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The Effect of STEM-PjBL Based Science and Social Learning on Critical Thinking and Collaboration Skills of Students of SD Negeri 3 Plumbungan

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ABSTRACT

Students should be given the opportunity to be actively involved in learning, for them to be able to construct their knowledge through critical thinking and developing collaboration by working together. Through STEM-PjBL-based Science and Social learning, students are involved in contextual learning and students are encouraged to learn to explore all their abilities. This study aims to determine the effect of STEM-PjBL-based Science and Social learning on critical thinking and collaboration skills of grade 6 students of SD Negeri 3 Plumbungan for the academic year 2022/2023. This research was conducted at SD Negeri 3 Plumbungan, Pagentan District, Banjarnegara Regency. This study uses a quantitative research approach, with associative research types (relationships), and uses quantitative analysis methods (numerical data). Data on critical thinking and collaborative thinking skills were collected through observation using assessment instruments in the form of rubrics. 6 students are used as the sample in this study. The research data were processed using a simple linear regression test with results for the effect of STEM-PjBL-based Science and Social learning on critical thinking skills tcount = 3,600 and ttable = 2,776, meaning tcount > ttable. For the effect of STEM-PjBL-based science learning on collaboration skills, tcount = 3.331 and ttabel = 2.776, means tcount > ttable. Based on the results of this study, it shows that there is an influence of STEM-PjBL-based Science and Social learning on critical thinking and collaboration skills of grade 6 students of SD Negeri 3 Plumbungan for the academic year 2022/2023. This research provides insight into the importance of STEM-PjBL-based Science and Social learning to improve 21st century skills, especially critical thinking, and collaboration of learners.

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1. INTRODUCTION

The world of education in the 21st century, faced with the challenge of human resources is expected to produce generations who have skills that can be developed as provisions in the future. According to Maloy, Edwards, and Wolf, (2016), to be able to compete in the 21st century, new skills called 21st century skills are needed. Quoted from kemdikbud.go.id skills or abilities of the 21st century, known as the 6C, which are *character*, *citizenship*, *critical thinking*, *creativity*, *collaboration*, and *communication.*

High-quality human resources are inseparable from the high-quality of education process, where in the educational process students are equipped with the ability to solve problems, finding alternative in problem-solving solutions, and think reflective and evaluatively. Skills that determine a person's excellence, including critical and collaborative thinking. Critical thinking and collaboration skills are one of the life skills that need to be developed through the educational process. These skills are essential to equip students to compete in a globalized world.

In reality, the learning process carried out by educators in Indonesia today, has not fully directed their students to be actively involved in learning so that their 21st century skills have become sidelined. The role of educators today should be the facilitators who are able to foster student motivation, so that they able to grow into a child with character, and can build their own knowledge through the process of critical thinking, creativity, collaboration, and communication. Educators must also be literate in current technology, and must be able to become role models for their students.

Quoted from kemdikbud.go.id, as reflected in the results of the 2018 *Program for International Student Assessment* (PISA) released by *The Organization for Economic Co-operation and Development* (OECD) where Indonesia's position in 2018 for science literacy is ranked 70 out of 78 countries *(OECD, 2018*). This is certainly a challenge for educators to carry out a learning process that can stimulate students to develop their abilities in the field of science even better.

Based on observations and interviews conducted with grade 6 teacher at SD Negeri 3 Plumbungan, Pagentan District, Banjarnegara Regency, the formative assessment results on Photosynthesis material obtained low results, where the average score of students for the HOTS question on Photosynthesis material was 61, below the school's Minimum Completeness Criteria. This happened because, in the material of Photosynthesis there are many foreign terms and teachers do not facilitate students to do a practicum. Whereas, based on the criteria of collaboration skills, learners in the category are less collaborative, they tend to work individually. In addition, the learning given to students still does not apply integrated learning, or only *monodisciplinary* learning, even though to solve problems in everyday life, it cannot be solved with only one field of science, but must be in multidisciplinary to be able to solve these problems. Seeing the condition of students, learning process that can help students improve critical thinking and collaborative skills is needed.

As an effort to foster critical thinking and collaboration skills, students must be given the opportunity to be actively involved in learning in order to be able to construct their knowledge and develop collaboration by working together, sharing tasks with friends in learning.

