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# Correlation of Student Learning Activities and Cognitive Learning Outcomes Using Problem-Based Learning

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**Abstract** : *This study aims to analyze the relationship between student learning activities and cognitive learning outcomes through the application of the Problem-Based Learning (PBL) model to ecosystem material. The study used a quantitative approach with a correlational design. The study population was all 10th-grade students of Mojoagung State Senior High School, Jombang, with a sample of 36 10th-grade students selected using a purposive sampling technique. Data on student learning activities were obtained through observation sheets, while cognitive learning outcomes were measured using a learning achievement test. Data analysis was performed using the Spearman correlation test using SPSS version 26 software. This is because the learning activity data is ordinal in scale. The results showed that there was a positive and significant correlation between student learning activities and cognitive learning outcomes with a Spearman correlation coefficient of 0.943 and a significance value of 0.000 ($p < 0.05$), which is in the very strong relationship category. This finding indicates that the higher the student learning activities in problem-based learning, the higher the cognitive learning outcomes achieved. The implications of this study confirm that the application of PBL which emphasizes active student involvement plays an important role in improving conceptual understanding, especially in ecosystem material which is complex and contextual.*

**Keywords** : *Learning activities; Cognitive learning outcomes; Problem-Based Learning; Ecosystem.*

## INTRODUCTION

Education is a crucial aspect in improving human resources, one of which is through student learning activities. Dewi et al., (2021) explained that student learning activities are influenced by several factors, one of which is the learning method. Student activity tends to increase when learning is interactive, involves hands-on practice, and is supported by effective teacher guidance. This is further clarified by Novitasari & Puspitawati, (2022), who state that student learning activities can be enhanced through the implementation of interactive learning models. This encourages students to be more active in exploring information and finding solutions to problems presented by teachers.

The urgency of this research lies in the low cognitive learning outcomes in biology, particularly in complex and contextual material such as ecosystems. This is evidenced by interviews and observations during learning, which show that students tend to be passive and uninterested in ecosystems material. One reason students are less active in class is a lack of understanding of ecosystems material and a tendency to memorize it, rather than simply

assessing final grades on tests, without understanding the extent of their learning activities during the learning process. This contrasts with the independent curriculum and the 21st-century approach, which emphasize student active learning. The results of this study can inform pedagogical decision-making, particularly in designing learning strategies that encourage student learning activities.

Ecosystems material is conceptual, contextual, and complex because it involves the interrelationships between biotic and abiotic components and the dynamics of interactions within an environmental system. Therefore, it demands higher-order thinking skills such as analysis and synthesis (Schreiber, 2022; Campbell et al., 2018). This material encompasses the relationships between biotic and abiotic components, which requires higher-order thinking skills. Understanding this material requires more than rote memorization, but requires active learning activities such as observing, analyzing, discussing, and relating phenomena to the surrounding environment. This material is also relevant to environmental issues and sustainable development, making it highly applicable.

The use of appropriate learning models can provide opportunities for students to construct their own understanding through discussions, asking or answering questions from the teacher, thereby increasing student engagement and active participation in learning. One such learning model is Problem-Based Learning (PBL). Ningsih et al., (2021) explains that the implementation of Problem-Based Learning (PBL) can significantly increase student activity. This is because this model encourages students to actively explore a problem, discuss it, find solutions independently, and collaborate in groups. High student activity can improve conceptual understanding and achieve high learning outcomes. This opinion is supported by Yusuf et al., (2017), who stated that this application can encourage students to actively search for, analyze, and utilize relevant learning resources. This is supported by Sholihah & Sari (2022), who stated that interactive learning can significantly increase student activity by creating a dynamic and participatory learning environment.

This study used the Problem-Based Learning (PBL) model, applied to the topic of Ecosystem Components and Their Interactions. In this lesson, students were asked to analyze a video on a Student Worksheet (LKPD) by observing the interactions between ecosystem components and then analyzing the relationships between biotic and abiotic components within the ecosystem. This learning activity also measured student activity during the lesson. Student activity in learning also plays a crucial role in determining learning success (Rosyidah & Sholihah, 2021). Based on constructivism theory, student activeness in learning is more likely to build better understanding. Therefore, student activity can be considered a factor influencing cognitive learning outcomes (Khotimah et al., 2023). Based on this background, the purpose of this study was to determine the correlation between student activity and cognitive learning outcomes using the Problem-Based Learning (PBL) model.

