



Impact of li-pro-gp model on metacognitive awareness and problem-solving skills in biology learning

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ARTICLE INFO	ABSTRACT
<p>Article history Received: 12 May 2025 Revised: 02 June 2025 Accepted: 10 June 2025</p> <p>Keywords: 21st century learning Li-Pro-GP Metacognitive awareness Problem-solving skills</p>	<p>21st century learning demands the development of metacognitive awareness and problem-solving skills, but science learning in schools is still predominantly teacher centered. This study aims to determine the effect of the Li-Pro-GP learning model (project-based literacy integrated with school literacy movement and character education) on metacognitive awareness and problem-solving skills in Biology science learning. The research used a quantitative approach with a non-equivalent control group quasi-experimental design. The sample consisted of VIII grade students in one of the private junior high schools in East Java, with VIII A as the control and VIII B as the experiment. The research instruments used included questionnaires to measure metacognitive awareness, essay questions to assess problem solving skills, and observation sheets to assess learning implementation. Data analysis was conducted using ANCOVA with the help of SPSS 26. The post-test results showed higher scores in the experimental class than the control for both variables. ANCOVA test showed a significant effect of Li-Pro-GP model on metacognitive awareness [$F(1,57) = 129.926, p = 0.000, \eta^2 = 0.695$] and problem-solving skills [$F(1,57) = 81.481, p = 0.000, \eta^2 = 0.588$]. The results of the analysis showed a significant difference and a large effect size, so it can be concluded that the Li-Pro-GP model can improve students' metacognitive awareness and problem-solving skills in learning Biological Science.</p>

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INTRODUCTION

The 21st century is characterized by the rapid development of science and technology which brings significant changes in various aspects of life, including the world of education (Septiani et al., 2023). Global challenges require education to not only emphasize mastery of content, but also develop critical thinking skills, be reflective, and adaptive to change (Sabrina et al., 2023). In the context of education in Indonesia, strengthening learning that fosters independent and purposeful thinking is an urgent need to independent and directed thinking is an urgent need in order to prepare the younger generation to face complex global challenges effectively (Kurniawati et al., 2019; Thana et al., 2022). This is in line with the direction of national education policy that emphasizes student-centered learning and is oriented towards strengthening the essential competencies of the 21st century (Anand, 2024; Qadir et al., 2020).

One of the important abilities that needs to be developed to form an independent, reflective, and directed way of thinking is metacognitive awareness. This ability refers to an individual's awareness of their thinking process, as well as the skills to plan, monitor, and evaluate the learning strategies used (Flavell in Irham, 2016). According to Schraw & Dennison (1994), metacognition consists of two main components, namely knowledge about cognition and regulation of cognition. However, the results of research by Rizkiani & Septian (2019) show that the level of metacognitive awareness of students in Indonesia is still low. This condition causes them to have difficulty distinguishing between the content of the lesson and the thinking process, which ultimately has an impact on ineffective learning strategies (Fauziah et al., 2019).

Problem-solving skills is also a very crucial skill in this era. Polya (1957) defines problem solving as an effort to find a solution through four cognitive stages: understanding the problem, designing a plan, executing the plan, and checking back (Putra et al., 2020). This ability is very important in connecting learning in school with real life (Indriana & Maryati, 2021). The results of Saidah & Nurita (2013) showed that students' problem-solving level was still low due to teacher-centered learning. In addition, many students find it difficult to understand the material because it is considered difficult and based on memorization, so they are less able to develop solutions systematically (Rahayu et al., 2021).

Science learning, especially biology, has great potential in developing metacognitive awareness and problem-solving skills through a scientific approach that involves activities such as observing, experimenting, and reflecting on results (Ismarani et al., 2023). However, in practice, science learning at the junior high school level is still dominated by a passive approach that does not optimally foster independent thinking and problem-solving skills (Suharyat et al., 2022). Based on observations in one of the private junior high schools in East Java, teachers have implemented various learning strategies to encourage student activeness. However, there are still students who tend to be passive, lack confidence in expressing their opinions, and have difficulty in planning learning strategies and linking concepts to everyday life. Perhaps time constraints, students' learning habits, and lack of space for reflection and self-evaluation are challenges. As a result, students' metacognitive awareness and problem-solving skills have not developed optimally. This suggests the need for more innovative and structured learning strategies to encourage students to think critically, actively, and reflectively.