One learning model that can provide the greatest opportunities for students can improve critical thinking and collaboration skills is *PjBL (Project* Based Learning). The Example of the advantages of PjBL according to Made Wena (2014: 147) are include increasing motivation, can improve problem-solving abilities, can increase collaboration, can improve resource management skills, and *Increased resource-management* skills, according to that PjBL can improve critical thinking skills, creativity, creative thinking skills and student achievement. In addition, one of the learning innovations in the 21st century era that can be applied in science learning, and can improve student competence, is through learning process that integrates science, *Technology, Engineering* and *Mathematics (STEM)* so that students are given a holistic understanding of the interrelation of science fields through 21st century learning experiences. STEM is suitable for critical thinking skills, because in the process *of science* and *mathematics*, students will be trained to solve problems systematically. In addition, STEM is suitable for collaboration skills because of this *technology engineering* process will help students to collaborate with their group mates so that they can find the right problem-solving concepts.

STEM-PjBL encourages learners to learn to explore all their abilities, in their own ways. STEM-PjBL will also bring out different and unexpected works from each individual or group. Moreover, collaboration, cooperation and communication skills will appear in the learning process because this approach is carried out in groups. Grouping students in STEM requires personal or interpersonal responsibility for the learning that occurs, this process will build students' understanding of the material that being studied.

Referring to the above problems, the purpose of this study is to identify the effect of STEM-PjBL-based Science and Scoial learning on students' critical thinking and collaboration skills.

2. RESEARCH METHODOLOGY

The purpose of this study is to identify the effect of *STEM-PjBL-based* Science and Social learning on students' critical thinking and collaboration skills. The research was carried out in grade 6 SD Negeri 3 Plumbungan, Academic Year 2022/2023 located in Plumbungan Village, Pagentan District, Banjarnegara Regency. The research was conducted in March 2023. This research is a quantitative approach research, which is an associative type of research, or is a study that aims to determine the relationship between two or more variables (Sugiyono, 2009). Researchers attempt to describe present conditions in a quantitative context reflected in variables.

The type of research used is in accordance with the objectives to be achieved, namely wanting to know the effect of *STEM-PjBL-based* Science and Social learning on critical thinking and collaboration skills after applying the *PjBL* model with a *STEM* approach.

The following is the research paradigm used, called a dual paradigm with two dependent variables (Sugiyono, 2009). The **Figure 1** is as follows.

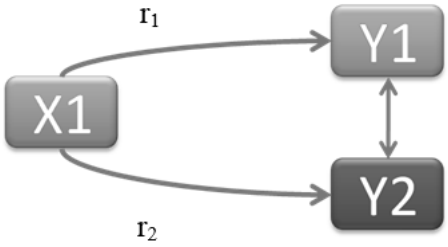

Figure 1. Dual Research Paradigm

Information:
X_1 : Independent variables
Y_1 : Dependent variables /bound variable1
Y_2 : Dependent variables /bound variable 2
r_1, r_2 : Simple correlation

The population of this study is all grade 6 students of SD Negeri 3 Plumbungan for the academic year 2022/2023 totaling 42 students consisting of grades 1 to 6. The sampling technique used is *purposive sampling technique. Purposive sampling technique* is the determination of a sample from the entire population with certain considerations, and to determine the sample based on the recommendation of the teacher. The sample is a portion or representative of the population under study. The sample in this study was grade 6 with 6 students.

In order to obtain data related to this study, researchers use data collection techniques consisting of documentation methods, test methods, and observation assessment rubric methods. Learning instrument is the measuring instrument that used in a study. Learning instruments are tools that used in research activities which include: Teaching Module with *STEM-Project Based Learning Model* which consists of 6 stages, those are: 1) Fundamental questions for project determination/ *Reflection*; 2) Design project planning/ *Research;* 3) Prepare a project creation schedule/ *Discovery*; 4) Monitor the Activeness and Development of the Project/ *Application*; 5) Testing results with presentation of project results/ *Communication*; 6) Evaluation of project results and learning experiences/ *Evaluation*. In addition to learning instruments, research instruments are needed, which useful as measuring tools in and as support in data collection techniques in this study. The research instrument used in research is a test.