This study focused on ecosystems material. This characteristically demands cognitive engagement and high-level learning activities, namely analysis, evaluation, and

synthesis. Furthermore, this study focused on the effectiveness of the PBL learning model, as seen from student learning activities and cognitive learning outcomes. Student learning activities are a prerequisite for cognitive processes, because physical and mental involvement in learning allows for meaningful information processing, schema formation, and knowledge construction (Slavin, 2019). In addition, student learning activities reflect students' mental and physical involvement, which influences their conceptual understanding. The correlation between learning activities and learning outcomes indicates that improved learning outcomes are inseparable from the quality of student learning activities during the learning process, because learning activities reflect the level of cognitive involvement that directly influences conceptual understanding (Mduwile & Goswami, 2024; Alice et al., 2021). The research location was at SMAN Mojoagung for several reasons. Students' cognitive learning outcomes are not evenly distributed, and student learning activities have not been systematically optimized. Based on this background, it is necessary to conduct research related to the correlation between student learning activities and student cognitive learning outcomes using PBL.

## METHOD

This type of research is a quantitative correlational study that aims to determine the correlation between student learning activities and cognitive learning outcomes. The advantage of correlation research is its ability to identify relationships between variables non-experimentally ((Hidayat & Sholihah, 2021). The variables to be studied are learning activities (X) and student cognitive learning outcomes (Y). This study uses a quantitative approach, namely data in the form of data and analyzed based on statistical analysis. This analysis uses SPSS 26. Hypothesis testing is conducted in this study. The technique used is purposive sampling.

1. Research Population and Sample

   The research population was 324 10th-grade high school students. However, the sample size was 36 10th-5th grade high school students. This research was conducted at Mojoagung State Senior High School, Jombang, from February 17-27, 2025.

2. Research Instruments

   The research instruments consisted of student learning activity observation sheets and cognitive learning achievement tests on the topic Ecosystem Components and Their Interactions.

3. Data Collection Techniques

   The data collection technique used was an observation sheet of learning activities and student learning outcomes. The observation sheet was completed by the observer during the learning process, while the learning outcomes were the results of the cognitive learning achievement test.

4. Data Analysis Techniques

Data on student learning activities were obtained from scores on the student learning activity observation sheet. Aspects of student learning activities are listed in Table 1.

**Table 1.** Aspects of the Learning Activity Observation Sheet

| No | Aspect | Score | Description |
|---|---|---|---|
| 1 | Asking questions to the teacher | 3 | Students actively ask questions to the teacher related to the learning material. |
| | | 2 | Students are less active in asking questions related to the material. |
| | | 1 | Students do not ask questions or are engaged in activities unrelated to the lesson. |
| 2 | Answering the teacher's questions | 3 | Students provide correct answers in accordance with the questions asked. |
| | | 2 | Students respond to the questions, but the answers are not completely correct. |
| | | 1 | Students do not respond to the teacher's questions. |
| 3 | Writing answers on the worksheet (LKS) | 3 | Students write worksheet answers independently and correctly. |
| | | 2 | Students write worksheet answers by referring to their peers' responses. |
| | | 1 | Students do not write answers on the worksheet. |
| 4 | Group discussion | 3 | Students actively participate in group discussions. |
| | | 2 | Students participate minimally in group discussions. |
| | | 1 | Students do not participate in group discussions or engage in off-task activities. |
| 5 | Expressing opinions | 3 | Students express their opinions clearly and appropriately. |
| | | 2 | Students only observe others expressing opinions. |
| | | 1 | Students do not express opinions or engage in off-task activities. |
| 6 | Listening to the teacher's explanation/information | 3 | Students listen attentively and calmly to the teacher's explanation or information. |
| | | 2 | Students listen to the explanation but are not attentive. |
| | | 1 | Students do not listen to the explanation or engage in off-task activities. |

The score obtained will be calculated using the following formula:

$$\text{Student Learning Activities} = \frac{(\text{score obtained})}{(\text{total score})} \times 100$$

Cognitive learning outcomes are obtained from the results of a cognitive test on the topic "Ecosystem Components and Their Interactions." The formula for calculating cognitive learning outcomes is as follows:

$$\text{Cognitive learning outcome score} = \frac{(\text{score obtained})}{(\text{total score})} \times 100$$

This study used two variables: variable X (learning activities) and variable Y (cognitive learning outcomes). A normality test was conducted to determine whether the data were normally distributed. The Spearman test was then used to determine the correlation between learning activities and student learning outcomes. The correlation results were then converted using an r table.

The data were analyzed using the Spearman correlation test because the student learning activity data is ordinal and the cognitive learning outcomes are interval. Data normality was tested using the Shapiro-Wilk test using SPSS version 26 software because the sample size was less than 50 respondents. The Spearman correlation test was used because the learning activity data were obtained through observation, making them ordinal in nature. This contrasts with student learning outcomes, which are interval in nature. The basis for decision-making in this study includes:

If the significance value is <0.05, there is a relationship between student activity and cognitive learning outcomes.

