) Fluency, 2) Flexibility, 3) Authenticity, and 4) Elaboration. The function of the Shapiro-Wilk normality test is to assess the findings of the pretest and posttest of creative thinking skills. The results of the Shapiro-Wilk tests are provided below.

Table 7. Normality Test Results Pretest-Posttest Creative Thinking Skills

	Shapiro-Wilk		
	Statistic	df	Sig.
Pretest	.945	31	.115
Post-test	.948	31	.141

The significance of the pretest and posttest normality tests in the table above is > 0.05, namely 0.115 and 0.141. It shows that the normality of data is safe. Furthermore, the data were analyzed using the Paired Sample T-test. The results of the paired sample T-test are shown in table 8 below.

Table 8. Results of Paired Sample T-test

Paired Samples Test				
Paired Differences				
		t	df	Sig. (2-tailed)
Pair 1	Pretest – Post-test	-33.869	30	.000

Table 8 shows the significance value obtained is <0.05, which is 0.000. It shows that there is a difference between the pretest and posttest. Furthermore, the data were analyzed using N-Gain, to ensure an increase in creative thinking skills.

Table 9. A score of Analysis of Creative Thinking Skills Indicators

Creative Thinking Skills Indicators	Pretest	Post-test	N-Gain	Criteria
Fluency	40.65	88.39	0.77	High
Flexibility	46.45	89.35	0.71	High
Originality	33.55	83.23	0.72	High
Elaboration	41.94	83.23	0.72	High
Average			0.73	High

The analysis results in the table above show an increase in the average value from pretest to posttest. The average N-Gain value obtained is 0.7, which can be categorized as high. The results prove that the Project-Based Learning model can help students' creativity. It is in line with Ulfah et al. [30], who state that the Project-Based Learning model can improve students' creative thinking skills, as evidenced by an increase in the first cycle test score of 40.40 (creative enough) to the second cycle of 60.61 (creative). The improvement of each indicator of creative thinking used, including fluency, flexibility, and elaboration (detailing) from the category of creative enough to be creative, the indicator of originality (authenticity) increased from less creative to quite creative.

This Project-Based Learning treatment is effective as an alternative in training students' skills to think creative things. The stages that can maximize students' creativity include 1) Specifying Basic Questions, 2) Designing Project Plans, 3) Preparing Schedules, and 4) Testing Results. At the stage of determining the basic questions, students can provide questions, ideas, and problem-solving regarding colloidal material or colloid projects smoothly even though they still require habituation in conveying them [31]. Then the stage of designing project plans, here students can determine their project ideas with unique and varied names or expressions and mention their project characteristics in detail. It can practice flexibility, originality, and the ability to detail students because they can provide an alternative and change their thinking from a variant point of view. The stages of preparing a schedule can train students to manage project completion time and the division of project completion in detail (elaboration). At the stage of testing the results, students can state the feasibility of the project, such as the advantages and disadvantages of the project, smoothly and flexibly. In line with Insyasiska et al. [32], who states that with the Project-Based Learning model, the creativity of experimental class students is 31.1% better than the control class, this can be seen from the results of projects, reports, and how they solve problems. During learning such as students can complete projects according to the scheduled time (fluency), they can use other alternatives to assemble methane gas cylinders (flexibility), come up with ideas during tube assembly (originality), and think about details (elaboration).

Student Learning Outcomes

Cognitive knowledge of students obtained from 10 questions pretest and posttest becomes a benchmark for student learning outcomes. Students can be declared complete if the value obtained has reached the minimum completeness of 76. The results of the student's knowledge domain are shown in the following graph.

