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Research Artikel

PROJECT-BASED LEARNING (PjBL) CONTAINS SUSTAINABLE DEVELOPMENT GOALS (SDGs): STUDENTS' METACOGNITIVE AWARENESS IMPROVEMENT EFFORTS

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Abstract

Students' metacognitive awareness can be developed through Project-Based Learning (PjBL) implementation integrating Sustainable Development Goals (SDGs) as a significant aspect of the Kurikulum Merdeka. The purpose of this study is to improve metacognitive awareness through PjBL containing environment change material SDGs. The research method used was a quasi-experiment with a nonequivalent pretest-posttest control group design. The research study covers two groups, i.e., a control group and an experiment group of 36 students of class X of Senior High School respectively. The data-collecting technique used questionnaires and observation. The metacognitive awareness questionnaire adapts the Metacognitive Awareness Inventory (MAI) and a learning implementation observation sheet was used as a research instrument. The data analysis used was an Independent Sample T-Test and N-Gain trial. The Independent Sample T-Test result showed a significant 0.000 difference from the final questionnaire average score between the control and experiment classes. The experiment class students' metacognitive awareness obtained an average score of 84.14 with the highest category and 0.433 of the N-Gain trial score belongs to the medium category. This improvement was supported by the learning implementation result of teachers and students with a very good category. This study was expected to be able to give an effective contribution for teachers to improve the biology learning quality by emphasizing on the students' metacognitive awareness improvement. The next research shall expand coverage by engaging more schools and considering other factors such as learning methods and students' learning facility.

***Keywords**: Environment change; Knowledge about Cognition; Metacognitive Awareness; Project-Based Learning; Regulation of Cognition; Sustainable Development Goals.*

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INTRODUCTION

One of important awareness in meaningful learning is metacognitive awareness. However, Indonesian students' cognitive awareness still requires improvements. The efforts to improve the importance of metacognitive of students has been conducted for the last two decades because awareness is important for solving problems and directing students to be wiser and more knowledgeable (Nieto-Márquez et al., 2020; Novia et al., 2019). Cognitive awareness can be defined as students' awareness of self-learning strategy and how, when, and the strategy is implemented successfully (Harrison & Vallin, 2018; Schraw & Dennison, 1994). Metacognitive awareness involves an understanding of required action, action that has been done, and possible action on whether learning context or specific problem-solving situation (Noushad, 2009).

Students' metacognitive awareness needs to improve in learning to make things easier for the students in learning (Ilma et al., 2022). The student who has metacognitive awareness is able to work better and more strategically compared with the student who does metacognitive awareness (Adhitama et al., 2018; Schraw & Dennison, 1994). Metacognition is one of factors that contributed to academic performance and success (Novia et al., 2019). Metacognitive awareness is important to empower so the students can be an independent learner (Fox & Riconscente, 2008). Thus, students will be ready to face future challenges more optimistically and confidently.

However, a metacognitive awareness survey result of high school students in Tarakan, Indonesia that was conducted by Ilma et al. (2022) revealed that planning indicators, information management strategy, and evaluation are included as a growing category. The research result of Rohmania et al. (2021) in SMAN 1 Kediri also shows that metacognitive awareness on regulation of cognition components is still low, especially in strategy indicators in managing information. Most students did not use their metacognitive awareness to solve the problems and students were often having problems in writing information (Fauziah et al., 2019; Ramadhanti & Yanda, 2021). Many learning environments in school do not encourage metacognitive awareness improvement and the applied learning strategy does not empower students' thinking (Rahmadhni & Chatri, 2023; Rodriguez, 2006).

The observation result of learning implementation conducted by Ilma et al. (2022) and Sholahuddin et al. (2021) showed that learning in school has not facilitated students to have an in-depth thinking generally. The learning orientation is only based on recitation and does not observe a high level of intellective ability improvement (Maryati et al., 2020; Sugiharto et al., 2020). A potential biology teacher also has less cognitive character and acknowledgment (Herlanti et al., 2019). Those factors are assumed to be the cause of low students' metacognitive awareness. As a result, students are not able to determine the effective and efficient learning strategy (Sugiharto et al., 2020).

