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Analysis of Metacognition and Achievement in Problem Based Learning based on Socio-Scientific Issue Learning in Regional Schools Coffee Plantation

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ABSTRACT

Based on PISA 2015, Indonesia showed a low science literacy score. This phenomenon reflects students' weak ability to think systematically, used scientific knowledge, and apply it in life. Therefore, empowering metacognition is crucial to improve the quality of science learning through approaches such as Problem Based Learning (PBL) based on Socio-Scientific Issue (SSI). This approach integrates factual problems from local potential, such as the coffee plantation environment, as a learning resource. This research aims to determine the effect of PBL-SSI learning model on metacognition skills and mastery of biology concepts of high school students in coffee plantation area. This research design uses quasi experimental with data acquisition techniques in the form of observation, inventory, and test methods. The result obtained through ANCOVA test on metacognition skills was sig 0.262 which indicates that PBL-SSI has no influence on students' metacognition skills because sig>0.050. The result of ANCOVA test on mastery of biological concepts was 0.043 which indicates that PBL-SSI influences students' mastery of biological concepts because sig < 0.050.

Keywords: PBL-SSI, metacognition skills, mastery of biology concepts, coffee plantation.

INTRODUCTION

Metacognition is a primary goal and focus in education, including in Indonesia. According to the *Program for International Student Assessment* (PISA) in 2015, Indonesia ranked 69th out of 75 countries, with a science literacy score classified as low, at 403 (Pamungkas *et al*., 2023). This low score is associated with students' limited ability to think systematically, which includes the use of scientific knowledge, analysis of statements, and fact-based reasoning. This phenomenon highlights the urgency of empowering metacognition to help Indonesian students become aware of and recognize their knowledge and skills during the learning process (Andira, 2022).

Indonesia is the fourth-largest coffee-producing country in the world. Jember Regency, East Java, is one of Indonesia's coffee-producing regions, with 16,882 hectares of plantations, 5,601.31 hectares of which are managed by local communities (Suratno *et al*., 2023). Certain geographical environments, such as coffee plantation areas, can influence the daily activities of the surrounding communities, including the education sector (Suratno *et al.*, 2020).

Students in schools located in coffee plantation areas tend to have different characteristics compared to those in urban areas. These students are generally more passive in learning, easily feel bored, have low learning independence, and lack self-confidence (Pratiwi *et al.*, 2023). These conditions can hinder their metacognitive abilities and concept mastery development (Suratno *et al.*, 2023).

Based on these characteristics, it is essential to implement a learning model that supports students in developing a scientific attitude. An effective learning model can enhance learning success and help students face global challenges (Pratiwi *et al.*, 2023*). Problem-Based Learning* (PBL) is a "problem-based" learning model that encourages students to gain understanding through investigation. This model enables students to collaboratively discover knowledge based on their perspectives on the problem being addressed (Fidan & Tuncel, 2019). The PBL model can be integrated with the *Socio-Scientific Issue* (SSI) approach, which involves socially relevant and controversial issues related to science. This approach allows students to apply scientific knowledge to solve complex real-life problems (Chen & Xiao, 2021).

Socio-scientific issues derived from local potential in the surrounding environment can be utilized as learning resources for students. By integrating learning materials, students can explore, develop, and understand their environmental conditions (Ule *et al*., 2021). Environment-based learning, such as learning in a coffee plantation environment, can support students' understanding of scientific issues related to their surroundings. Utilizing the potential of coffee plantations as a learning resource enables students to grasp concepts more effectively and develop specific skills (Adinia *et al*., 2022). Beyond helping students understand theories, environment-based learning also encourages them to integrate relevant concepts, enhancing their ability to think critically, objectively, and rationally (Misbahudholam *et al*., 2022).

MATERIALS & METHODS

This study employs a quantitative research method with a *Quasi-Experimental* design. The population consists of all 10th-grade students at SMA Negeri Jenggawah, distributed across six classes during the first semester of the 2024/2025 academic year. The research subjects include Class X6 as the experimental group and Class X2 as the control group. The control and experimental classes were determined through an initial test, with the results analyzed using normality and homogeneity tests, followed by selection through the *Random Sampling* method.