Improving students' problem-solving skills and metacognitive awareness is strongly influenced by student-centered learning strategies that encourage students to build their understanding (Irham, 2016). The Li-Pro-GP model is one potential solution by integrating project-based literacy learning, school literacy movement (SLM), and Strengthening Character Education (SCE) (Pantiwati, Fatmawati, et al., 2022). The model is designed through project-based learning methods integrated with literacy activities in three main stages, namely familiarization, development, and learning. In addition, this model also emphasizes strengthening five main character values, namely nationalism, independence, mutual cooperation, integrity, and religion (Pantiwati, Permana, et al., 2022). This approach allows students to control the learning process, organize thoughts in solving a problem, and increase metacognitive awareness through planning, monitoring, and evaluating the thinking process in solving problems (Pantiwati, Nurrohman, et al., 2023).

The Li-Pro-GP learning model that integrates project-based learning (PjBL), literacy, and character education has the potential to improve metacognitive awareness and problem-solving skills in science education (Pantiwati, Kusniarti, et al., 2023; Pantiwati, Nurrohman, et al., 2023). Project-based learning (PjBL) trains students in formulating problems, analyzing data, and evaluating solutions, thus improving metacognitive awareness and authentic problem solving (Awal et al., 2023; Rahmawati

& Haryani, 2015). Meanwhile, literacy supports metacognition by helping students understand, plan, monitor, and evaluate learning, and improve problem solving through searching and analyzing information (González et al., 2022; Setiawan & Dores, 2019). Strengthening Character Education (SCE) independence, responsibility, and cooperation, which support cognition regulation and problem-solving effectiveness (Maduretno & Andrini, 2018; Zubaidah, 2019). However, most of the previous studies only highlighted the effectiveness of PjBL in general and have not explored the integration of PjBL, literacy, and character thoroughly, especially at the junior high school level.

Based on these conditions, this study aims to determine the effect of the Li-Pro-GP learning model on increasing metacognitive awareness and problem solving skills in biological science learning at the junior high school level. The results of this study are expected to contribute to the development of learning strategies that are relevant to the demands of the 21st century and support the improvement of the overall quality of science education.

METHODS

Research Design

This research uses a quantitative method with a quasi-experimental approach that incorporates a control group but cannot fully regulate foreign variables (Sugiyono, 2018). The design used was a non-equivalent control group design, where the two groups were not randomly selected but given different treatments. In this design, both experimental and control classes are first given a pre-test to determine the initial ability of students, and then a post-test is conducted to measure changes in learning outcomes after treatment in experimental and control classes.

Population and Samples

The population in this study was all students of class VIII in one of the private junior high schools in East Java, consisting of four classes, each with 30 students. The sample was selected using a purposive sampling technique based on the criteria of academic level equality, and the learning material used during the study, namely science with the topic 'Structure and Function of the Body of Living Things', in accordance with the applicable curriculum. This material is considered relevant to develop students' problem-solving skills and metacognitive awareness. Class VIII A, with 30 students, was designated as the control group that followed Problem-Based Learning (PBL). Class VIII B, also with 30 students, was designated as the experimental group that received learning with the Li-Pro-GP model.