The instruments used by researchers in conducting research are described as follows:

1. Written test questions in the form of description questions to measure students' critical thinking skills totaling 5 questions arranged based on indicators of critical thinking skills, the indicators are as follows: a) Provide simple explanations (*elementary clarification*); b) Build basic support skills (*basic support*); c) Making conclusion (*inferring)*; d) Make further explanations (*further clarification*); e) Set (*strategies and tactics).*
2. The observation assessment rubric is used to measure the implementation of learning with STEM-PjBL and student collaboration activities when carrying out *STEM-Project Based Learning based* science and social learning. The STEM-PjBL implementation assessment rubric has 10 criteria, arranged based on the STEM-PjBL syntax. And, the rubric of the observation assessment of collaboration skills amounts to 10 criterias, arranged based on indicators of collaboration skills, as follows: a) Cooperation; b) Flexibility, c) Responsibility; d) Compromise; e) Communication Value.

Before the research instrument is used for data collection, researchers first test the validity and reliability of the instrument. To test the items, test questions must have requirements in form of validity and reliability so that the instruments must be in form of description questions and observation assessment rubrics so the insturments that given are valid and reliable. Researchers conducted validity and reliability tests using the *SPSS 25 for windows application.* The instruments test is declared valid if rcalculate > rtabel, and vice versa if rcalculate < rtabel then the insturemt is declared invalid or void. From the results of the instrument reliability test is consulted with the price *of r produc moment* is at the level of significance of 5%. If the price of *r11* > rtable, then the research instrument is said to be reliable, but if on the contrary the price of *r11* < rtable, then the instrument is said to be unreliable.

Before conducting an analysis about the effect of the independent variable on the dependent variable, it is necessary to conduct a prerequisite test. In prayarat test consists of normality test and linearity test. The data normality test is used as a reference to be able to see that the sample data comes from a normally distributed population. Normality testing using *SPSS 25 for windows* based on the *Kolmogorov-Smirnov* test. To establish the normality of the data, the significance level of the test uses $\alpha = 0.05$. If the significance obtained is $>\alpha$, then the sample comes from normally distributed pupolation. Meanwhile, a linearity test is a procedure used to determine the status of a research data is linear or not. Testing on *SPSS 25 for windows* using *Test for Linearity* resulted basic decision-making using ANOVA output at a signification level of 0.05. If the *sign* > 0.05 then the relationship between the two variables is linear.

After the instrument and prerequisite tested, researchers then take data using these instruments. The data obtained, then analyzed. Researchers used simple linear regression analysis to determine the effect between the independent variable and the dependent variable. The choice of regression is simple because the researcher wants to identify the effect of STEM-PjBL-based Science and Social learning (X) on critical thinking skills (Y1) and the effect of STEM-PjBL-based Science and Social learning (X) on collaboration skills (Y2).

The simple linear regression formula used in this study is:

$Y = a + bx$

Information:

Y : dependent variables
X : independent variable
a dan b : constant

To find the prices of a and b used the following formula (the **Figure 2** is as follows).

$$a = \frac{\sum y \sum x^2 - \sum x \sum xy}{N \sum x^2 - (\sum x)^2}$$

$$b = \frac{N \sum xy - \sum x \sum y}{N \sum x^2 - (\sum x)^2}$$

Figure 2. Formula to Find The Prices of a and b

However, in this study, the calculation of a simple linear regression test was analyzed using *SPSS 25 for windows*. Criteria for acceptance and rejection of the hypothesis as if:

1. $t_{table} < t_{count}$, or significant ≤ 0.05 then the null hypothesis (H0) is rejected and the alternative hypothesis (H_a) is accepted. Which means that there is a significant influence between one independent variable and the dependent variable.
2. $t_{table} > t_{count}$, or significant ≥ 0.05 then the null hypothesis (H0) is accepted and the alternative hypothesis (H_a) is rejected. This means that there is no significant influence between one independent variable and the dependent variable.

3. RESULTS AND DISCUSSIONS

Data Description

The purpose of this reserach was to determine the effect of STEM-PjBL-based science and social learning on critical thinking and collaboration skills in grade 6 at SD Negeri 3 Plumbungan Banjarnegara. This research is included in associative research using quantitative analysis methods (numerical data) which aims to determine the relationship or influence between two or more variables. The population in this study was all students at SD Negeri3 Plumbungan Banjarnegara. For the sample, researchers took 6 grade 6 students at SD Negeri3 Plumbungan.