Thus, it requires a learning strategy that can improve students' metacognitive awareness. Teachers should consider the usage of appropriate learning strategies to encourage and inspire students to be more actively engaging in the learning process (Dewi, 2023; Gunawan et al., 2017; Khoiri et al., 2023). The research result of Zulfiani et al., (2020) showed that biology teachers have high metacognitive awareness towards planning and implementation of learning processes. It becomes one of the solutions for teachers to plan learning strategies by implementing an appropriate learning model to improve students' metacognitive awareness.

Among learning models that can be used is Project-Based Learning (PjBL). The main characteristic of PjBL is the project itself. The project is designed in questions or issues forms. Through this project, students are doing investigations to solve the proposed questions or problems (Artama et al., 2023; Khoiri et al., 2023). In addition, the learning achievement on the final E-Phase of Kurikulum Merdeka also emphasizes simple project-making, so PjBL is very important to be implemented to students (BSKP Kemendikbudristek, 2022).

The PjBL stages like planning, implementation, monitoring, and evaluating project results can help students to improve metacognition activity (Adhitama et al., 2018; Bas, 2011). PjBL directs students to extend knowledge, ability, and controls their metacognition activity (Fajra & Novalinda, 2020). The research result of Ilma et al. (2022) also showed that the classes that implement PjBL and conventional learning have respectively a metacognitive awareness average score of 23.81 and 21.18. In the meantime, Afifi et al. (2016) mentioned that PjBL can direct students to determine the most appropriate learning strategy to complete projects so students are more responsible for their tasks. Students who have better metacognitive awareness are more aware and responsible toward learning (Novia et al., 2019). However, some of those research results have not yet explained how the learning process on the PjBL stage can improve metacognitive awareness effectively, therefore, further research is required.

Beside the PjBL conduction, the Kurikulum Merdeka also emphasizes the importance of Sustainable Development Goals (SDGs) in learning (BSKP Kemendikbudristek, 2022). The SDGs implementation involves the social, economy, and environment aspects handling with a complex relation (Filho et al., 2019). Storey et al., (2017) mentioned that the crucial challenges that are faced by the education world is how to equip citizens, academics, and leaders to implement significant change and prevent crises in the future. Therefore, one of efforts that can be made is by integrating SDGs into learning so it significantly affects in reaching better goals and lives in the future (Filho et al., 2019).

One of 17 SDGs that can be integrated into learning is the SDG 13 on climate change handling or climate action. Climate change is an urgent challenge that should be faced by humans and affecting a lot of components such as land ecosystem, vegetation change, farm, and food system (Campbell, 1976; Yang et al., 2020). Climate change, which is one of the environmental changes, can be raised as a current issue so that it can broaden students' insight into environmental issues (Rachim & Ambarwati, 2021). Teachers need to determine the right learning models and media to teach climate change so that students' critical thinking skills can be improved (Efwinda et al., 2023). In the Senior High School stage according to the E-Phase of Kurikulum Merdeka, climate change handling is learned by environmental change material. Among the abilities that are required to be planted in students related to this material is the communication ability in simple project form (BSKP Kemendikbudristek, 2022). A simple project to integrate climate change handling as the SDG 13 can be realized using PjBL (Mitarlis et al., 2023).

Learning process using SDG-contained PjBL requires metacognitive awareness to implement knowledge in preventing and handling various things that cause climate change. The students also need to use their metacognitive awareness to understand the work-on project contribution to be able minimize climate change impact. Therefore, SDG-contained PjBL implementation is one effort to improve students' metacognitive awareness.

METHOD

This study used a quasi-experiment research method with nonequivalent pretest-posttest control-group design (Cresswel, 2014). This design involves two treatment groups, covers an experiment group and a control group. The experiment group applied the SDG 13 contained PjBL, while the control group applied conventional learning namely cooperative learning.

This population study contains all class-X students in a Senior High School in Kabupaten Bandung Barat. Research sample covers two classes i.e., control class and experiment class, in which each class consists of 36 students. This study used purposive sampling arranged based on non-homogen population characteristic and certain purpose. The purpose is to know the SDG 13 contained PjBL effect towards environment change material, so the chosen sample criteria is students who are learning environment change material and schools that applied Kurikulum

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Merdeka. While the data-collecting technique in this study involves the combination between observation and questionnaire. The used instruments were metacognitives awareness questionnaire and PjBL implementation observation sheet on students and teachers.