Instrument

This study used three types of instruments, namely the metacognitive awareness questionnaire (MAI), problem-solving skills essay test, and learning implementation observation sheet. The MAI questionnaire was adapted from Schraw & Dennison (1994) one that is still widely used and has proven to be valid and reliable in measuring the knowledge and regulation components of metacognition in the educational context (Safitri et al., 2024). The questionnaire consists of 52 items measuring two main components, namely cognitive knowledge (declarative, procedural, and strategic) and cognitive regulation (planning, information management, monitoring, improvement strategies, and evaluation). All items were valid, with Cronbach's Alpha reliability of 0.941. The essay test instrument was developed based on four indicators of problem-solving ability according to Polya (1957), namely understanding the problem, planning the solution, implementing the solution, and checking back. Although it is a classic model, Polya's model remains a solid foundation and is often cited in recent educational research because of its clear and comprehensive framework in the problem-solving process (Putra et al., 2020). The test consisted of 10 questions, but only five questions were declared valid based on the validity test (p -value < 0.05). The reliability test showed a value of 0.850 for the pretest and 0.908 for the posttest, both falling into the high reliability category.

The implementation observation sheet was used to ensure that the learning process in each group was implemented by the syntax of the model that had been designed. The assessment was conducted using the "Yes" and "No" format for the implementation indicators. The percentage of implementation was calculated from the number of "Yes" indicators to the total indicators observed (Jannah et al., 2023). In addition, the LKPD and teaching modules were validated by experts and practitioners, with assessment results of 75.2% and 89.4% for LKPD, and 77.2% and 87.5% for modules, respectively.

Based on these results, all learning tools were declared valid to be used to support the implementation of the learning model in this study.

Procedure

This research procedure includes six stages, namely: (1) Preliminary studies, including initial observations and literature studies to identify problems in the field and formulate research focuses, followed by interviews with science teachers in one of the private junior high schools in East Java; (2) Preparation of learning tools Li-Pro-GP), which is a learning model that combines literacy with project-based learning, and is integrated with the School Literacy Movement (SLM) and Strengthening Character Education (SCE) - which was then validated by experts; (3) Instrument development, including the design of a metacognitive awareness questionnaire (MAI) and a problem solving ability essay test which was reviewed by expert lecturers and tested outside the research sample; (4) Initial measurement (pretest), conducted to determine the initial ability of students in the experimental group and control group; (5) Implementation of learning, with the application of the Li-Pro-GP model in the experimental group, while the control group followed learning with the Problem-Based Learning (PBL) model; and (6) Evaluation and analysis, in the form of giving a posttest to measure changes in learning outcomes, followed by data analysis to determine the effect of learning models on metacognitive awareness and problem solving skills of students which became the basis for drawing conclusions.

To provide a clearer picture of the syntax stages applied to each learning model, the following is a comparison of the syntax of the Li-Pro-GP model in the experimental group and the PBL model in the control group in (Table 1).

Table 1

Comparison of syntax of Li-Pro-GP and PBL learning models.

No.	Li-Pro-GP Model Syntax (Experimental group)	PBL Syntax (Control group)
1.	Starting with the big question: The teacher presents contextual issues related to daily life to build students' awareness. Students read the source (Habituation stage of the SLM) for 15 minutes to spark curiosity. Nationalism and religious values are fostered through relevant issues (SCE).	Orienting students to the problem: Students are introduced to a real problem to analyze together.
2.	Designing a project plan: Students develop a project plan based on literacy information from the enrichment book (Development stage of the SLM). Collaboration between members fosters the value of mutual cooperation and integrity (SCE).	Organizing students to learn: The teacher divides the groups and assists students in designing the investigation.
3.	Making a schedule: Students develop a schedule for project implementation, fostering the values of independence and discipline (SCE). The teacher provides light guidance related to time management.	Guiding the investigation: The teacher monitors students' investigation activities both in groups and individually.
4.	Monitoring the progress of the project: The teacher facilitates periodic reflection and additional reading from literacy resources (Learning stage of the SLM). The values of integrity and mutual cooperation continue to be honed in teamwork (SCE).	Developing and presenting work: Students organize the results of their investigations and present them in a presentation.
5.	Assessing project results: Students conduct inter-group assessments objectively, instilling the value of integrity and appreciation for the work of friends (SCE).	Analyzing and evaluating the problem solving process: Students reflect on the work process and final results with the teacher.
6.	Evaluating the learning experience: Students write personal reflections related to the learning process and results, and reread the material for concept reinforcement (Learning stage of the SLM). The value of independence and nationalism is strengthened (SCE).	