If the significance value is >0.05, there is no relationship between student activity and cognitive learning outcomes.

Next, to determine the level of relationship between the two variables, the Spearman test relationship level guidelines are used in Table 2.

**Table 2.** Spearman's Test Relationship Level Guidelines

| Correlation Coefficient (ρ) | Interpretation |
|---|---|
| 0.00 – 0.199 | Very weak |
| 0.20 – 0.399 | Weak |
| 0.40 – 0.599 | Moderate |
| 0.60 – 0.799 | Strong |
| 0.81 – 1.00 | Very strong |

(Source: Hinkle, Wiersma, & Jurs, 2003)

The r table is used to determine the degree of correlation between the two variables, using the formula: correlation result > r table. The hypotheses in this study are as follows:

H0: There is no relationship between learning activities and cognitive learning outcomes of grade X-5 high school students at SMAN Mojoagung.

Ha: There is a relationship between learning activities and cognitive learning outcomes of grade X-5 high school students at SMAN Mojoagung.

## RESULTS AND DISCUSSION

### 1. Results

The results of this study on the relationship between student learning activities and cognitive learning outcomes can be seen in several data sets.

*Learning Activity Results and Student Cognitive Learning Outcomes.*

This study produced two data sets: the results of the learning activity instruments and the results of students' cognitive learning outcomes. This data can be seen in Figure 1.

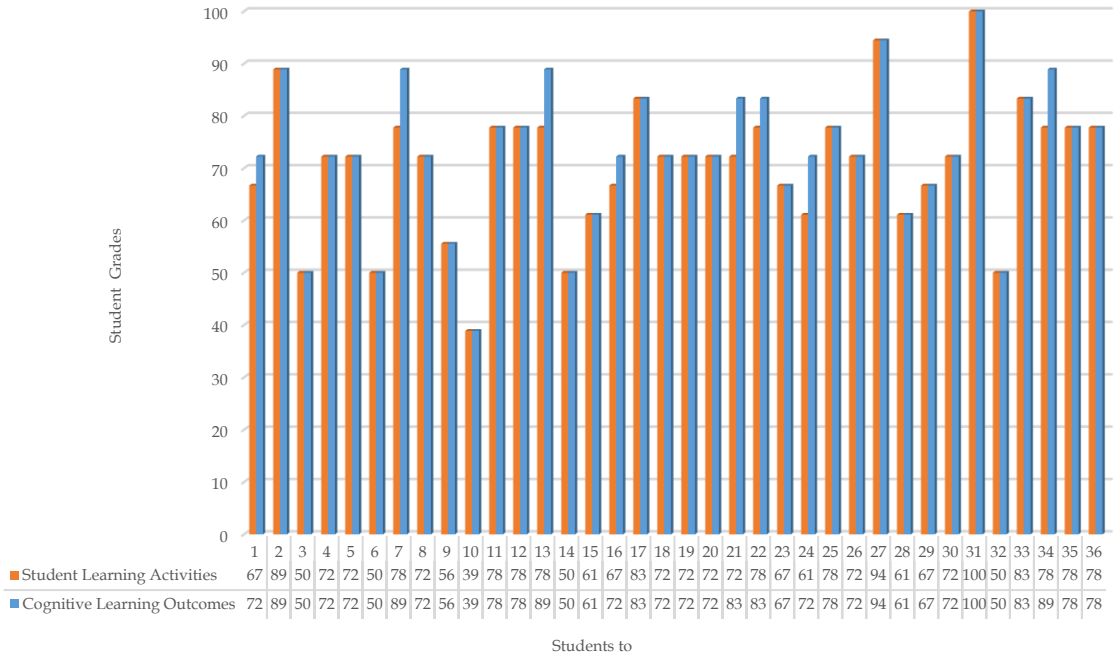


**Figure 1.** Results of Learning Activities and Students' Cognitive Learning Outcomes

Student learning activity results, measured through observation scores, tend to be higher and more stable than cognitive learning outcome scores obtained from tests. To confirm the relationship between the two variables, a Spearman correlation test is necessary.

*Normality Test Results*

The results of the normality test between student learning activities and cognitive learning outcomes can be seen in Table 3.