Metacognitive awareness used questionnaires as an instrument to assess students' metacognitive awareness level before and after PjBL being conducted on experiment class and cooperative learning on control class. Each class was given an initial questionnaire (before treatment) and final questionnaire (after treatment). The questionnaire was adapted from Metacognitive Awareness Inventory (MAI) according to Schraw & Dennison (1994). The metacognitive awareness questionnaire consists of 16 statements to measure two components i.e., knowledge about cognition and regulation of cognition. Knowledge about cognition component consists of three indicators i.e., 1) declarative knowledge, 2) procedural knowledge, and 3) conditional knowledge. The regulation of cognition component consists of five indicators i.e., 1) planning, 2) information management strategies, 3) comprehension monitoring, 4) debugging strategies, and 5) evaluation. The metacognitive awareness questionnaire can be seen in Table 1.

Table 1. Metacognitive Awareness Questionnaire MAI-Adapted

No.	Metacognitive Awareness Component	Metacognitive Awareness Indicator	Operational	Statement No.	Quantity
1.	Knowledge about cognition	Declarative knowledge	Students acknowledge the information types that should be known in doing projects	1, 2	2
		Procedural knowledge	Students acknowledge learning strategies that used and how to use the strategies	3, 4	2
		Conditional knowledge	Students acknowledge the appropriate times to learn	5, 6	2
2.	Regulation of cognition	Planning	Students plan projects to reach the goals	7, 8	2
		Information management strategies	Students can process information efficiently starting from organizing to focusing on important information	9, 10	2
		Comprehension monitoring	Students analyze unknown things and monitor the realization of the work-on-project progress	11, 12	2
		Debugging strategies	Students analyze yet unknown things more efficiently starting from organizing to focusing on important information	13, 14	2
		Evaluation	Students improve the disadvantages in working on project	15, 16	2
			Average		16

The metacognitive awareness measurement through the usage of the Likert scale with point range from 1 to 4, showed the approval level from very disagree to very agree. Each metacognitive awareness indicator score then changed to 100 scale and categorized into five categories; 0-20 (very low); 21-40 (low); 41-60 (medium); 61-80 (high); 81-100 (very high) (Jaleel & Premachandran, 2016).

Observation sheets of learning implementation on students and teachers are used to see the PjBL implementation on improving students' metacognitive awareness in experiment class. The observation sheets are modified from the PjBL stages according to Syarif & Susilawati (2017) covers: 1) Identifying basic questions, 2) Project design plan, 3) Schedule arrangement, 4) Monitoring the students and project progression, 5) Result evaluation, and 6) Evaluating experience. The observer fills in the observation sheets that were measured according to Likert scale, scale 1 to 5 is not done until it is well-conducted. The administered of learning implementation observation score is done by looking at the percentage (%) and categorized into

five categories i.e., 0-20 (very insufficient); 21-40 (insufficient); 41-60 (sufficient); 61-80 (good); 81-100 (very good) (Ekantini & Wilujeng, 2018).

Before the instrument was used in the research, an instrument trial was done on 25 students of class-X to determine metacognitive awareness questionnaire feasibility. The instrument trial covers assessment towards validity and reliability analyzed using SPSS software. The result of the validity trial stated that all statements in the metacognitive awareness questionnaire were valid. Furthermore, Alpha Cronbach reliability trial obtained 0.889 score, thus it belongs to the highest category.

The data analysis consists of a precondition test, median test, and the N-Gain test analyzed using SPSS software. The precondition was through applying normality testing and homogeneity testing. The normality test was conducted through Shapiro-Wilk test because the sample number is less than 50, while the homogeneity test used Levene's Test because the test was done on two data groups. The result stated that data on the control class or experiment class was distributed normal and homogeneous. The Independent Sample T-Test trial functioned to analyze mean difference of initial questionnaire score and final metacognitive awareness on unpaired data. The metacognitive awareness score improvement analyzed using the N-Gain test categorized into 3 categories, among them high ((g) > 0.70); medium (0.30 < (g) < 0.70); and low ((g) < 0.30) (Hake, 1999).

