

EFFORTS TO IMPROVE STUDENTS' DATA INTERPRETATION AND COLLABORATION SKILLS THROUGH THE IMPLEMENTATION OF THE DISCOVERY LEARNING MODEL

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ABSTRACT

The mastery of students data interpretation and collaboration skills in schools is still relatively low, falling into the “fair” category. Therefore, strategies are needed to improve these skills. This study aims to improve students' data interpretation skills and collaboration skills through the implementation of the discovery learning model. The research employed a Classroom Action Research (CAR) design conducted in two cycles. The subjects were 11 grade X ATPH students. Data were collected using a data interpretation skills test and a collaboration observation sheet, both of which had been content-validated by experts. The results showed that teacher activity increased from 82% in Cycle I to 88% in Cycle II, while student activity increased from 80% to 84%. The average student collaboration skills improved from 54% in the pre-cycle to 66% at the end of Cycle I, and further increased to 72% at the end of Cycle II, with all indicators falling into the collaborative category. Data interpretation skills also showed improvement, with the class average rising from 68% in Cycle I to 77% in Cycle II. These findings indicate that the implementation of the discovery learning model is effective in enhancing students' data interpretation and collaboration skills. This model can serve as an alternative instructional strategy to foster the development of data interpretation and collaboration skills in the classroom.

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1. INTRODUCTION

The Merdeka Curriculum is a learning approach that provides students with greater opportunities to develop competencies and deepen concepts through more flexible learning activities. This curriculum is officially regulated under the Ministry of Education, Culture, Research, and Technology Regulation No. 12 of 2024 as the foundation and structure of the national curriculum across all educational institutions in Indonesia. One of the subjects in the Merdeka Curriculum is Ilmu Pengetahuan Alam dan Sosial (IPAS/Natural and Social Sciences), which integrates several disciplines such as Physics, Biology, Chemistry, Economics, Sociology, and Geography. In this context, Physics plays an important role as it is closely related to daily life and aims to equip students with the ability to understand concepts and solve problems independently. At the vocational high school (SMK) level, learning is not only aimed at

understanding theoretical content but also emphasizes the mastery of practical skills relevant to workforce needs. Data interpretation skills have shifted from being merely technical abilities to becoming a fundamental literacy required by all professionals (Wills, 2014; Frey & Osborne, 2017). Data interpretation and collaboration skills are increasingly essential, as today's workforce demands the ability to analyze information accurately and to work collaboratively in cross-disciplinary teams. However, field realities indicate that students' data interpretation and collaboration skills remain relatively low.

Preliminary observations in Grade X of SMK Negeri 1 Bantan revealed that students' data interpretation skills were at 62% and collaboration skills at 54%, categorized as moderately collaborative. This indicates that many students struggle to understand data-based information, such as graphs and tables, and have yet to demonstrate optimal collaboration skills in group tasks. These conditions are also reflected in learning outcomes that have not reached the Minimum Mastery Criteria (KKM), limited active participation in group discussions, and low efficiency in teamwork. These findings are consistent with previous studies by Purnomo (2017) and Sari (2019), which revealed that the low level of data interpretation ability was caused by learning approaches that were overly theoretical and passive. Similarly, Hidayat and Sulastrri (2023) found that the use of technology in learning was not sufficiently supported by methods that encourage active student engagement. Regarding collaboration, Andriani and Setiawati (2023) reported that students were unable to collaborate effectively due to a lack of facilitated learning strategies that promote structured interaction and teamwork.

To address these issues, the Discovery Learning model is considered a relevant solution. This model provides students with opportunities to actively engage in exploration and the discovery of concepts, both individually and collaboratively, thereby enhancing critical thinking, data interpretation, and collaboration skills. Several studies have demonstrated the effectiveness of this model in secondary education. Setiawan et al. (2021) showed that Discovery Learning improved vocational high school students' data interpretation skills, while Sujono and Lestari (2022) as well as Yuliana and Febrianto (2023) emphasized its benefits in developing collaboration and critical thinking skills. In addition, Ramadhani et al. (2023) found that integrating this model with educational technology accelerated students' understanding of data and improved their ability to solve problems collaboratively.

