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Implementation of Discovery Learning Model to Improve Students' Collaborative Skills in Biology Learning in Secondary Schools

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ABSTRACT
The evolving demands of 21st-century education increasingly emphasize collaborative competencies as core components of global learning goals, including at the senior high school level. In response, this study aims to investigate the implementation of the Discovery Learning model in enhancing the collaborative skills of Grade X.8 students at SMAN 11 Pekanbaru. Employing a descriptive research method, data were collected through structured observations and documentation. The analysis was conducted using descriptive statistical techniques. Findings reveal that the application of Discovery Learning positively influences students' collaborative abilities, particularly in group discussions, laboratory practicums, and material presentations. The structured stages of Discovery Learning provide opportunities for students to actively engage, communicate, and co-construct knowledge, thereby strengthening their interpersonal and team-working skills. The study concludes that the Discovery Learning model is effective in fostering collaboration among students. It further recommends optimizing the educator's role as a facilitator and integrating complementary strategies to enhance the efficacy of the model's implementation in classroom settings.

Keywords*: collaboration skills, discovery learning, learning models*

INTRODUCTION

Twenty-first century education emphasizes the integration of key competencies such as collaboration, communication, critical thinking, and creativity into school curricula worldwide. These skills are now widely acknowledged as essential for preparing students to succeed in an increasingly complex and fast-evolving global landscape. In particular, collaboration and teamwork are critical for personal growth, academic achievement, and future employability. Core 21st-century skills—critical thinking, creativity, communication, collaboration, and digital literacy—are thus foundational to cultivating adaptive, innovative, and resilient learners (Aliyev, 2024; Todorova, 2024; Barus, 2024; Chusna, 2024).

One pedagogical approach that supports the development of collaborative skills is the Discovery Learning model. This student-centered learning strategy engages learners in investigative processes that require them to explore, analyze, and construct knowledge actively. Discovery Learning promotes interaction, teamwork, and shared understanding by positioning learners as active agents in their own learning. It emphasizes experiential learning through

exploration, problem-solving, and the discovery of concepts. According to Iwantoro, Rahmat, and Haris (2022), Discovery Learning fosters greater student autonomy, leading to improved knowledge retention. Fadilah, Sulisworo, and Maruto (2020) found that this model particularly benefits kinesthetic and visual learners through hands-on engagement and meaningful learning experiences.

Collaborative competence has emerged as one of the most crucial skills in contemporary education. Walanda and Napitupulu (2022) define collaboration as involving teamwork and social relationships, while Asrori and Tjalla (2020) emphasize the role of sharing and cooperation. In both educational and professional contexts, collaboration enhances problem-solving capacity, creativity, and overall productivity. Modern workplaces increasingly value candidates who can function effectively within diverse teams to achieve collective goals and address complex global challenges. Likewise, collaboration in educational settings fosters professional development among educators and contributes to improved student learning outcomes (Yadav et al., 2024; Lyu et al., 2023; Remorosa & Paglinawan, 2024).

Despite its potential, the implementation of Discovery Learning in secondary education often encounters several challenges. These include limited student engagement in group activities, insufficient guidance from educators, and discrepancies in students' individual capabilities. While collaboration is vital, effectively cultivating it requires structured pedagogical strategies and responsive facilitation. These challenges highlight the need for ongoing research and innovation in instructional approaches (French et al., 2016).

Previous studies have demonstrated the benefits of Discovery Learning in enhancing students' critical thinking and problem-solving abilities (Alfieri et al., 2011), improving learning outcomes in biology (Risky & Hajar, 2024), and increasing student motivation (Rezki & Hajar, 2024). It has also been linked to academic success as measured by performance outcomes (Ismaeti & Hajar, 2024). However, limited research has specifically examined the impact of Discovery Learning on collaborative skill development, particularly within the context of secondary education in Indonesia. This is a critical gap, considering the growing importance of teamwork and collaboration in academic and professional settings (OECD, 2018).

Indonesia's evolving education system—particularly the implementation of the Independent Curriculum—presents both opportunities and challenges in fostering holistic student development. Given the pressing need to enhance collaboration among students, further research is required to understand how Discovery Learning can be optimally implemented in high school contexts. Moreover, there is a lack of empirical evidence regarding practical strategies that educators can employ to facilitate effective group collaboration within this model.