RESULTS AND DISCUSSIONS

Students' Metacognitive Awareness Achievement through PjBL on Environment Change Material

Metacognitive awareness achievement can be known by seeing the score obtained by students after doing a metacognitive awareness questionnaire. The metacognitive awareness questionnaire result was analyzed using a statistical test covering normality test, homogeneity test, median test, and N-Gain test. The students' metacognitive awareness statistic result can be seen in Table 2.

Table 2. Students' Metacognitive Awareness Statistic Test Result

Data Types / Class		Initial Questionnaire		Final Questionnaire	
		Control	Experiment	Control	Experimen
N		36	36	36	36
Average		62.36	63.23	71.83	84.03
Average Category		High	High	High	Very high
Normality Test	Significancy	0.157	0.072	0.263	0.286
	Interpretation	Normal	Normal	Normal	Normal
Homogeneity Test	Significancy	0.145		0.528	
	Interpretation	Homogeneous		Homogeneous	
Independent Sample T-Test	Significancy	0.467		0.000	
	Interpretation	Not different significantly		Different significantly	

The data in Table 2. stated that there was score improvement from the initial questionnaire to final questionnaire on both classes, the control class and the experiment class. However, the improvement on the experiment class is 20.8 increased from high category into very high. Meanwhile, the control class only experienced an increase of 9.47 with similar categories on the initial and the final, namely high category.

The initial questionnaire score average for both groups, whether control class or experiment class, was obtained with not much difference in scores by 62.36 and 63.23 respectively, therefore, the Independent Sample T-Test testing result showed a significant decrease by 0.467. The non-significant initial questionnaire score between the control class and the experiment class was caused by teachers not being used to applying metacognitive awareness-related learning on both

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classes. This caused the students to not use their metacognitive awareness to the maximum. Lidia & Sarwi (2018) also state that students did not understand the metacognitive usage because teachers were not used to implementing metacognitive-based learning.

The absence of significant difference between the class control and the experiment class on the initial questionnaire score was also caused by teachers being more frequent in applying lecture mode in material teaching than assigned students to answer questions. This caused the students less-understanding of metacognitive awareness importance in the learning process carried out. This study result was in accordance with Fiteriani et al. (2020), Ilma et al. (2022), and Pratama et al. (2018) which showed that teachers were more frequent in implementing conventional learning like answering questions on task books which answers were available on the book.

Another reason that caused the insignificant initial questionnaire score on both classes was learning activity was more focused on mastery concepts and students tend to learn by recitating. Learning process by recitation causes students to pay less attention to the learning strategies that were used and the obtained knowledge can be forgotten easily. Teachers tend to implement learning on cognitive ability improvement which is only oriented on content knowledge, lack of material connection in real life, lack of improving students' potential (Ratini et al., 2018; Safitri et al. (2018); Sholahuddin et al., 2021).

Different with the final learning result, the average final questionnaire for both classes, the control class and the experiment class obtained quite different averages by 71.83 and 84.03 respectively, so that the Independent Sample T-Test testing result showed 0.000 in significance. The experiment class which implemented the SDG 13 contained PjBL was more superior compared to the control class which implement cooperative learning. The high metacognitive awareness score average on the experiment class was caused by the PjBL stages able to facilitate and improve students' metacognitive awareness.

The PjBL stages are: 1) Determination of basic question can facilitated declarative knowledge; 2) Designing a project plan can facilitated declarative knowledge, procedural knowledge, planning, and strategy in managing information; 3) Arranging schedule can facilitated declarative knowledge, planning; 4) Monitoring students and project progression can facilitated conditional knowledge, monitoring to understanding, repairing strategy; 5) Testing result can facilitated strategy in managing information, repairing strategy; and 6) Evaluating experience can facilitated evaluation. Bas (2011) also revealed that the PjBL stages like planning, implementing, and evaluating project results can improve metacognition activity.