Nevertheless, research specifically examining the application of Discovery Learning to strengthen both data interpretation and collaboration skills simultaneously remains limited, particularly in the context of IPAS learning within vocational high schools under the Merdeka Curriculum. Therefore, this study aims to explore efforts to improve the data interpretation and collaboration skills of Grade X students at SMK Negeri 1 Bantan through the implementation of the Discovery Learning model. This research is expected to contribute to the development of learning approaches that not only improve academic achievement but also foster students who are capable of critical thinking, effective collaboration, and readiness to face the challenges of a technology- and data-driven workforce.

2. METHODS

This study is a Classroom Action Research (CAR) following the Kurt Lewin model, which consists of four main stages: planning, implementation, observation, and reflection. The purpose

of this study was to improve students' data interpretation and collaboration skills through the application of the Discovery Learning model. The research was conducted at SMK Negeri 1 Bantan in the Grade X ATPH class during the even semester of the 2024/2025 academic year, from January to May 2025. The research design can be seen in Figure 1.

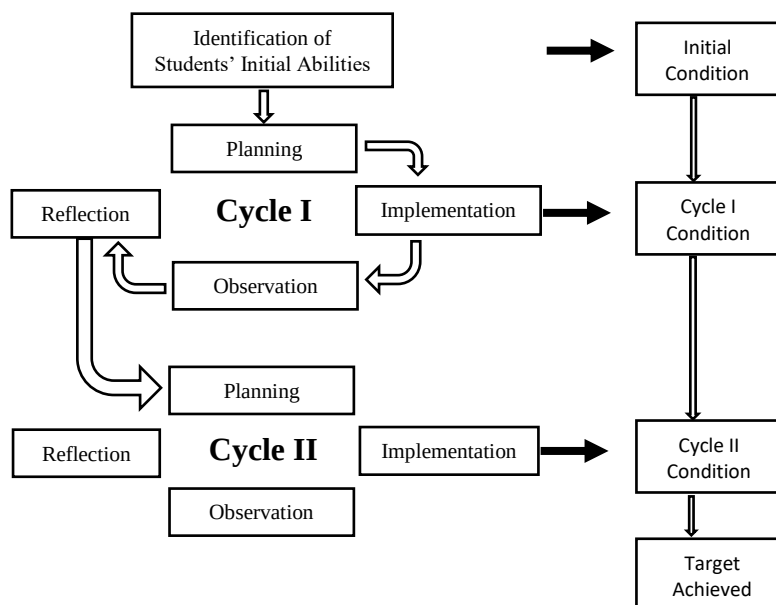


Figure 1. Research Design

The Figure 1 study was designed in two cycles, with each cycle consisting of four meetings. Before implementation, the researcher identified students' initial abilities and prepared learning plans based on the Merdeka Curriculum, including selecting learning outcomes (CP), learning objectives (TP), learning objectives sequence (ATP), and developing a teaching module. The module included lesson plans (module), student worksheets (LKPD), learning media, and assessments aligned with the indicators of data interpretation and collaboration skills. The collaboration skill indicators were developed based on Harlen's framework (2006), as shown in Table 1.

Table 1. Collaboration Skill Indicators

Collaboration Skill Indicator	Statement Indicator
Actively contributing	Always expresses ideas, suggestions, or solutions during discussions
Working productively	Uses time efficiently while staying focused on tasks
Being responsible	Submits the LKPD on time

The Table 1 data collection instruments in this study consisted of observation sheets and written test items. Observations were used to assess teacher activity, student activity, and collaboration skills, while the written test was employed to measure data interpretation skills based on indicators such as connecting observations, identifying patterns/regularities in a series of observations, and drawing conclusions. Data were analyzed quantitatively. Test and questionnaire results were analyzed using percentages and Likert scales to describe the general trends in the

improvement of students' data interpretation and collaboration skills. In addition, the research instruments and learning materials were validated through expert judgment and categorized as valid. The assessment of data interpretation skills was based on students' scores from the written test, whereas collaboration skills were analyzed using observation sheets according to predetermined indicators (active contribution, productive work, and responsibility). The study was considered successful if students' data interpretation skills reached at least 60% mastery at the class level, and collaboration skills indicated that a minimum of 60% of students were categorized as collaborative or highly collaborative. A collaboration score above 60% was deemed indicative of success (Abdulhak & Darmawan, 2013).