The first procedure carried out by the researcher was to ask permission from the headmaster of SD Negeri3 Plumbungan and the grade 6 teacher that the reaasearchers would carry out the research. The study was conducted on March 15 – 16, 2023. This research runs in accordance with the Learning Implementation Plan (RPP) that has been made by the researcher as attached. The data in this study was obtained through two methods, that are the written test method in the form of a description and an assessment rubric. The test method used by researchers is a written test of students' critical thinking skills, this written test aims to determine the effect of STEM-PjBL-based science and social learning on students' critical thinking skills. The written test used is a description with 5 assessment questions with a score of answers on a scale of 2 to 10 for each question. The test uses the observation assessment rubric used next, aiming to determine the effect of STEM-PjBL-based science and social learning on student collaboration skills. This assessment is carried out to students when carrying out STEM-PjBL-based

science and social learning activities. The assessment rubric used was developed from collaboration performance indicators with 10 assessment scales.

A. Instrument Test, Prerequisite Test, dan Hypothesis Test

Based on the instrument validity test, the value of each question item for STEM-PjBL-based science and social learning variables, critical and collaborative thinking skills were obtained from the calculation of $r_{count} > r_{tabel}$, and sig scores. (2 tailed) is valued at 0.000 0.000 < 0.05 in each questions item so that it is declared valid.

The result of the calculation of the reliability test, a variable is said to be reliable if it has a Cronbach Alpha (α) value of > 0.6. The value of Cronbach Alpha for each variable in this study is >0.6 which means that the instruments in this study are reliable and can be used for future research.

The normality test used in this study was the *Kolmogrov-Smirnov One-Sample* test using a signification level of 0.05. Data is declared normally distributed if the significance is greater than 5% or 0.05. The critical thinking and collaboration skills variable has a significance value of 0.200. So, in this study the two variables can be said to be normally distributed.

Test for Linearity based on decision-making using ANOVA output at a signification level of 0.05. If sign > 0.05 then the relationship between the two variables is linear and if the *sign* < 0.05 then the relationship is not linear. The results of the linearity test calculation in this study showed a product significance value of > 0.05 which means the STEM-PjBL-based science and social learning variable and the critical thinking and collaboration skills variable is linear.

Hypothesis test in this study is using simple linear regression to determine the influence of the independent variable influence on the dependent variable with the following equation: Y = a + bx. The criteria for acceptance of the hypothesis are that if the $t_{table} < t_{count}$, or significant ≤ 0.05, then the null hypothesis (H_0) is rejected and the alternative hypothesis (H_a) is accepted. This means that there is a significant influence between one independent variable and the dependent variable.

B. Analysis of Hypothesis I

Hypothesis 1 in this study is as follows.

1. H_0: $\mu_1 = \mu_2$ There is no effect of STEM-PjBL-based science and social learning on the critical thinking skills of grade 6 students of SD Negeri3 Plumbungan.
2. H_1: $\mu_1 \neq \mu_2$ There is a significant influence of STEM-PjBL-based science and social learning on the critical thinking skills of grade 6 students of SD Negeri 3 Plumbungan.

Through a simple linear test, results are obtained as presented in **Table 1** and **Table 2**.

Table 1. Output Regression Test (Model Summary)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.874[a]	0,764	0,705	1,443

a. Predictors: (Constant), STEM-PjBL

b. Dependent Variable: CRITICAL THINKING

Table 1 shows the magnitude of the correlation / relationship value (R) which is 0.874. From this output, a coefficient of determination (R Square) of 0.764 was obtained which contains the understanding that the influence of the independent variable (STEM-PjBL) on the dependent variable (Critical Thinking Skills) is 76.4%, and the influence of other factors is 23.9%.

Table 2. Output Regression Test (Coefficients)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-24,167	17,926		-1,348	0,249
	STEM-PjBL	1,500	0,417	0,874	3,600	0,023

a. Dependent Variable: CRITICAL THINKING

Based on the significance value from **Table 2**, a significance value of 0.023 < 0.05 is obtained so that it can be concluded that the STEM-PjBL (X) INFLUENCES the Critical Thinking variable (Y1).

Based on the t value of the t_{count} is 3,600 > t_{table} 2,776 so that it can be concluded that the STEM-PjBL (X) INFLUENCES the Critical Thinking variable (Y1).

Based on the *Constant* value and regression equation on the effect of STEM-PjBL-based science and social learning on critical thinking skills is Y = a + bX i.e. Y = -24.167 + (1.500X), which means that every addition of one STEM-PjBL-based science and social learning value to critical thinking skills is 1,500.