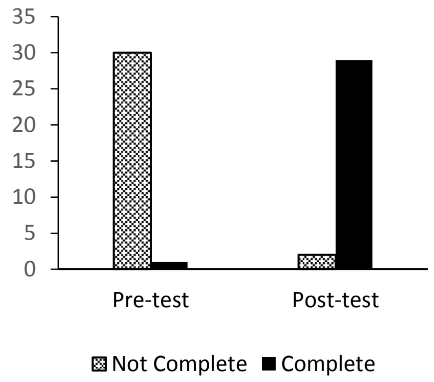

Figure 3. Results of Student Knowledge Domain

Based on the picture above, there is one student who completed and 30 other students who incomplete the cognitive knowledge pretest, meaning that the 31 students scored <76. Meanwhile, in the pretest results, 28 students completed and 3 did not, meaning that the 28 students scored 76. It shows that the student's learning results can also be improved by using the treatment learning approach to strengthen their critical thinking skills and creativity. It is in line with Wahyuni [33], who states that Project Based Learning can guide students' understanding of the nomenclature of chemical compounds. The results were an increase in students' learning mastery from 13.89% to 19.44% in cycle 1 and a significantly increased in cycle 2 to 80.56%. In addition, Emelda et al. [34] also stated that the Project-Based Learning model was able to help student learning outcomes in the Basic Laws of Chemistry subject. It is proven by the increase in the percentage result of classical completeness of students' learning outcomes from 3.44% in the first-class meet to 48.27% in the second-class meet and 86.2% in the third-class meet. Sasmono [35] adds that there is an increase in cognitive scores from 55% to 97% of learning completeness when the Project-Based Learning methodology is applied to the subject of Nature of Chemistry subject. Project-Based learning is one of the interesting treatment styles with the principle of "Learning by Doing." If the learning paradigm is intriguing, students are motivated to learn. If students have a strong desire to study, they can understand the material being studied more easily. The material obtained can be directly realized in the projects they make. It can increase their understanding of the colloid material they are studying. As in the project planning stage, students can go directly to create projects based on the material that has been studied realistically. In addition, at the evaluation stage of the experience in this treatment, it can be remembered as a correction as well as a summary for students on an understanding of colloidal material, which is indicated by the success of the project.

Student Response

Student responses to the Project-Based Learning model were obtained from a student response questionnaire consisting of five statements, ticking the answer "Yes" or "No". Student response questionnaires are filled out by students honestly and without coercion from any party. The response results obtained were then analyzed using the Guttman scale criteria. The results of the percentage of responses obtained include: 1) Students who state that the learning model applied is very pleasant, obtaining a response of 100%; 2) Students who stated that the applied learning model could improve their understanding of colloidal material, received a response of 94%; 3) Students who say they can develop critical thinking abilities using the applied learning model including analyzing data or phenomena, explaining phenomena, interpreting data or phenomena, making conclusions based on data, assessing or correcting data, and developing self-ability in processing data, obtaining response as much as 90%; 4) Students who state that the applied learning model can train the skill to think creatively including making ideas or ideas for a project and compiling a project design, received a response of 95%; and students who stated that the applied learning model could make students active during the learning process, received a response of 97%. Then the average result of the student's response is 95%. The results obtained indicate that the Project-Based Learning model gets a positive response from students 95%. For students learning using Project-Based Learning, the learning style is very interesting because it is a new way of learning from learning in general. In addition, they feel challenged and do not feel bored with the treatment learning model compared to learning using conventional models. They can collaborate and discuss with other students to solve problems and complete projects as best they can. In addition, they feel challenged and do not feel bored with the Project-Based Learning style compared to studying using conventional models. They can collaborate and discuss with other students to solve problems and complete projects as best they can. Obtained indicate that the Project-Based Learning style gets a positive response from students 95%. For students learning using Project-Based Learning, the methodology is highly appealing because it is a new way of learning from learning in general. In addition, they feel challenged and do not feel bored with the treatment compared to learning using conventional models. They can collaborate and discuss with other students to solve problems and complete projects as best they can.

For their Project-Based Learning classes, students must understand the material

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and time management and be well-prepared. It is necessary to note that the direction for students, assessments and skills studied can be received and obtained optimally. To make sure the learning process goes well and the desired learning objectives can be achieved. Besides, this treatment learning model is different from the constructivist learning strategy, so it is recommended to implement a more varied learning strategy before using Project Based Learning. It is done so that students are familiar with new learning models or learning strategies.

CONCLUSION

The implementation of the Project-Based Learning model is effective, achieving an average percentage of 81% (Very Good). The activity level of students is 89%, so it can be said that it is good. The critical N-Gain and creative thinking skills results are 0.73, which is classified as high criteria. Student learning outcomes based on classical completeness increased from 0.03% to 14.5%. So it can be inferred that the Project-Based Learning model is potent in training students' skills to think critically and creatively concerning colloidal material.

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