3. RESULTS AND DISCUSSION

3.1 Teacher and Student Activities

The improvement of teacher and student activities from the first to the fourth meeting in Cycle I is presented in Figure 2.

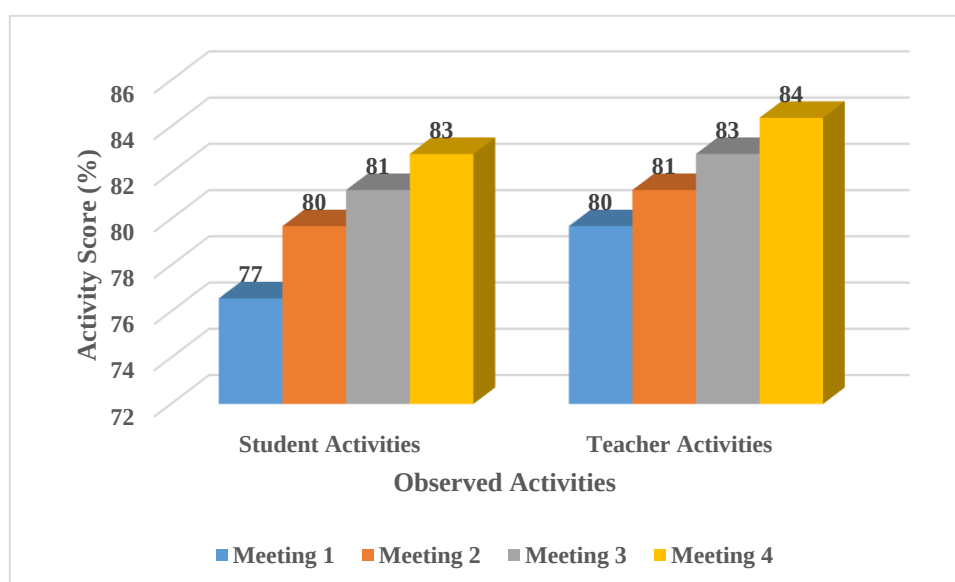


Figure 2. Improvement of Teacher and Student Activities in Cycle I

Based on Figure 2, it can be observed that there was an increase in activities for both students and teachers from the first to the fourth meeting. Student activities in the first meeting reached 77%, then increased to 80% in the second meeting, 81% in the third meeting, and reached 83% in the fourth meeting. This indicates a positive trend and consistent improvement in student participation during the learning process. Meanwhile, teacher activities also showed a significant improvement. In the first meeting, teacher activities were recorded at 80%, rising to 81% in the second meeting, then 83% in the third meeting, and finally reaching 84% in the fourth meeting. This improvement illustrates that teachers became increasingly optimal in managing the learning process over the course of the meetings, thereby creating a more active and conducive learning atmosphere.

The implementation of teacher and student activities in each meeting of Cycle II is presented in Figure 3.