In light of these considerations, the present study seeks to investigate the extent to which the Discovery Learning model can enhance students' collaborative skills at the senior high school level. Additionally, it aims to identify the challenges and strategic interventions educators can implement to support student collaboration. The findings of this study are expected to contribute to the body of educational literature and inform best practices for fostering collaborative learning in Indonesian classrooms.

METHODOLOGY

This study adopted a quantitative descriptive approach to examine students' collaborative skills during the implementation of the Discovery Learning model in Biology instruction. The descriptive method was deemed appropriate as it aligns with the study's objective—to provide a comprehensive account of collaborative processes grounded in empirical classroom data (Sugiyono, 2019). This methodology enabled a holistic exploration of the learning experience by

analyzing student interactions, group dynamics, and knowledge construction across various stages of learning, such as discussions, practical activities, and presentations (Creswell, 2014). The primary focus was not on academic achievement, but rather on the development and manifestation of collaborative behaviors, including the enabling and constraining factors influencing their emergence during the instructional process.

The research was conducted in Class X.8 at SMA Negeri 11 Pekanbaru during the second semester of the 2023/2024 academic year, with the topic centered on *environmental change*. The school was purposively selected due to its adoption of the Merdeka Curriculum, which emphasizes student-centered learning and skill integration. A cluster sampling technique was employed to ensure internal validity, involving a two-phase procedure: *Homogeneous Class Identification Phase*, Homogeneity was established using academic performance data—specifically, Biology quiz scores from the preceding three months. Data were analyzed using Bartlett's test (to assess variance) and one-way ANOVA (to compare means). Classes yielding a significance value >0.05 were classified as academically homogeneous (Sudjana, 2018). Based on this criterion, three classes demonstrated equivalent academic ability. *Randomization Phase*, From the identified homogeneous classes, one was randomly selected through a closed drawing procedure each class from X.3, X.6, and X.8 was assigned a unique code, which was then placed in sealed envelopes. The drawing process was conducted in the presence of the Biology teacher, who served as an impartial witness to ensure fairness and objectivity. As a result of the drawing, class X.8 was selected as the final research sample.

Data Collection involved two primary techniques: structured observation and video documentation. Observations were guided by a validated instrument designed to capture five core indicators of collaborative skill: (1) positive interdependence, (2) face-to-face promotive interaction, (3) individual accountability, (4) communication skills, and (5) group processing skills. Observational data were gathered across three learning sessions, each involving a different collaborative learning activity: group discussions on environmental problem-solving, ecosystem pollution simulations, and group presentations of findings.

To enrich the observational data and ensure reliability, all sessions were video-recorded. This allowed for frame-by-frame analysis of student behavior and the identification of subtle collaborative interactions potentially overlooked during live observations. The observational instrument was adapted from Lestari & Rahmawati (2024) and validated by two pedagogical experts to ensure content and construct validity. A pilot readability test was also conducted in a non-sample class to assess instrument clarity and functionality. Data Analysis was conducted using both quantitative descriptive (univariate) and qualitative thematic approaches. Univariate analysis included the calculation of frequency distributions, mean scores for each collaboration indicator, and achievement percentages per aspect. The integration of structured observation and video analysis ensured a richer, more reliable dataset, supporting a nuanced understanding of student collaboration in a Discovery Learning context.

This methodological design provides a robust framework for evaluating the development of 21st-century skills—particularly collaboration—within the context of science education. Future research is recommended to adopt quasi-experimental designs to examine the causal impact of Discovery Learning on collaborative abilities, possibly incorporating moderator variables such as students' cognitive styles.

RESULT AND DISCUSSION

The data obtained in this study pertain to students' collaborative skills developed through the implementation of the Discovery Learning model. The findings are presented and analyzed as follows.