When conducting PjBL, students have clear project purposes so every student knows how to reach the purpose with the most appropriate strategy. PjBL also encourages students to be responsible for their tasks and their respective roles in the group. After completing the project, students were also assigned to evaluate the project process and working results. This process gave opportunity to students in identifying advantages and disadvantages. Therefore, gaining in-depth understanding on learning process carried out can be obtained by students. This result was in accordance with Novia et al. (2019) that stated that students who have better metacognitive awareness are more aware and more responsible for their learning.

The magnitude of metacognitive awareness improvement towards the control and experiment classes can be seen through the N-Gain average score. The N-Gain average result is in Table 3.

Table 3. Students' N-Gain Score

Class	N-Gain Average	Category
Control	0.210	Low
Experiment	0.433	Medium

The data in Table 3. shows that average N-Gain score for the class control was classified low, with the average by 0.210. Meanwhile, the experiment class was classified as medium, with the average by 0.433. Therefore, the PjBL implementation on the experiment class was more

capable in improving students' metacognitive awareness.

Fajra et al. (2020) explained that PjBL can deepen the knowledge and ability by creating projects related to the students' competency. The research conducted by Baser et al. (2017) explained that students were working together in groups to work on the project involving the usage of technology and collaborative ability. Students participated in research, experiment, and final presentation process. Teachers played a role as facilitator and directed students while working on a project and gave feedback and counseling. Therefore, PjBL involved intellectual groups in designing, solving problems, and making decisions that were useful for life. There are basic questions that direct students to look for information from various sources, choosing, and processing the information according to the presented context (Bas, 2011; Rais et al., 2021). A focus question also allows students to do a depth exploring (Habok & Nagy, 2016).

Student' Metacognitive Awareness Achievement through PjBL on Metacognitive Component

Metacognitive awareness covers two components, i.e., knowledge about cognition and regulation of cognition. Knowledge about cognition is defined as students' understanding of their cognitive learning process. Metacognitive awareness achievement on knowledge about cognition component can be known by seeing students' questionnaire score on three indicators categorized in knowledge about cognition, i.e., declarative knowledge, procedural knowledge, and conditional knowledge. Knowledge about cognition score average results can be seen in Figure 1.

The data on Figure 1, stated that the initial questionnaire average score between the control class and the experiment class before given treatment are not much different. However, after given treatment, the control class increased by 13.43 and obtained the final questionnaire average score by 75.46, with high metacognitive awareness category. Meanwhile, the experiment class increased by 21.76 and obtained a final questionnaire average score of 84.14, with a very high metacognitive awareness category. Bigger knowledge about cognition increasing on the experiment class was caused by PjBL entailed students to be actively involved in real problem-solving. Students should use cognitive ability like critical thinking, analysis, and synthesize to complete projects. The learning experience gave opportunity for students to have a deeper understanding and learning process in achieving success (Hovey & Ferguson, 2014).

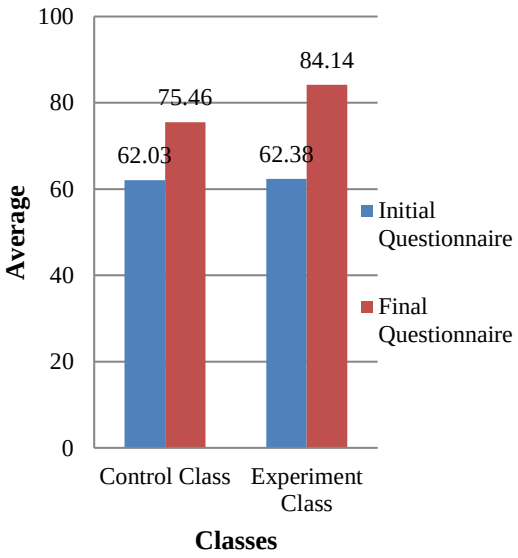

Figure 1. Knowledge About Cognition Score Average

Next metacognitive awareness component is regulation of cognition. Regulation of cognition covers the planning process of the learning process to evaluate the learning process. Metacognitive awareness achievement on regulation of cognition component can be known by seeing students' questionnaire score on five indicators categorized in regulation of cognition, i.e., planning, information management strategies, comprehension monitoring, debugging strategies, and evaluation. The regulation of cognition score average can be seen on Figure 2.