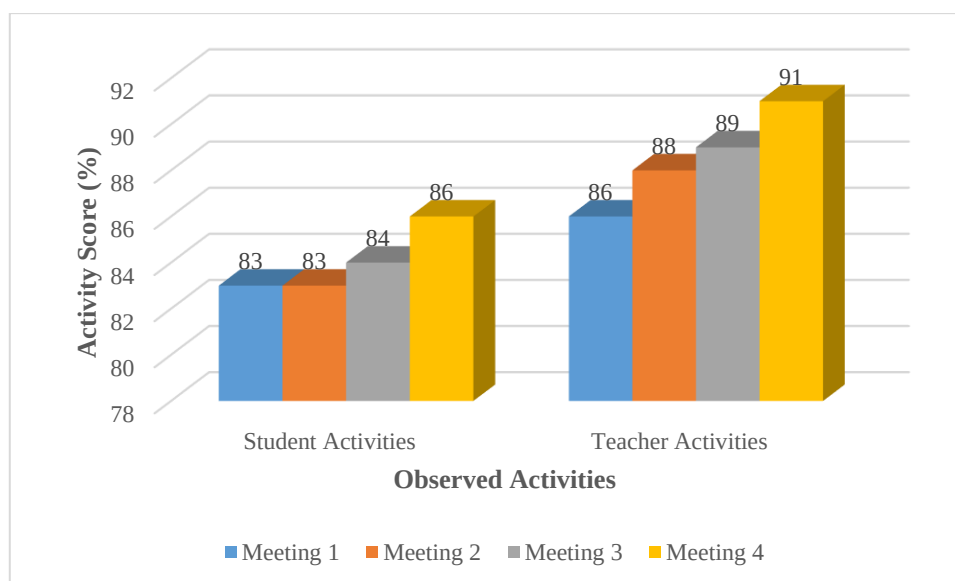


Figure 3. Improvement of Teacher and Student Activities in Cycle II

The findings presented in Figure 3 illustrate a consistent improvement in both teacher and student activities across the four meetings of Cycle II. Student activity, which initially reached 83% in the first and second meetings, gradually increased to 84% in the third meeting and further to 86% in the fourth meeting. This progression suggests that students became more accustomed to the Discovery Learning model, which enhanced their engagement and active participation during the learning process. Similarly, teacher activity demonstrated a steady increase, starting from 86% in the first meeting, rising to 88% in the second, 89% in the third, and ultimately achieving 91% in the fourth meeting. These results indicate that teachers became more effective in implementing instructional steps, guiding learners, and managing classroom dynamics. The gradual increase also reflects the teachers' growing adaptability and mastery in facilitating learning activities.

These results are consistent with a wide body of research highlighting the pivotal role of teachers in shaping student engagement. A cross-context meta-analysis by Xue, Li, and Shen (2022) demonstrated that teacher–student relationships and positive teacher behaviors are moderately correlated with student engagement ($R=0.46$ and $R=0.42$, respectively). Similarly, Hussein and Othman (2025) found that students' perceived support from teachers is strongly associated with higher motivation, greater engagement, and improved academic achievement. Evidence from the PISA 2022 report (OECD, 2025) further reinforces this perspective, showing that supportive teacher–student interactions foster a stronger sense of belonging, higher achievement, and reduced anxiety among students.

From the pedagogical perspective, these findings align with Rahman et al. (2024), who confirmed that appropriate teaching strategies contribute positively to student engagement. Mulyani (2024) further emphasized that the teacher's role as a facilitator is central in providing guidance, structuring learning activities, and ensuring meaningful evaluation. The current study provides empirical support for these arguments, as the consistent improvement in teacher activity was accompanied by a corresponding rise in student engagement. Moreover, the findings corroborate previous studies on the Discovery Learning model. For instance, Novita, Irawati, and Jumiarni (2023) reported that Discovery Learning significantly enhances both teacher and student activities across learning cycles. Likewise, Khairun Nisa et al. (2024) documented that the

implementation of innovative activity-based learning models consistently resulted in improvements in classroom engagement.

Taken together, these findings highlight that the progressive improvement in teacher facilitation directly contributes to the enhancement of student participation and engagement. This underscores the importance of the teacher's role as a facilitator, not only in delivering content but also in cultivating an active, supportive, and conducive learning environment. Based on the results of the study, the average percentage of teacher and student activities in learning using the Discovery Learning model in Cycles I and II is presented in Table 2.