C. Analysis of Hypothesis II

Hypothesis 1 in this study is as follows:

1. H_0: $\mu_1 = \mu_2$ There is no effect of STEM-PjBL-based science and social learning on the collaboration skills of grade 6 students of SD Negeri3 Plumbungan.
2. H_1: $\mu_1 \neq \mu_2$ There is a significant influence of STEM-PjBL-based science and social learning on the collaboration skills of grade 6 students of SD Negeri3 Plumbungan.

Through a simple linear test, results are obtained as presented in **Table 3** and **Table 4**.

Table 3. Output Regression Test (Model Summary)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.857[a]	0,735	0,669	1,820

a. Predictors: (Constant), STEM-PjBL

Table 3 shows the magnitude of the correlation / relationship value (R) which is 0.857. From this output, a coefficient of determination (R Square) of 0.735 was obtained which contains the understanding that the influence of the independent variable (STEM-PjBL) on the dependent variable (Collaborative Skills) is 73.5% and the influence of other factors is 26.5%.

Table 4. Output Regression Test (Coefficients)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-33,250	22,604		-1,471	0,215
	STEM-PjBL	1,750	0,525	0,857	3,331	0,029

a. Dependent Variable: COLLABORATION

Based on the significance value from **Table 4**, a significance value of 0.029 < 0.05 is obtained so that it can be concluded that the STEM-PjBL (X) INFLUENCES the Collaboration variable (Y2).

Based on the t value of the t_{count} of 3.331 > t_{table} 2.776 so that it can be concluded that the STEM-PjBL (X) INFLUENCES the Collaboration variable (Y2).

Based on the *Constant* value and regression equation on the effect of STEM-PjBL-based science and social learning on collaboration skills is Y = a + bX i.e. Y = -33,250 + (1,750X), which means that each addition of one STEM-PjBL-based science and social learning value to collaboration skills is 1,750.

D. Implementation of STEM-PjBL

The implementation of the STEM-integrated PjBL learning model in class 6 on science learning for Photosynthesis material is carried out based on the learning syntax that has been designed by the teacher. There are 6 learning syntaxes that are carried out in the learning process divided into two meetings. Based on the assessment conducted by grade 6 teacher, it was stated that the implementation of the learning process obtained a score of 73.6% at the two meetings that had been carried out, where each learning syntax was carried out well by students and researchers. The implementation of the learning process with STEM-PjBL is presented in **Figure 3**.

The application of the PjBL learning model at the first meeting carried out 4 learning syntax, those are: determining the main question or problem (*reflection*), designing project planning (*research*), preparing a project creation schedule (*discovery*), and monitoring the activeness and development of the project (*application*).

There are two goals to be achieved at 1st meeting. The first objective, researchers want to see the collaboration skills of students in making product planning innovations / development of oxygen-producing devices in the room, which apply the principle of photosynthesis to green plants, with the help of internet media and broad insight. The second objective is researchers want to see students' critical thinking skills when solving problems in planning innovative products / development of oxygen-producing devices in the room, which apply the principle of photosynthesis to green plants based on internet assistance/ references and previous experience. The implementation carried out to achieve the first goal, students carry out the stages of determining the project, designing project planning *(research)*, and compiling a project creation schedule (*discovery*). Likewise, implementation to achieve the second goal, students carry out the same stages by adding stages, where researchers monitor the activeness and development of the project (*application*). Product formulation and design activities that have been carried out by grade 6 students of SD Negeri3 Plumbungan can hone *basic support* and manage *strategies and tactics* of students which are indicators of critical thinking. Then at this stage, students can also develop several *subskills* of collaboration skills including, cooperation, compromise, and value communication. These activities start from designing the tools and materials needed, designing work procedures to be carried out, designing "simple biophotoreactor" products with attractive drawing designs and in accordance with standards so that the product can function properly. This product planning activity is integrated with the STEM approach, such as *Engineering*, students design, draw, and prepare tools and materials for the "simple biophotoreactor" project as an oxygen producer. Project planning based on the design that has been made, will then be applied to the implementation of learning meeting 2.