Collaborative Skills in Discussion

The results of data analysis show that there has been a development in aspects of students' collaborative skills in discussions through the application of discovery learning in Biology learning in class X.8 SMAN 11 Pekanbaru in the 2023/2024 academic year. The aspects that have increased are: a) attention to problems in the sufficient category (83%), b) students' ability to work together in the sufficient category (83%), c) listening to friends' ideas in the sufficient category (100%), d) group agreement or cohesiveness in the sufficient category (100%). For more details, see Table 1

Table 1. Data on the Development of Students' Collaborative Skills Aspects in Discussion Activities

No	Collaboration aspects	Meeting & Critera					
		I (%)		II (%)		III (%)	
		Not Enough	Enough	Not Enough	Enough	Not Enough	Enough
1.	Attention to problems	50.0	50.0	17.0	83.0	17.0	83.0
2.	Cooperation	50.0	50.0	67.0	33.0	17.0	83.0
3.	Respecting group members' opinions		100		100		100.0
4.	Reaching group agreement	50.0	50.0	50.0	50.0		100.0
	Avarage	**37,5**	**62,5**	**33,5**	**66,5**	**8,5**	**91,5**

The discovery learning model consists of six stages: stimulus, problem identification, data collection, data processing, proof, and generalization. In order to effectively carry out each phase of this model, collaboration among students is essential. According to Alysa (2018), collaboration skills enable individuals, particularly students, to work together efficiently in both understanding and solving problems. Kusumastuti (2022) emphasizes the importance of enhancing student involvement by fostering active participation and critical thinking. Aldalur & Sagarna (2023) further assert that the discovery learning model encourages students to focus more intensely, as they are confronted with real-world problems. Structured group discussions, whether conducted face-to-face or online, play a crucial role in improving students' collaborative skills, as demonstrated by Prayudha (2023), Maryuningsih et al. (2024), and Kandel & Kandel (2023).

Additional studies highlight the necessity for teachers to prepare structured worksheets to facilitate effective student work (Prasetya & Harjanto, 2020; Rosmawati et al., 2024; Muhimmatin & Jannah, 2018). Moreover, the discovery learning model provides ample opportunities for students to cultivate respect for one another within their groups. Arifah et al. (2024) suggest that group members should foster openness and role distribution during group discussions, irrespective of personal friendships. It is critical for teachers to emphasize the establishment of clear agreements within each group, outlining roles and responsibilities. Such agreements help minimize ambiguity and mitigate potential conflicts among team members, as noted by Dodds (2024) and Bringardner et al. (2016).

The results of recent studies indicate a notable increase in students' collaborative skills during discussion activities through the discovery learning model, with improvements reaching an impressive 91.5%. This trend highlights the effectiveness of the discovery learning approach in fostering collaboration. For a clearer perspective, the increase in collaborative skills among

students in discussion activities, specifically in class X at SMAN 11 during the 2023/2024 academic year, is illustrated in Figure 1.

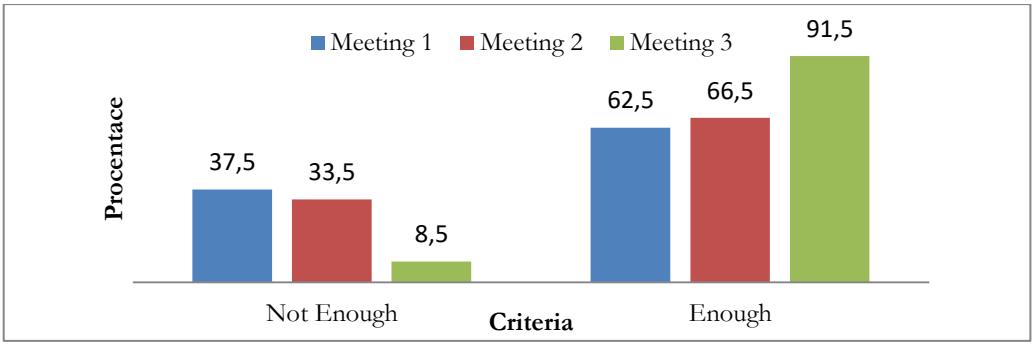

Figure 1. Data on Students' Collaboration Skills in Discussion Activities Through Discovery Learning Model

The findings of this study reveal that collaboration skills during discussions, within the context of the discovery learning model, are predominantly categorized as sufficient (91.5%). Several factors contribute to this outcome. First, in discussion activities, not all students engage actively in addressing the problem at hand. There are still students who adopt passive roles, either by merely listening or following the instructions of more dominant peers, without offering substantial input to the discussion content. This reflects the fact that not all students possess the confidence, communication skills, or understanding of the importance of playing an active role in collaborative efforts.