Table 2. Teacher and Student Activities in Cycles I and II

No.	Activity	Cycle I	Cycle II	Increase
1	Teacher Activity	82%	88%	6%
2	Student Activity	80%	84%	4%

The observation data in Table 2 indicate a positive increase in both teacher performance and student engagement across the two learning cycles. In terms of teacher activity, the percentage increased from 82% in Cycle I to 88% in Cycle II, reflecting a 6% improvement. This suggests that the teacher became more effective in fulfilling the role of a learning facilitator. The teacher demonstrated more structured delivery of materials, provided guidance, motivated students, and managed the classroom more effectively. This finding is consistent with Ni'mah & Agustina (2024), who reported that Discovery Learning, when integrated with digital media, significantly enhances teacher and student activity by encouraging affective, cognitive, and psychomotor engagement.

For student activity, the percentage rose from 80% in Cycle I to 84% in Cycle II, an improvement of 4%. This increase shows that students became more actively involved in learning activities such as group discussions, observations, data processing, and presenting their work. High student activity reflects a learner-centered environment, as emphasized by Bruner's Discovery Learning model, which focuses on active learning through exploration and discovery. This is in line with the findings of Heryana (2022) and Safitri & Azizah (2023), who stated that Discovery Learning fosters interactive classrooms, encourages questioning, promotes discussion, and involves students in problem-solving.

3.2 Students' Collaboration Skills

The data interpretation skills trained in this study involved connecting observations, identifying patterns or regularities in a series of observations, and drawing conclusions using the Discovery Learning model. The average score for students' data interpretation skills is presented in Figure 4.

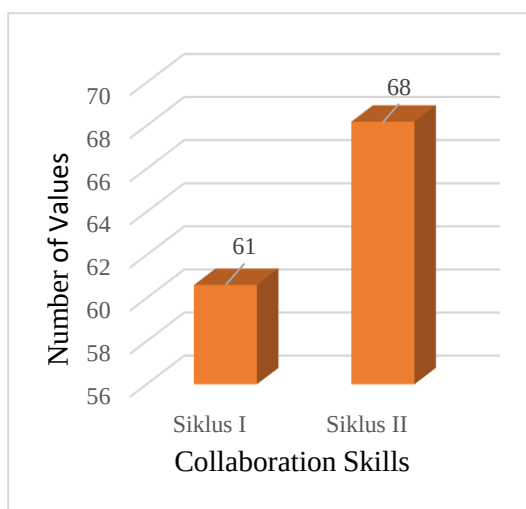


Figure 4. Graph of Students' Collaboration Skills Development

The Figure 4 average collaboration skill score of students increased from the “fairly collaborative” category in the pre-cycle (54%) to the “collaborative” category at the end of Cycle II (68%). In Cycle I, the final collaboration score was 66%, and all indicators showed improvement in Cycle II. These findings are consistent with Sukarjita & Tae (2025), who reported that Discovery Learning with a collaborative approach can enhance students' teamwork skills, including active contribution, productivity, and a sense of responsibility. This improvement reflects students' growing ability to demonstrate collaborative behaviors, such as contributing to group discussions, working productively with group members, and showing responsibility for assigned tasks.

The improvement in collaboration skills can also be observed through the predetermined indicators, as presented in Table 3.

Table 3. Students' Collaboration Skills by Indicator

No.	Indicator	Cycle I	Cycle II	Increase
1	Active Contribution	61%	67%	6%
2	Productive Work	55%	65%	10%
3	Responsibility	65%	73%	7%

The Table 3 improvement in students' collaboration skills over the two learning cycles was reflected in three indicators: active contribution, productive work, and responsibility. All three indicators showed an increase in achievement percentage from Cycle I to Cycle II, indicating positive development in students' collaborative abilities following the implementation of the Discovery Learning model.