Figure 3. Implementation of STEM-PjBL

The syntax at the 2nd meeting is to monitor the activeness and progress of the project (*application*), test the results with the presentation of project results (*communication*), and evaluate the project results and learning experiences (*evaluation*). In the learning process at 2nd meeting, students carry the learning process out with a STEM approach, where at the stage of product preparation, students first measure the volume of a tubular container (*mathematics*). The implementation of the learning process at the second meeting aims to see the critical thinking skills and collaboration of students in the application of biophotoreactor product planning that has been designed at 1th meeting. The project implementation activities carried out are, making product testing of product results by presenting them, then evaluating the results and learning experiences. At the stage of testing product results by presenting them, students use scientific knowledge and flows regarding the process of photosynthesis, which requires carbon dioxide and light to be able to produce oxygen and glucose (*Science*). Then students also understand how to use technology, in this case in relation to the use of electric devices (red blue light) as a light producer that will help the process of photosynthesis in aquatic plants (*Technology*).

Based on STEM-PjBL based science and social learning, satisfactory results can be seen, as stated by Eliza, Suriyadi, and Yanto (2021), where the objectives of the *Project Based Learning* learning model are as follows:

1. Improve students' ability to solve problems.
2. Make learners become active in solving project problems with real product results.
3. Acquire new knowledge and skills in learning.
4. Develop and improve students' skills in processing materials or tools to complete projects.
5. Improve group student collaboration

E. Critical Thinking Skills Results

Assessment of learners' critical thinking skills is carried out at the second meeting at the end of learning. The indicators used to measure critical thinking skills, according to Ennis in Anggraini (2015), is knowing the critical thinking skills of students in solving problems using indicators provide simple explanations (*elementary clarification*), build basic skills *(basic support*), make conclusions (*inferring)*, make further conclusion *(advanced clarification)*, and set *strategies and tactics*. The aspect of providing a simple explanation refers to the ability of learners to ask and answer the questions presented, the aspect of building basic skills refers to the skills of learners in observing and considering the results of observations, the aspect of making conclusions refers to the skills of

learners in making deductions and considering the results, then on the aspect of organizing strategies and tactics refers to the skills of learners in define assumptions.

The problem that students must solve is to make a "simple biophotoreactor" product with the following conditions:

1. The resulting products are of useful value to humans related to the preservation of oxygen, especially for oxygen supply in the room.
2. There is development or innovation/ product development, both in product manufacturing technology/ product manufacturing techniques.
3. Explain in detail related to the usefulness of the resulting product.

Explaining in detail what is meant is that students make further explanations related to the products made, both in terms of manufacturing procedures, product use, and their benefits that students can identify independently with their groups.

The acquisition of students' critical thinking skills scores is calculated by the following formula:

$$\text{Average} = \frac{\text{Scores obtained}}{\text{Total score}}$$

The average score of 71.2 is presented in **Figure 4**.

Figure 4. Acquisition of Average Critical Thinking Skills

After obtaining the average value, the value can be categorized according to the following **Table 5**.

Table 5. Criteria for Critical Thinking Ability

Category	Interval (%)
Excellent	86 – 100
Good	71 – 85
Cukup	56 – 70
Less	≤ 55

Source: Adapted from Pramesswari, et al (2018)

Based on the criteria of critical thinking skills, the average score obtained shows that the critical thinking skills of grade 6 students of SD Negeri3 Plumbungan are in the good category.

F. Critical Thinking Skills Results

Assessment of students' collaboration skills is carried out at each meeting during the learning process. Indicators of collaboration skills used according to Trilling (2009), that are cooperation, flexibility, responsibility, compromise, and communication value. The cooperation aspect refers to the ability of learners to group effectively with diverse teams, the flexibility aspect refers to the ability of learners to contribute individually and adapt to fellow team members, the responsibility aspect refers to the ability of learners to be collaboratively responsible or have the initiative to measure themselves, the compromise aspect refers to the ability of learners to take compromises as well as deliberation to make decisions, then the value of communication aspect, refers to the ability of learners to communicate effectively in groups.

The collaboration activity that must be shown by students is to make a "simple biophotoreactor" product with the following conditions:

1. Contribute actively in the group, for example being able to bring themselves in the diversity of group members, leading the course of discussion, being responsible for joint work, and being able to deliberate and communicate effectively.
2. Take on initiative by themselves, or without being instructed by teachers as well as other friends.
3. Communicate ideas confidently and respect the opinions of others.

The acquisition of student collaboration skills scores is calculated by the following formula:

$$\text{Average} = \frac{\text{Scores obtained}}{\text{Total score}}$$

The average score of 77.8 is presented in **Figure 5**.

Figure 5. Collaboration Skills Average Score

After obtaining the average value, the value can be categorized according to the following **Table 6**.