The assessment of metacognitive skills awareness using a questionnaire was conducted twice, namely pretest and post-test. The collected data was processed through normality and homogeneity tests before conducting the ANCOVA test. The response options provided in the questionnaire were Agree (S) with a score of 1 and Disagree (TS) with a score of 0. The obtained scores were then accumulated and calculated based on assessment values and criteria, as presented in the following table.

Score Achievement = (number of scores)/ (maximum score) x 100

Table 1. Criteria for Assessing Metaognitive Skills

Category	Criteria
0	Not yet developed
1 – 20	Still very risky
21 – 40	Not so developed yet
41 – 60	Strat growing
61 – 80	Well Developed
81 – 100	Very well developed

(Suratno *et al*., 2023).

Students' biology concept mastery was measured using the pretest and post-test scores, with identical questions for both tests. The pretest and post-test scores were analyzed using the ANCOVA test. The scoring system for the test followed a 20:80 ratio between Multiple Choice and Essay questions. The 10 multiple-choice questions

were assigned a total score of 20, with each question carrying a weight of 2 points.

RESULT

The selection of the research sample was carried out using the Purposive Random Sampling technique, based on the initial test scores of 9th-grade Biology material for all six 10th-grade classes at SMA Negeri Jenggawah. The normality test using One-Sample Kolmogorov-Smirnov indicated that classes X1 to X6 at SMA Negeri Jenggawah were normally distributed as they had sig values > 0.05. Subsequently, classes that met the normality distribution criteria were analyzed using Levene's Test for homogeneity testing. The homogeneity test yielded a sig value of 0.434, indicating that the data was homogeneous (sig > 0.05). After meeting both normality and homogeneity criteria, the experimental and control classes were selected using the *Random Sampling* method.

The data on students' metacognitive skills was measured using an inventory adopted from Schraw and Dennison (1994), consisting of 35 questions divided into five metacognitive skill indicators. The questionnaire was distributed in the form of a *Microsoft Forms* link.

Table 2. Students' Metacognitive Skills Results

Class	Test	Component		
		Minimum Score	Maximum Score	Average ± SD
Experiment	*Pretest*	54	100	80 ± 14,61
	Post-Test	51	100	86 ± 11,97
Control	*Pretest*	54	97	75 ± 11,34
	Post-Test	57	100	80 ± 14,35

To determine the effect of the applied treatment in terms of the learning model used in the experimental and control classes on metacognitive skills, a normality test was conducted using the *One-Sample Kolmogorov-Smirnov* test and a homogeneity test using *Levene's Test*. Student metacognition data that met the criteria for normality and homogeneity were then analyzed using ANCOVA, with the results as follows.

Table 3. ANCOVA Test Result for Pretest and Post-Test of Metacognitive Skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	718.137[a]	2	359.069	33.973	.000
Intercept	145.418	1	145.418	13.759	.000
PRETEST	638.787	1	638.787	60.438	.000
KELAS	13.593	1	13.593	1.286	.262
Error	602.446	57	10.569		
Total	52071.000	60			
Corrected Total	1320.583	59			
a. R Squared = .544 (Adjusted R Squared = .528)					
b. Computed using alpha = .05					

The ANCOVA test results on the pretest and post-test data of students' metacognitive skills yielded a significance value of 0.262. This significance value indicates that H0 is accepted and H1 is rejected because the value is >0.05. The rejection of H1 and acceptance of H0 explain that the *Problem-Based Learning* model based on *Socio-Scientific Issues* has no effect on the metacognitive skills of high school students in a coffee plantation environment.

The conceptual mastery data was obtained from the results of the pretest and post-test using the test method. The test consisted of 10 multiple-choice questions and 5 essay questions. The summary of the conceptual mastery test results for the pretest and post-

test in the experimental and control classes is presented in the following table.

Table 4. Biology Concept Mastery Result

Class	Test	Component		
		Minimum Score	Maximum Score	Average ± SD
Experiment	*Pretest*	9	70	41 ± 16,78
	Post-Test	47	100	72 ± 12,72
Control	*Pretest*	20	64	39 ± 13,47
	Post-Test	23	90	64 ± 16,78

The data that met the normality and homogeneity assumptions as prerequisite tests were then analyzed using ANCOVA, with the results as follows.