For the active contribution indicator, students' achievement rose from 61% in Cycle I to 67% in Cycle II, representing an increase of 6%. This improvement suggests that students began to demonstrate greater participation in their groups, both in presenting ideas, providing feedback, and engaging in group discussions. Furthermore, for the productive work indicator, there was a 10% increase, from 55% in Cycle I to 65% in Cycle II. This was the highest improvement among the three indicators. It indicates that students started to demonstrate the ability to complete group tasks efficiently, distribute roles fairly, and maintain focus on shared goals throughout the learning process. For the final indicator, responsibility, the score increased from 65% in Cycle I to 73% in

Cycle II, representing a 7% improvement. This shows that students are increasingly aware of the importance of taking responsibility for their tasks and roles within the group, such as completing the portion of work assigned to them and maintaining commitment to group agreements. This finding is consistent with Ni'mah & Agustina (2024), who reported that technology-based Discovery Learning encourages students to work more efficiently, share roles effectively, and maintain focus on learning objectives.

Overall, the improvement in all three collaboration skill indicators demonstrates that the application of the Discovery Learning model has positively contributed to the development of students' teamwork abilities. The model provides opportunities for students to actively participate in discussions, share roles, and learn to take responsibility both individually and as a group. Nevertheless, these collaboration skills still need to be continuously improved through consistent, reflective, and collaborative learning practices.

3.3 Students' Data Interpretation Skills

Data interpretation skills were measured through three indicators: (1) connecting observations, (2) identifying patterns or regularities, and (3) drawing conclusions. Improvements were seen in all three indicators from Cycle I to Cycle II, as shown in Table 4.

Table 4. Students' Data Interpretation Skills by Indicator

No	Indicator	Cycle I	Cycle II	Increase
1	Connecting Observations	73%	75%	2%
2	Identifying Patterns/Regularities	59%	63%	4%
3	Drawing Conclusions	73%	75%	2%

Based on the data in Table 4, there was an improvement in students' data interpretation skills across all three indicators observed during the two learning cycles. These results are consistent with Tsai (2024), who revealed that active learning with an emphasis on data analysis can enhance interpretation skills, critical thinking, and the ability to draw logical conclusions. For the indicator of connecting observations, the percentage of achievement increased from 73% in Cycle I to 75% in Cycle II, an improvement of 2%. This shows that students began to be able to relate various observations obtained during the learning process, although the increase remains relatively low.

The indicator of identifying patterns or regularities in a series of observations showed a more significant improvement compared to the other indicators. In Cycle I, achievement for this indicator was 59%, increasing to 63% in Cycle II, representing a 4% improvement. This reflects the development of students' ability to recognize patterns and regularities based on observed data or phenomena, although the achievement level is still relatively low and requires greater attention in future lesson planning. Meanwhile, for the indicator of drawing conclusions, achievement increased from 73% in Cycle I to 75% in Cycle II, a 2% improvement. This indicates that students began to draw conclusions based on their observations, although the improvement was not highly significant.

Overall, the three indicators of data interpretation skills showed improvement from Cycle I to Cycle II, with the highest increase in the indicator of identifying patterns/regularities. Although

the improvement is still in the low category, the results indicate that efforts to improve learning through the implemented Discovery Learning model have begun to positively impact students' data interpretation skills. Therefore, it is necessary to strengthen the lower-achieving indicators through more varied and student-centered learning approaches.

The mastery level of data interpretation skills among students varied in Cycle I. Classically, the average score of students' data interpretation skills was 70. Out of 11 Grade X ATPH students, 6 students did not achieve mastery, while 5 students did. The percentage of classical mastery can be seen in Figure 3.4. In Cycle II, the classical average score of data interpretation skills increased to 77. Out of 11 students, 4 did not achieve mastery and 7 students did. The percentage of classical mastery is presented in Figure 5.