Table 6. Collaboration capability criteria

Category	Interval (%)
Excellent	81- 100
Good	61 – 80
Enough	41 – 60
Less	21 – 40
Very Lacking	≤ 20

Source: Adapted from Astuti (2014)

Based on the criteria for collaboration skills above, the average score obtained shows that the collaboration skills of grade 6 students of SD Negeri 3 Plumbungan are in the good category.

Discussion

The research discussion explain how the results of the research that have been tested are then analyzed again and seen how the influence given by the STEM-PjBL-Based Science and Social Learning Variables on the Critical Thinking Ability and Collaboration Skills of grade 6 students of SD Negeri 3 Plumbungan, Banjarnegara.

A. The Effect of STEM-PjBL-Based Science and Social Learning on Critical Thinking Skills

The results of statistical testing between the STEM-PjBL-Based Science and Social Learning indicator (X1) on the Critical Thinking Skills (Y1) variable had a Regression of 0.874 (Strong), while the magnitude of the influence was 76.4%, and the influence of other factors was 23.9%. From the data, it is also obtained t_{count} (3,600) ≥ t_{table} (2,776). So that the results of the hypothesis test that have been carried out can be known that H_0 is rejected and H_a is accepted, which means that there is a significant influence of the STEM-PjBL variable (X) on the Critical Thinking variable (Y1).

Learners' critical thinking skills result from test scores at the end of learning. The test questions given measure it, according to critical thinking indicators, while the test material is adjusted to the learning activities of students who apply STEM-PjBL.

After the implementation of STEM-PjBL, the value of students' critical thinking skills increased by 16.7% compared to before the implementation of STEM-PjBL. This is in accordance with the research of Capraro *et al*., (2013), which affirms that PjBL-STEM in PjBL provides challenges and motivates learners because it trains learners to think critically, analyze and improve higher-order thinking skills.

Through PjBL-STEM learning, students have science and technology literacy that can be seen from reading, writing, observing, and doing science so that it can be used as a provision for living in society and solving problems faced in everyday life related to the field of PjBL-STEM science (Mayasari *et al*., 2014).

B. The Effect of STEM-PjBL-Based Science Learning on Collaboration Skills

The results of statistical testing between the STEM-PjBL-Based Science and Social Learning indicator (X1) on the Collaboration Skills (Y2) variable had a Regression of 0.857 (Strong), while the magnitude of the influence was 73.5%, and the influence of other factors was 26.5%. From the data also obtained t_{count} (3,331) > t_{table} (2,776). So that the results of the hypothesis test that have been carried out can be known that H_0 is rejected

and H_a is accepted, meaning that there is a significant influence of the STEM-PjBL variable (X) on the Collaboration variable (Y2).

Learners' collaboration skills result from the process of making a "simple biophotoreactor" product that researchers value using an observational assessment rubric during the STEM-PjBL-based science and social learning process. The assessment rubric used measures it, according to indicators of collaboration skills.

After the implementation of STEM-PjBL, the value of students' collaboration skills has increased, from less to good, compared to before the implementation of STEM-PjBL. This is in accordance with research conducted by Gede Sandi (2021) that

there is an influence of the STEM approach on increasing understanding of electroplating concepts, critical thinking skills, and cooperation skills. Gede Sandi's research explained that there was an increase in students' working skills before being given learning with a STEM approach compared to after being given a STEM approach at each stage of STEM learning.

4. CONCLUSIONS

Based on the research's results and data analysis using simple linear regression techniques that have been carried out in this study, it can be concluded that, first; there is a significant influence of STEM-PjBL-based science and social learning on the Critical Thinking Ability of Grade 6 Students of SD Negeri 3 Plumbungan Banjarnegara for the Academic Year 2022/2023. The magnitude of the influence of STEM-based science learning on Critical Thinking Skills was 76.4%, the remaining 23.9% was influenced by other factors.

Second, there is a significant influence of STEM-PjBL-based science and social learning on the Collaboration Skills of Grade 6 Students of SD Negeri 3 Plumbungan Banjarnegara for the Academic Year 2022/2023. The magnitude of the influence of STEM-based science learning on Collaboration Skills was 73.5%, and the remaining 26.5% was influenced by other factors.

This is because STEM-PjBL-based in science and social learning together can be a innovation in learning that can bring up critical solutions and collaboration skills between students, making it easier to solve a problem. Therefore, it is highly recommended to educators to use PjBL's integrated STEM approach as a learning innovation in schools.

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