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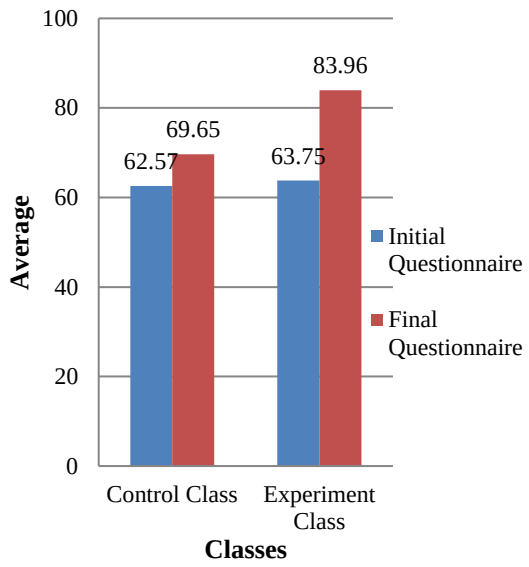

Figure 2. Regulation of Cognition Score Average

The data on Figure 2, stated that the initial questionnaire average score between the control class and the experiment class before given treatment are not much different. However, after treatment given, the control class increased in the amount of 7.085 and obtained a final questionnaire average score in the amount of 69.65, with a high metacognitive awareness category. Meanwhile, the experiment class increased in the amount of 20.21 and reached the final questionnaire average score of 83.96, with a very high metacognitive awareness category. Bigger regulation of cognition improvement on the experiment class was caused by the students' opportunity given by PjBL to monitor progress in reaching goals and evaluating success related to the work-on project. Rais et al. (2021) explained that through self-monitor, students can improve awareness of advantages, disadvantages, and things that required improvement.

The study result on Figure 1 and Figure 2, shows that regulation of cognition is lower than knowledge about cognition on the control class or experiment class. This is because most students are not used to planning self regulation like planning learning strategy, fixing learning process that has done, or evaluating learning progress. Meanwhile, Suwandi et al. (2019) explained that one of the reasons of why regulation of cognition is lower than knowledge about cognition is because students are lack of realization of the awareness importance for arranging thinking process. Lower regulation of cognition is in accordance with this study result following the previous study result done by Adhitama et al. (2018) which showed that regulation of cognition has a percentage in the amount of 63.3%, lower than knowledge about cognition in the amount of 70%. The study result of Ilma et al. (2022) also showed that regulation of cognition is included in the growing category so that students' metacognitive awareness still requires improvement.

Therefore, some strategies that can be done to improve students' regulation of cognition is that teachers should train students to do self-reflection, self-monitoring, and problem-solving. Then, teachers are expected to give specific and constructive feedback on students' learning progress. The study result of Padmanbha (2020) explained for students to be more used to regulation in thinking so they can solve problems well.

Though regulation of cognition average score is lower than knowledge about cognition as following this study result, however, knowledge about cognition is very highly correlated with regulation of cognition (Adhitama et al., 2018; Rodriguez, 2006). Knowledge about cognition provides foundation for effective regulation, i.e., how and when planning, monitoring, and evaluating should be done. Therefore, knowledge and regulation components are completing each other and both are important to reach optimized performance (Ku & Ho, 2010).

Students' Metacognitive Awareness Achievement Through PjBL on Each Metacognitive Indicators

Metacognitive awareness achievement of each indicator on the control class can be seen in Table 4.

Table 4. Each Indicators of Metacognitive Awareness Achievement on Control Class

Metacognitive Awareness Indicator	Data Types			
	Initial Questionnaire	Category	Final Questionnaire	Category
Declarative knowledge	63.19	High	81.25	Very High
Procedural knowledge	60.76	High	72.91	High
Conditional knowledge	62.15	High	72.22	High
Planning	62.15	High	71.18	High
Information management strategies	64.93	High	68.75	High
Comprehension monitoring	63.54	High	69.79	High
Debugging strategies	60.07	High	73.26	High
Evaluation	62.15	High	65.27	High

The data on Table 4. stated that the indicator that obtained the highest final questionnaire score on the control class is the declarative knowledge indicator in the amount of 81.25 with a very high category. The high indicator of declarative knowledge is because control class students already know what information they need to know before working on LKPD in cooperative learning. Students also already know the topic or part of the concept of environmental change that they have mastered because the teacher has previously explained the learning material to students. Schraw & Moshman (1995) explained that through declarative knowledge, students are expected to understand what things have not been mastered and what they have mastered and what things must be mastered.