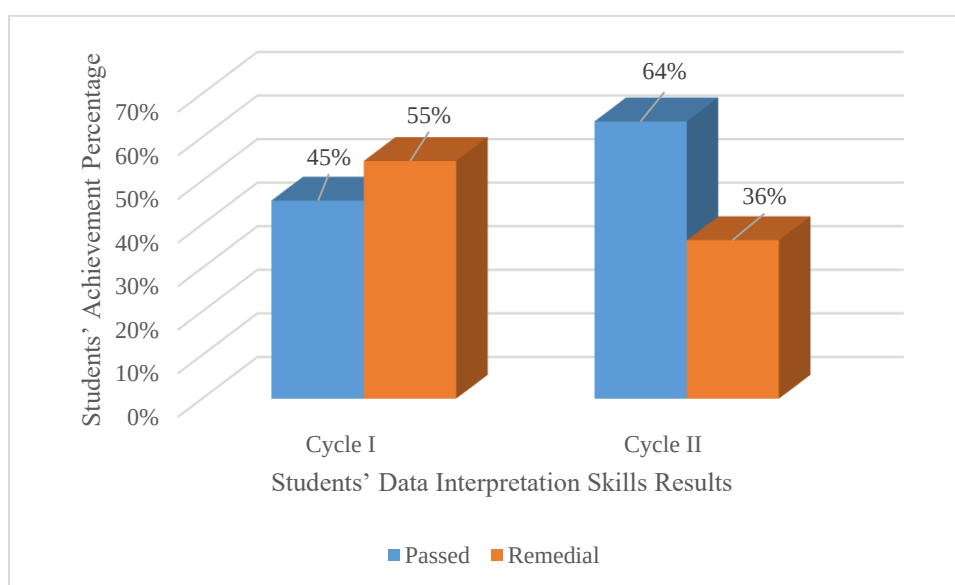


Figure 5. Mastery of Data Interpretation Skills

Figure 5 illustrates an improvement in student learning outcomes from Cycle I to Cycle II. In Cycle I, the percentage of students who achieved mastery was only 45%, while those who had not yet reached mastery remained relatively high at 55% and were required to undergo remedial activities. This indicates that the actions taken in the first cycle were not fully effective in helping the majority of students meet the minimum mastery standard. After improvements were made in the learning process during Cycle II, the number of students who achieved mastery increased to 64%, while those requiring remedial work decreased to 36%. Thus, there was a 19% increase in mastery and an equivalent decrease in remedial cases. These results show that the improvement strategies implemented in the second cycle had a positive impact on students' understanding.

Despite the increase in mastery from Cycle I to Cycle II, 36% of students still did not meet the minimum standard. The low performance of some students can be attributed to several factors. First, a lack of learning motivation led certain students to be less active in classroom activities. This finding is in line with Slavin (2015), who emphasizes that variations in student motivation significantly influence learning outcomes. Second, there were notable differences in students' prior knowledge, which made the process of concept discovery in the discovery learning model more challenging for those with lower initial abilities. This is consistent with Bruner's (1961) assertion that the effectiveness of discovery learning is strongly influenced by students' readiness and cognitive capacity. Third, limited instructional time also posed a challenge, as students

required adaptation to become accustomed to the inquiry-based steps of discovery learning. Similar results were reported by Putra and Dewi (2020), who found that time constraints are one of the main obstacles in implementing discovery-based learning in classrooms.

Therefore, motivation, prior knowledge, and time constraints provide scientific explanations for the relatively low performance of some students in this cycle. Compared with previous research, these findings confirm that the success of discovery learning is not only determined by instructional design but also by students' internal conditions and the availability of sufficient learning time. Consequently, teachers need to implement differentiated strategies, provide additional guidance, and strengthen students' motivation so that all learners can achieve mastery in subsequent cycles.

4. CONCLUSION

Based on the results of the classroom action research conducted over two learning cycles using the discovery learning model, it was found that students' data interpretation skills and collaboration skills showed positive improvement. Initially, both skills were not yet optimal, particularly in recognizing data patterns and contributing actively to group work. However, after the implementation of discovery learning, data interpretation skills improved through students' ability to connect observations, identify patterns, and draw conclusions more independently. Meanwhile, collaboration skills also increased, as demonstrated by active participation, a more balanced division of roles, and greater responsibility in completing group tasks. This success was supported by the provision of direct learning experiences, group discussions, and strategic guidance from the teacher, which encouraged students to think critically while working together productively. Therefore, it can be concluded that the implementation of discovery learning is effective in enhancing students' data interpretation and collaboration skills, while also fostering a more active, interactive, and meaningful learning environment.

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