**Table 3**. Normality Test Results

| **Tests of Normality** | | | |
|---|---|---|---|
| | Shapiro-Wilk | | |
| | Statistic | df | Sig. |
| Learning Activity | .951 | 36 | .111 |
| Cognitive Learning Outcome | .951 | 36 | .116 |
| a. Lilliefors Significance Correction | | | |

The results of the normality test showed that student activity had a ρ value of 0.001, indicating that the data were not normally distributed. Meanwhile, for cognitive learning outcomes, the ρ value was 0.117, indicating that the data were approximately normally distributed. Because one of the variables (student learning activities) was not normally distributed, the Spearman correlation test was chosen as an alternative correlation.

*Correlation Test Results*

The results of the correlation test between student learning activity scores and cognitive learning outcomes using the Spearman correlation test can be seen in Table 4.

**Tabel 4.** Correlation Result

| **Correlations** | | | | |
|---|---|---|---|---|
| | | | Learning Activity | Cognitive Learning Outcome |
| Spearman's rho | Learning Activity | Correlation Coefficient | 1.000 | .943** |
| | | Sig. (2-tailed) | . | .000 |
| | | N | 36 | 36 |
| | Cognitive Learning Outcome | Correlation Coefficient | .943** | 1.000 |
| | | Sig. (2-tailed) | .000 | . |
| | | N | 36 | 36 |
| **. Correlation is significant at the 0.01 level (2-tailed). | | | | |

The Spearman correlation between student learning activities and learning outcomes is 0.943 with a -value (Sig.) = 0.000. Since the value is <0.05, there is a significant correlation between student activities and learning outcomes. The value of 0.943 indicates that the relationship between student activities and learning outcomes is at a very strong level. Compared to the r table (0.2709), the correlation value of 0.943 > 0.2709, which means this correlation is quite strong and significant.

## 2. Discussion

The results of the Shapiro-Wilk normality test indicate that the student learning activity variable has a significance value of ρ = 0.111, while the cognitive learning outcome variable has a significance value of ρ = 0.116. Both values are greater than 0.05, indicating

that the data are statistically normally distributed. The Shapiro-Wilk test is the most robust and accurate normality test for small samples, so its results are prioritized in decision-making (Sianturi, 2025)

The results of the normality test were followed up with a Spearman correlation test. The Spearman test was used because the learning activity data were obtained through observation, making them ordinal in nature. This contrasts with student learning outcomes, which are interval scaled. The analysis results showed a positive correlation between student engagement and learning outcomes. The Spearman correlation of 0.943 also indicates a very strong relationship. Because the correlation between student engagement and learning outcomes ranges from 0.40 to 0.599, the relationship is considered moderate. This means that student engagement contributes to learning outcomes, but other factors can also influence it. With a ρ value of <0.05, it can be seen that this relationship is not coincidental but rather indicates a real relationship. Students who are more active in learning, such as frequently asking questions, discussing, and completing assignments, tend to have better learning outcomes.

Theoretically, this finding is in line with constructivism theory, which emphasizes that knowledge is actively constructed through student involvement in the learning process (Sianturi, 2025; Handoyo, 2025). Learning activities such as discussing, asking questions, working on assignments, and solving problems allow students to construct a deeper conceptual understanding. This theory aligns with the principles of the problem-oriented learning model (PBL), namely that problem-oriented learning and the level of active student involvement have a significant contribution to improving cognitive learning outcomes, especially in activity-based learning and student-centered learning (Schreiber, 2022; Twiningsih, 2019). Thus, the results of this study confirm that student learning activities are a strong predictor of cognitive learning outcomes, so efforts to improve the quality of learning need to focus on strategies that encourage active student involvement. Faridah et al., (2022) stated that active participation in class improves students' absorption of learning materials. This is supported by studies that emphasize that students who are active in learning tend to have better academic achievement than those who are passive.

## CONCLUSION

Based on these results, it can be concluded that there is a positive and significant relationship between student learning activities and cognitive learning outcomes in biology lessons that implement Problem-Based Learning (PBL) on ecosystems. The Spearman correlation test showed a correlation coefficient of 0.943 with a significance value of 0.000 ($\rho < 0.05$), which is categorized as a very strong relationship. This finding indicates that the higher the student learning activities during the learning process, the higher the cognitive learning outcomes achieved.

Student learning activities, such as asking questions, discussing, expressing opinions, and analyzing problems, play a crucial role in supporting the process of

knowledge construction and conceptual understanding. In the context of problem-based learning, active student involvement is a key factor in facilitating optimal cognitive learning outcomes, particularly in the complex and contextual nature of ecosystems. Therefore, improving cognitive learning outcomes is inextricably linked to the quality of student learning activities during the learning process. The implications of this study suggest that teachers need to design learning that encourages active student involvement through the presentation of contextual problems and learning activities oriented toward student-centered learning.

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