Data Analysis Techniques

The data analysis technique in this study used IBM SPSS software version 26 and Microsoft Excel. Data from pretest and posttest results, both for metacognitive awareness and problem-solving ability, were analysed through several stages. As an initial stage, the prerequisite test of analysis was conducted,

which included normality and homogeneity tests. After the data fulfilled these assumptions, the analysis continued with hypothesis testing using analysis of covariance (ANCOVA) to determine the effect of treatment on the dependent variable by controlling for the pretest score.

Prerequisite tests include normality and homogeneity tests. After the data met the requirements, the analysis continued with the one-way ANCOVA test to determine the difference in posttest scores between the experimental group and the control group by controlling for the pretest score. The results of the normality test are shown in [Table 2](#).

Table 2
Normality Test.

Component	Statistic	DF	Sig.
Metacognitive Awareness	0.097	60	0.200
Problem Solving Skills	0.093	60	0.200

Based on [Table 2](#), the results of the Kolmogorov-Smirnov test analysis show that the residual data from the metacognitive awareness questionnaire are normally distributed, with a value of $D(60) = 0.097$ and $p = 0.200$. Meanwhile, the problem-solving skills test data were also normally distributed with $D(60) = 0.093$ and $p = 0.200$. Referring to the Pratama & Permatasari (2021) criteria, data is said to be normal if the significance value is more than 0.05.

Table 3
Homogeneity Test.

Component	Levene Statistic	df1	df2	Sig.
Metacognitive Awareness	0.017	1	58	0.896
Problem Solving Skills	0.355	1	58	0.554

Based on [Table 3](#), the results of Levene's test show that the variance of metacognitive awareness data between the experimental group and the control group is homogeneous, with a value of $F(1,58) = 0.017$ and $p = 0.896$. Similarly, the problem-solving skills data also showed homogeneity, with a value of $F(1, 58) = 0.355$ and $p = 0.554$. Referring to the criteria put forward by Ulfa et al (2022) the data is said to be homogeneous if the significance value ($p \geq 0.05$). Therefore, it can be concluded that the assumption of homogeneity is met.

RESULTS AND DISCUSSION

This study aims to determine the effect of the Li-Pro-GP learning model on students' metacognitive awareness and problem-solving skills. To measure the effect, a pretest and posttest were conducted in the experimental group and the control group. The average pretest and posttest scores for metacognitive awareness variables are presented in [Table 4](#).

Table 4
Average Pretest Posttest Score of Metacognitive Awareness.

Component	Pretest		Post-test		Gain
	Mean	SD	Mean	SD	
Model Problem Based Learning (PBL)	165,8	27,6	175,8	23,9	10,0
Model Li-Pro-GP	166,7	25,1	219,9	22,8	53,2

Based on [Table 4](#), the average pretest and posttest scores of metacognitive awareness showed an increase in both groups with different learning models. The PBL group increased from 165.8 to 175.8, while the Li-Pro-GP group experienced a more significant increase, from 166.7 to 219.9. This shows that the Li-Pro-GP model is more effective in improving students' metacognitive awareness compared to the conventional PBL model. This result supports Schraw & Dennison (1994) view that metacognitive skills can be developed through a structured and reflective learning approach. In addition, the significant improvement in the Li-Pro-GP group is also in line with the findings of recent research by Pantiwati, Nurrohman et al (2023) which highlighted the effectiveness of project-based learning in improving metacognition

Students' problem-solving skills was also measured through pretest and posttest in both groups. The average scores of each group are shown in (Table 5).

Table 5
Average Pretest Posttest Score of Problem-Solving Skills.