Table 5. ANCOVA Test Result for Biology Concept Mastery

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4824.385[a]	2	2412.192	15.176	.000
Intercept	15869.136	1	15869.136	99.841	.000
PRETEST	3807.568	1	3807.568	23.955	.000
KELAS	683.428	1	683.428	4.300	.043
Error	9059.799	57	158.944		
Total	289017.000	60			
Corrected Total	13884.183	59			
a. R Squared = .347 (Adjusted R Squared = .325)					
b. Computed using alpha = .05					

The significance result from the ANCOVA test on the pretest and post-test data for concept mastery in students was 0.043. A significance value of <0.05 indicates that H0 is rejected and H1 is accepted. The rejection of H0 signifies that the implementation of the Problem-Based Learning model based on Socio-Scientific Issues has a significant influence on the biology concept mastery of high school students in a coffee plantation environment.

DISCUSSION

The results of the ANCOVA test on metacognitive skills scores showed a significance value of 0.262. This value indicates the acceptance of H0 and rejection of H1, as sig > 0.05. Based on these results, the implementation of the PBL-SSI learning model did not show a significant effect on students' metacognitive skills in the coffee plantation environment. This is likely due to students already having a high initial level of metacognitive skills, resulting in an insignificant difference between pretest and post-test scores. The average score difference between the experimental and control classes was relatively small, ranging from 5-6 points. Similar findings were reported by Lidia *et al.* (2018), where the Problem-Based Learning (PBL) model did not have a significant impact on students' metacognitive skills. However, the average score of each metacognitive skill indicator in the experimental class that applied PBL was relatively higher than in the control class.

Through an awareness of metacognitive skills, students can recognize their strengths and weaknesses in the learning process, enabling them to improve their proficiency effectively and develop self-confidence (Siswati *et al.*, 2023). The insignificant effect of PBL-SSI on metacognitive skills may be influenced by several factors. Measuring students' metacognitive skills requires a relatively long duration. According to Downing *et al.* (2009), the assessment of metacognitive skills conducted on university students in Hong Kong took 15 months. Additionally, the implementation of the Discovery Learning model in the control class may have affected the results. Discovery Learning is an instructional model that enables students to actively participate in the learning process.

Student engagement in this learning approach is closely related to their ability to identify and address their own learning needs, which in turn impacts their metacognitive skills (Fitriah *et al.*, 2023). Findings from this study indicate that both learning models (PBL-SSI and Discovery Learning) had a positive impact on students' metacognitive skills in the coffee plantation environment. These models encourage students to actively seek and process information independently, construct meaningful learning experiences, and develop their own knowledge based on personal experiences (Jannah *et al.*, 2022).

The ANCOVA test results showed a significance value of 0.043 (sig < 0.05), indicating that the PBL-SSI learning model significantly influences students' understanding of biological concepts in coffee plantation areas. Referring to research conducted by Narsan (2022), the implementation of PBL in learning contributes to improving students' mastery of biological concepts, thereby helping them understand biological concepts effectively and optimally. The problem-based learning model allows students to expand and deepen their knowledge by engaging with real-world issues within their communities. According to research by Samputri & Jumini (2024), learning that incorporates Socio-Scientific Issues (SSI) can enhance students' concept mastery. Through the SSI approach, students can analyze, interpret, and express ideas based on their knowledge, which can then be applied to social phenomena in their surroundings.

Problem-Based Learning (PBL) encourages students to build strong connections between concepts and the facts they learn. In this approach, students actively engage with the information presented rather than passively receiving it (Chen & Xiao, 2021). Integrating PBL with Socio-Scientific Issues (SSI) in learning provides students with real-world learning experiences, allowing them to grasp learning competencies more easily. The PBL-SSI learning model has been shown to be more effective in enhancing students' concept mastery in the experimental class. This suggests that the approach creates meaningful learning experiences, which support a deeper understanding of concepts. Utilizing local environmental potential as real-world issues helps students enrich their knowledge and apply it in practical contexts (Lubis *et al*., 2022).

CONCLUSION

The research findings indicate that the implementation of the PBL-SSI learning model does not have a significant impact on students' metacognitive skills in the coffee plantation environment. However, the model significantly influences students' biology concept mastery in the same setting. Overall, this study suggests that while PBL-SSI does not significantly affect metacognitive skills, it is effective in enhancing students' understanding of biological concepts. Implementing a learning model that promotes active exploration and contextual issues can help students develop their knowledge more deeply and meaningfully.

Declaration by Authors

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