Furthermore, both educators and students often focus primarily on the cognitive aspects of problem-solving or information gathering, rather than emphasizing cooperation. This limited focus on cognitive outcomes may lead students to prioritize task completion over effective collaboration. The absence of strong discussion skills further exacerbates this issue, causing students to default to communication patterns aimed at solving problems individually, rather than fostering a collaborative environment. Additionally, factors such as limited time and ingrained individualistic learning habits hinder the development of effective collaborative skills, creating barriers to productive teamwork in the discovery learning model.

Students' Collaborative Skills in Practical Activities

The results of the data analysis indicate a significant development in students' collaborative skills during practical activities through the implementation of the discovery learning model in Biology lessons for class X.8 at SMAN 11 Pekanbaru in the 2023/2024 academic year. Key aspects of collaboration that showed improvement in practical activities through this model include: a) cooperation in preparation, which was categorized as very good by 33% of students, b) the observation of experiments, which was rated as very good by 100% of students, and c) teamwork in preparing reports, which was rated as good by 100% of students. For a more detailed overview, refer to Table 2.

Table 2. Aspects of Collaborative Skills in Practicum in the Discovery Learning Model

No	Collaboration aspects	Meeting & Criteria			
		I (%)		II (%)	
		Good	Very Good	Good	Very Good
1	Preparation for the practicum	67	33	67	33
2.	Observingthe experiment	100			100
3.	Compiling a report	100		100	
Average		**89**	**11**	**55,67**	**44,33**

Developing collaborative skills in preparing for practical activities through the discovery learning model is a multifaceted approach that significantly enhances student engagement and teamwork. This approach encompasses various aspects and interrelated steps, ensuring that practical activities are not only effective but also safe and meaningful for students. One critical aspect of this model is the preparation of tools and materials for the practicum. According to Agustina et al. (2024), integrating practicum tools and materials into discovery learning activities plays a crucial role in improving collaboration skills among students. Similarly, Ekaputra (2023) highlights that the preparation phase in discovery learning notably enhances students' collaborative abilities.

Effective preparation requires careful consideration of the types of tools and materials, the students' interests, the research objectives, the contextual relevance of the materials, and the depth of guidance provided. Marthalita et al. (2024) emphasize that ensuring the availability of necessary facilities and equipment is fundamental for the success of the discovery learning model. In this study, students actively investigated the effects of air pollution during the practicum. They engaged in observing, recording, proving, and reporting the results of the experiment. By experiencing and observing firsthand the conditions that plants and animals face, students were able to deepen their understanding of the material within a 25-minute observation period. Risky and Hajar (2024) suggest that practicum activities enhance students' understanding of the material, while Lubis (2020) further asserts that discovery learning encourages students to actively participate in identifying the desired material and independently search for information. For collaborative skills to be effectively developed, experimental observations in the discovery learning model must involve group-based activities. These should include joint discussions, reflection sessions, active problem-solving, and the use of systematic and continuous collaborative observation tools, as highlighted by Saleh et al. (2019). Agustina et al. (2024) also note that discovery learning, particularly in practical settings like laboratory activities, promotes active participation and collaboration among students.

To further enhance collaboration during report preparation in a laboratory setting, engaging in collaborative data analysis is essential. This allows team members to collectively interpret data, foster a shared understanding of the results, and identify patterns that may be overlooked by individuals working in isolation. Additionally, using a shared laboratory notebook helps centralize experimental procedures and observations, facilitates communication, and reduces errors among team members. The results from Class X.8 at SMAN 11 Pekanbaru in the 2023/2024 academic year indicate a notable improvement in students' collaborative skills during practical activities through the discovery learning model. By the second meeting, students reached the very good category, with a collaboration skill rating of 44.33%. For a more detailed overview of the increase in collaborative skills during practical activities through this model, please refer to Figure 2.