Component	Pretest		Post-test		Gain
	Mean	SD	Mean	SD	
Model Problem Based Learning (PBL)	20,1	8,7	25,9	13,8	5,8
Model Li-Pro-GP	20,8	8,0	45,0	13,0	24,2

Based on Table 5, the average pretest and posttest scores of problem-solving skills increased in both groups. The PBL group increased from 20.1 to 25.9, while the Li-Pro-GP group increased from 20.8 to 45.0. The higher improvement in the Li-Pro-GP group indicates that this model is more effective in developing students' problem-solving skills than the PBL model. This effectiveness can be explained by the Li-Pro-GP approach, which explicitly involves students in the stages of problem identification, planning, implementation, and evaluation of the project, which are in accordance with Polya (1957) problem-solving indicators. In addition, this model emphasises knowledge management, which is crucial for developing problem-solving strategies and higher-order thinking skills (Pantiwati, Nurrohman, et al., 2023).

In addition to analyzing pretest and posttest scores, observations of learning implementation were also made to ensure that each stage in the Li-Pro-GP and PBL models had been implemented according to the designed syntax. Observations were conducted by two observers at each meeting, with the observed aspects reflecting the learning steps in the module. The average results of the implementation during all meetings are presented in Table 6.

Table 6
The average results of the implementation of the learning model.

Component	Average Percentage (%)	Category
Li-Pro-GP Learning Model	97	Very good
Problem Based Learning Model	97	Very good

Based on Table 6, the observation results showed that the average learning implementation in the experimental group (Li-Pro-GP) and control group (PBL) both reached 97%, which is included in the "very good" category. This high level of implementation reflects that the learning process in both groups has taken place in accordance with the syntax of each model consistently. Consistency in learning implementation is important because according to Wahyudin (2023), the application of learning models in accordance with the design stages will affect the effectiveness of learning and the achievement of student learning outcomes. Therefore, the suitability of the implementation with the design in both models supports the validity of the results of this study, especially in comparing the impact of the Li-Pro-GP and PBL models.

Furthermore, to determine the difference in the effect of Li-Pro-GP and PBL learning models on students' metacognitive awareness and problem-solving skills, an analysis of covariance (ANCOVA) was conducted. This test is used because it considers the initial score (pretest) as a covariate to control the initial differences between groups. The ANCOVA test results are presented in Tables 7 and 8.

Table 7
One-way ANCOVA Test Results of Metacognitive Awareness.

Component	Type III Sum of squares	Df	Means square	F	Sig.	Partial Eta Squared
Corrected Model	48566.664 ^a	2	24283.332	111.925	.000	.797
Intercept	5021.593	1	5021.593	23.145	.000	.289
Pre_MAI	19438.597	1	19438.597	89.595	.000	.611
Model	28188.810	1	28188.810	129.926	.000	.695
Error	12366.736	57	216.960			
Total	2410798.000	60				
Corrected Total	60933.400	59				

a. R Squared = .797 (Adjusted R Squared = .790)

Based on [Table 7](#), the results of the one-way ANCOVA test, there is a significant difference in the metacognitive awareness score between the group using the Li-Pro-GP learning model and the group using the PBL model after controlling for the pretest score [$F(1, 57) = 129.926, p = 0.000, \eta^2=0.695$]. The significance value ($p < 0.05$) indicates that the Li-Pro-GP model has a significant effect on increasing students' metacognitive awareness. The partial eta squared (η^2) value of 0.695 indicates that the effect is classified as large. Based on Cohen's criteria in Richardson (2011), the η^2 value above 0.5 the η^2 value above 0.5 indicates a large influence.

This finding supports Schraw & Dennison (1994) theory that metacognitive awareness can be improved through learning approaches that explicitly encourage planning, monitoring, and evaluating the learning process. The Li-Pro-GP model, which emphasizes independent exploration, problem solving, and personal reflection, provides more space for students to actively develop their cognitive regulation. This is in line with the findings in previous research by Chen (2020) which states that learning interventions based on metacognitive strategies can significantly improve students' ability to manage their thinking processes.