The indicator that received the lowest final questionnaire score in the control class was the evaluation indicator of 65.27 in the high category. The low evaluation indicators are caused by the learning stages not facilitating students to evaluate the projects they are working on. Meanwhile, it is important to carry out evaluation activities, one of which is by evaluating yourself, thinking about whether there are easier alternatives for doing something, or whether students have considered all the ways to do something (Habók & Nagy, 2016; Moshman, 2018). The metacognitive awareness achievements for each indicator in the experimental class can be seen in Table 5.

Table 5. Each Indicators of Metacognitive Awareness Achievement on the Experiment Class

Metacognitive Awareness Indicator	Data Types			
	Initial Questionnaire	Category	Final Questionnaire	Category
Declarative knowledge	61.8	High	84.03	Very High
Procedural knowledge	61.45	High	86.81	Very High
Conditional knowledge	62.50	High	85.07	Very High
Planning	60.41	High	87.50	Very High
Information management strategies	64.93	High	80.56	Very High
Comprehension monitoring	64.93	High	81.25	Very High
Debugging strategies	63.88	High	83.68	Very High
Evaluation	65.97	High	83.33	Very High

The data in Table 5. states that the indicator that received the highest final questionnaire score in the experimental class was the planning indicator with a score of 87.5 in the very high category. The high level of planning indicators is because students have been able to achieve predetermined goals. This process is in accordance with the 2nd stage of PjBL, namely planning project planning. Before working on a project, students are required to plan the project through a problem identification process until they find the best solution to solve the problem. Students are also required to look for references regarding tools, materials and work methods and relate them to SDG 13. For example, to carry out a project to make pencil holders from used bottles and tissue holders from straws, students must choose tools and materials that can reduce waste to minimize climate change. Students must plan work methods that pay attention to SDG 13, such as not burning CO_2 gas, not littering when working on projects, and recycling waste to reduce the production of methane gas as one of the causes of climate change. Thus, project planning activities are related to SDG 13 regarding handling climate change. PjBL is efficient for improving skills and knowledge related to climate change (Lozano et al., 2022; Wróblewska & Okraszewska, 2020). Nurazizah et al. (2024) also explained that PjBL containing SDG is able to increase students' sustainability awareness, so that students are more aware of the environment as a place of life.

In the 3rd stage of PjBL, namely planning a schedule, each group is required to determine a schedule and deadline for project work which will help students to manage time effectively and ensure that students can complete the project according to the specified schedule. The division of tasks for each member and the person responsible for each activity is also carried out at the planning stage. Rahmadhni & Chatri (2023) explain that students who have a plan for learning will find it easier to set goals, maximize resources, and choose the right strategy in completing assignments. The high level of planning indicators in this research is in line with the research results of Afifi et al. (2016) which shows that the planning indicators in the experimental class that implemented practicum-based PjBL had the highest average value of 3.41 because the PjBL stage involved students in determining themes, objectives, project plans, and dividing project work schedules.

The indicator that received the lowest final questionnaire score in the experimental class was the information management strategies indicator of 80.56 in the high category. The low indicator of strategies for managing information is because students tend not to be optimal in conducting research to find information in various sources such as books, articles and other resources according to theme of the project they are working on. Class X students are also unable to ensure credibility and relevance of information found. Meanwhile, Habok & Nagy (2016) explained that students must be able to assess the adequacy and reliability of the information found, including when using information technology tools in the projects they are working on.

The low value of information management strategies indicators is also caused by students not being able to create their own examples and answer questions and discussions on the LKPD comprehensively. Students who have the strategic ability to manage information well will focus their attention and slow down their reading time to find important information (Moshman, 2018). The results of this research are in line with research by Rohmania et al., (2021) which shows that indicators of strategies for managing information are still low because students are not yet able to process important information in the learning process.