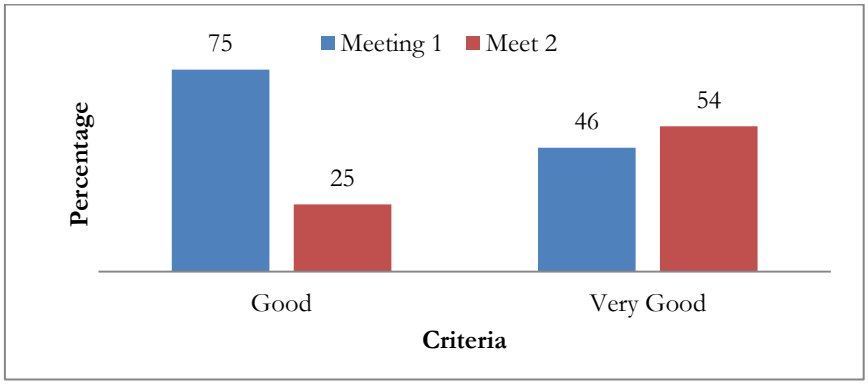

Figure 2. Students' Collaborative Skills in Practical Activities Through the Discovery Learning Model

Based on the results of this study, it can be concluded that collaboration skills in practicums using the discovery learning model are rated as very good, with 54% of students demonstrating effective teamwork. This indicates that a significant portion of students successfully collaborated, contributing to the overall success of the activity. However, it is important to note that there remains a need to strengthen strategies to ensure that all students achieve the highest level of collaboration. To further enhance these skills, improvement efforts can be directed toward promoting equal participation among all students, strengthening communication within the groups, and establishing a routine of group reflection following practicum activities. These strategies will help foster a more inclusive and collaborative environment, ensuring that every student is actively engaged and able to contribute to the group's success.

Collaborative Skills in Presentation Activities

The results of data analysis show that there is a development in aspects of students' collaborative skills in presentation activities through the application of discovery learning in Biology learning in class X.8 SMAN 11 Pekanbaru in the 2023/2025 academic year. The aspects that have increased are in preparation reaching the very good category (50%), presenting material reaching the very good category (50%), maintaining audience focus in presentation activities reaching the good category (100%), and constructive feedback building a team in the good category (100%). For more details, see Table 3.

Table 3. Data on Collaborative Skills Aspects in Presentation Activities in the Discovery Learning Model

No	Collaboration aspects	Meeting & Criteria						
		I (%)			II (%)		III (%)	
		Enough	Good	Very Good	Enough	Good	Very Good	Enough
1.	Preparation	33	50	17	67	33	50	50
2.	Presenting the material	33	67		83	17	50	50
3.	Maintaining focus	17	83		100		100	
4.	Encourage feedback		100		100		100	
	Average	**20.75**	**75**	**4.25**	**87.5**	**12.5**	**75**	**25**

Effective presentation preparation within the context of discovery learning can significantly enhance students' collaborative skills by encouraging them to work together in compiling materials, sharing ideas, and communicating effectively. According to Nainggolan & Purwaningsih (2024), educators can apply various strategies that foster engagement and teamwork. One of these strategies is the teacher's role as a facilitator, guiding students through the discovery process without directly providing answers, as emphasized by Christianto & Chrismastianto (2022). Bicknell-Holmes & Hoffman also contributed to the understanding of discovery learning by organizing its architecture into case study learning, incidental learning, and simulation learning. Ismail et al. (2024) further enhanced this by integrating personalized scaffolding, which involves adjusting teaching methods based on student abilities to ensure support at the right level. Additionally, interactive activities, such as didactic games, are valuable strategies for encouraging engagement and fostering collaboration (Stoffova, n.d.).

In the context of improving collaborative skills in presentations, it is crucial to emphasize clear role division, open communication, and joint practice. Furthermore, enhancing collaborative skills during team presentations in discovery learning requires the application of well-defined task distribution, facilitation of group discussions and reflections, instructor guidance, structured discovery learning cycles, and problem-based learning methods. Group

projects that include presentations and feedback exchanges between teams not only improve collaboration but also enhance communication, problem-solving skills, and a deeper understanding of the material. The data analysis results revealed that collaborative skills during presentation activities in the discovery learning model showed a significant increase, with students in class X at SMA Negeri 11 Pekanbaru reaching the very good category (25%) in the 2023/2024 academic year. For a more detailed overview, refer to Figure 3.