Table 8
One-way ANCOVA Test Results of Problem-Solving Skills.

Component	Type III Sum of squares	Df	Means square	F	Sig.	Partial Eta Squared
Corrected Model	12556.286 ^a	2	6278.143	103.886	.000	.785
Intercept	520.302	1	520.302	8.610	.005	.131
Pre_KPM	7045.869	1	7045.869	116.589	.000	.672
Model	4924.186	1	4924.186	81.481	.000	.588
Error	3444.698	57	60.433			
Total	91545.000	60				
Corrected Total	16000.983	59				

a. R Squared = .785 (Adjusted R Squared = .777)

Based on [Table 8](#), the results of the one-way ANCOVA test, there is a significant difference in the problem-solving skills scores between students taught with the Li-Pro-GP model and the PBL model after controlling for pretest scores [$F(1, 57) = 81.481, p = 0.000, \eta^2=0,588$]. The significance value ($p < 0.05$) indicates that the Li-Pro-GP model has a significant effect on students' problem-solving skills. The magnitude of the effect of the learning model on learning outcomes is indicated by the partial eta squared (η^2) value of 0.588, which is classified as a large category. Referring to Cohen's criteria in Richardson (2011), a η^2 value above 0.5 indicates a large influence.

These results reinforce the view that the Li-Pro-GP model that integrates literacy, projects, and reflection in learning allows students to not only understand concepts in depth but also develop systematic and reflective thinking strategies. This finding is also in line with the results of a study by Habibah et al (2023), which emphasized that a learning environment that supports collaboration, exploration, and real problem solving can effectively improve students' critical thinking and problem-solving skills. Therefore, the Li-Pro-GP model is proven to be not only statistically effective, but also pedagogically relevant in improving students' problem-solving skills in a meaningful way.

Effect of Li-Pro-GP learning model on Metacognitive Awareness

The results showed that the Li-Pro-GP learning model had a greater influence on students' metacognitive awareness than the PBL model. This significant increase reflects that the Li-Pro-GP learning syntax is able to foster students' awareness in planning, monitoring, and evaluating their learning process (Pantiwati, Nurrohman, et al., 2023). With a structured and reflective approach, this model encourages students to be more aware of the learning strategies used and be able to manage their thinking processes independently (Pantiwati, Kusniarti, et al., 2023).

This improvement is supported by Li-Pro-GP's systematic syntax, which includes six main stages: starting with a big question, designing a project plan, creating a schedule, monitoring project progress, assessing results, and evaluating (Pantiwati, 2023). In the early stages, students are invited to build declarative knowledge through exploration of concepts and contextual problems (Ardhana, 2020; Lukitasari et al., 2021). Furthermore, when designing projects and making schedules, they develop procedural and conditional knowledge through joint decision-making and strategic planning (Pantiwati,

Kusniarti, et al., 2023). At the monitoring to evaluation stage, students engage in reflective activities to assess the effectiveness of strategies and manage learning consciously (Wardana et al., 2020).

The integration of the School Literacy Movement (SLM) in Li-Pro-GP also strengthens metacognitive awareness. The familiarization stage helps students understand concepts through scientific reading, the development stage encourages them to evaluate information and learning strategies, while the learning stage strengthens the selection of strategies according to project needs (Fajar & Putri, 2020; Rahmi et al., 2023; Setiawan & Dores, 2019). These activities form a complete metacognitive process through planning, monitoring and evaluating skills.

In addition to cognitive and literacy aspects, strengthening character education is also an integral part of Li-Pro-GP. Values such as independence, responsibility, cooperation, integrity, and honesty are instilled through project activities and group reflection (Pantiwati, Nurrohman, et al., 2023; Qosim et al., 2023; Zubaidah, 2019). Students are trained to be objective in assessing work results, open to feedback, and responsible for the roles and decisions taken in the group (Prapnuwanti & Danuwanti, 2022).