Thus, one effort that can be made to increase students' metacognitive awareness is that the role of the teacher as a facilitator in the learning process is needed. Teachers are a crucial factor in increasing metacognitive awareness in order to achieve learning goals (Afifi et al., 2016; Novia et al., 2019). Teachers should use various learning strategies and teach "learning how to learn" so that students can solve various problems and develop competencies to face future challenges (Maryati et al., 2020).

Implementation of PjBL Containing SDG 13 for Teachers and Students

The implementation of PjBL for teachers and students can be seen by looking at the average score for each meeting as assessed by three observers. The results of implementing PjBL for teachers and students can be seen in Table 6.

Meanwhile, the lowest percentage of learning applicability was 91.11% at the 5th meeting, namely assessing results and evaluating experiences. The stages of evaluating experience can facilitate evaluation indicators. At the experience evaluation stage, students are tasked with evaluating the project they are working on and expressing their feelings and experiences while working on the project. At this stage, students can also evaluate themselves by thinking about whether there are other easier ways to work on the project or whether they have considered all ways to work on the project (Schraw & Moshman, 1995). The low average percentage at the fifth meeting was because there were several groups who presented for too long so that it did not fit within the allotted time.

Table 6. The Implementation of PjBL for Teachers and Students

N-Meeting (PjBL Stages)	Teachers Implementation (%)	Category	Students Implementation (%)	Category
1st Meeting (Basic questions determining stages)	92.22	Very Good	88.15	Very Good
2nd Meeting (Designing project plan and schedule arranging)	93.89	Very Good	90	Very Good
3rd Meeting (Project assignment)	94	Very Good	92	Very Good
4th Meeting (Monitoring students and project progression stages)	91.43	Very Good	89.78	Very Good
5th Meeting (Evaluating result and evaluating experience stages)	91.11	Very Good	89.52	Very Good
Total Average	92.53	Very Good	89.89	Very Good

The highest implementation rate for students at 92% was also at the 3rd meeting, namely the project assignment stage. At the third meeting, students had brought tools and materials to make the planned project. The high average percentage at the third meeting was due to students being enthusiastic about working on projects with their groups. Apart from that, students act according to their respective roles in the group and support each other when working on projects. Rais et al. (2021) explained that PjBL was able to encourage each group to work on the project with enthusiasm and students enjoyed the learning carried out.

The implementation of learning for students who obtained the lowest percentage of 88.15% was found at the 1st meeting, namely determining basic questions. The stage of determining basic questions can facilitate declarative knowledge indicators. At the stage of determining basic questions, students discuss choosing one root of the problem and plan a project to solve the problem. Project planning requires analysis and references from various sources. This process engages students in developing a deeper understanding of the concepts being studied. Bas (2011) and Rais et al. (2021) stated that investigations based on problems discovered independently by students help investigations that lead to more contextual problem solving. However, the low average percentage at the first meeting was due to some students still having difficulty determining one root problem based on several problems that had been identified.

Project-based learning focuses on learning that is more student-centered than teacher-centered. In this sense, students take dominant participation during the learning process thereby allowing students to learn and try new things. Teachers become facilitators when students face difficulties and need direction (Artama et al., 2023; Khoiri et al., 2023). Teachers are also expected to be able to improve the learning process so that students are able to face changes in the 21st century and develop various skills to deal with the dynamics of life (Hairida et al., 2021)

CONCLUSION

The research results show that PjBL containing the SDG 13 is able to increase the metacognitive awareness of experimental class students on all indicators. The indicator that experienced the highest increase in the experimental class was planned at 27.09, while the control class was declarative knowledge at 18.06. The results of the N-Gain analysis for the experimental class show a value of 0.433, which can be classified into the medium category, while for the control class, the N-Gain value reaches 0.210 which is in the low category. The greater increase in metacognitive awareness in the experimental class was supported by the results of implementing PjBL learning for teachers and students who obtained an average percentage of 92.53% and 89.89% which were categorized as very good. Suggestions that can be given are that it is better to research PjBL containing SDGs on other biological materials and integrate technology more in learning according to current developments.

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