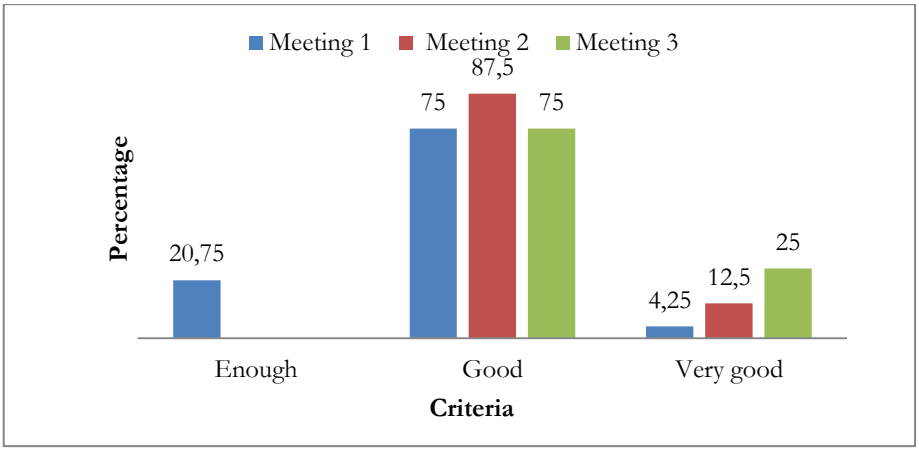

Figure 3. Collaborative Skills in Presentation Activities in the Discovery Learning Model

Based on the results, although excellent collaboration skills are achieved in terms of quality, only a small proportion of students consistently demonstrate exceptional collaboration. This disparity can be attributed to several factors, including imbalanced contributions from team members, low levels of responsibility and compromise, insufficient active participation, less effective learning methods, and constraints related to social and facility factors. As a result, the 25% figure reflects the proportion of students who are truly active and effective in collaborating during presentations, while the remainder still requires improvement. To increase the percentage of students demonstrating excellent collaboration, efforts should focus on promoting an equitable division of tasks, reinforcing responsibility and compromise among team members, and implementing more interactive and collaborative learning methods. Additionally, fostering an inclusive and supportive culture of cooperation within groups is crucial to ensuring that all students are actively engaged and able to contribute effectively to the group's success.

CONCLUSION

Based on the results of the study, it can be concluded that the implementation of the discovery learning model in Biology instruction on the topic of environmental change in Class X.8 at SMA Negeri 11 Pekanbaru during the 2023/2024 academic year significantly enhanced students' collaborative skills across three main learning activities: *Discussion Activities,* Students' collaborative skills in discussion activities were categorized as moderate. During group discussions focused on planning solutions to environmental issues, students engaged in intensive face-to-face interactions. They demonstrated increasing attention to the problems, actively exchanged ideas, and provided constructive feedback to one another. The application of the discovery learning model in this context stimulated critical thinking and collaboration in problem-solving, enhancing not only their conceptual understanding but also their social competence. However, there is room for improvement in ensuring equal participation and deeper engagement from all members during discussions. *Practical Activities*, In practical activities, students' collaborative skills were categorized as very good. During practicum sessions, students worked

together to address real-world environmental challenges, such as simulating the effects of pollution on ecosystems. These activities promoted positive interdependence and individual accountability, as each group member relied on and was responsible for their assigned tasks. Although collaboration was strong, clearer role distribution during the practicum is recommended to further improve teamwork efficiency. This would ensure that each student actively contributes to the task and understands their responsibilities more clearly. *Presentation Activities*, Students' collaborative skills in presentation activities were also categorized as very good. In the final stage of presenting group findings, students developed their communication skills by systematically delivering their results and responding to questions from other groups. This process not only built self-confidence but also reinforced individual accountability, as each student was expected to understand and defend the group's work in front of the class. While the quality of collaboration was strong, ongoing support in fine-tuning presentation skills and role distribution would further enhance team performance and individual contributions in future presentations. In general, this study demonstrates that the discovery learning model is not only effective in achieving cognitive learning objectives but also plays a crucial role in fostering the development of collaborative skills—one of the core competencies needed in the 21st century. The findings highlight the importance of collaboration in the learning process, as students engage more actively and work together to solve problems and share ideas. Future research is recommended to explore additional supporting factors, such as the teacher's role in facilitating collaboration within the discovery learning framework. Understanding how teachers can best guide and support student collaboration will provide valuable insights into optimizing the model. Moreover, further investigation into the impact of discovery learning on students' affective domains, such as their attitudes, values, and emotional responses to learning, will help provide a more comprehensive understanding of the model's effectiveness in promoting holistic student development.

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