The high implementation rate of 97% (Jannah et al., 2023) ensures that the entire syntax is consistently executed, so the measured effect is truly from the application of the model. In contrast to PBL, which emphasizes initial problem solving without an explicit reflective structure, Li-Pro-GP consciously guides students throughout the learning process, from planning to self-evaluation (Chen et al., 2017; Dulyapit et al., 2023; Liu et al., 2019). Thus, Li-Pro-GP can provide a learning space that not only encourages academic achievement but also forms students who are aware of their learning process independently and sustainably.

Effect of Li-Pro-GP learning model on Problem-Solving Skills

The results showed that the Li-Pro-GP model had a stronger effect on students' problem-solving skills than the PBL model. This significant increase shows that the Li-Pro-GP learning syntax can guide students systematically in understanding, planning, implementing, and evaluating problem-solving. With a clear and sustainable structure, Li-Pro-GP encourages students to develop more reflective and purposeful problem-solving strategies (Pantiwati, Kusniarti, et al., 2023).

The Li-Pro-GP syntax, starting from the big question to the evaluation stage, directly supports the mastery of the four problem-solving indicators. Through these stages, students are trained to identify the core of the problem, develop a solution strategy, implement the plan systematically, and conduct a final evaluation of the applied solution (Ayuninrum & Saputra, 2024). Each step in the syntax encourages students' active involvement in instilling the habit of reflecting on the effectiveness of the steps that have been taken. This process as a whole strengthens higher-order thinking skills and the ability to develop logical and measurable solutions (Karina et al., 2022).

The integration of the School Literacy Movement (SLM) strengthens this process through reading, analyzing information, and reflecting on the effectiveness of solutions (González et al., 2022; Harnani et al., 2021). In the early stages, literacy helps students understand the context of the problem through a variety of valid reading sources. Furthermore, students learn to assess the feasibility of information, compare alternative solutions, and integrate the data obtained to support project planning (Anisa et al., 2021). This activity not only enriches insights but also trains critical thinking skills and the selection of appropriate strategies in problem-solving.

In addition, the application of Strengthening Character Education (SCE) values in Li-Pro-GP learning also supports the strengthening of students' problem-solving skills. The value of independence is seen in students' ability to manage time and complete projects responsibly (Sunarni et al., 2024). Cooperation and respect among group members, while integrity is shown through honesty and commitment to work results. Nationalism and religious values are reflected in concern for contextual issues and the habit of praying before activities (Pantiwati, 2023). These five values form a reflective and collaborative attitude that supports the problem-solving process as a whole (Mutholaah, 2022; Pantiwati, 2023; Zubaidah, 2019).

The consistency of learning implementation, which was recorded at 97% (Jannah et al., 2023), indicates that all syntax was implemented as designed. This ensures that the improvement in problem-solving skills is a direct result of the treatment, not external factors. In contrast to PBL, which although supports problem solving, often faces implementation challenges such as time constraints, teacher training, and student participation (Eboi et al., 2024; Hasibuan & Megalina, 2024), Li-Pro-GP provides

more explicit and structured guidance. This approach is proven to be able to form a complete and consistent problem-solving process (Pantiwati, Permana, et al., 2022).

CONCLUSION

The Li-Pro-GP learning model is proven to be able to improve students' metacognitive awareness and problem-solving skills before and after treatment. The increase in scores in the experimental group was supported by the ANCOVA test results, which showed a significant difference ($p < 0.05$) in both variables, namely metacognitive awareness and problem-solving skills, with a large effect size. These findings indicate that the integration of literacy, projects, and character strengthening in the Li-Pro-GP model has a positive impact on Biological Science learning. Therefore, the Li-Pro-GP model is recommended to be applied in other learning subjects to develop higher order thinking skills. In the future, further research needs to be conducted to examine the long-term impact of the application of this model, as well as further testing at other levels of education or subjects to obtain a broader and deeper picture of its effectiveness.

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