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The Effect of Differentiation Implementation in the Discovery Learning Model on Communication Skills and Learning Outcomes

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Abstract: This study aims to examine the effect of implementing differentiated instruction within the Discovery Learning model on students' communication skills and learning outcomes. This research employed a quasi-experimental design with a posttest-only control group, involving 55 eleventh-grade students at SMAN 2 Bantaeng in the 2025/2026 academic year. The experimental class received differentiated Discovery Learning, while the control class was taught using conventional Discovery Learning. Data were collected through observation (communication skills) and essay tests (learning outcomes), and analyzed using descriptive and inferential statistics, including MANOVA. The results showed that students in the experimental class achieved higher communication skills than those in the control class. The mean score of oral communication in the experimental class (89.87) was higher than in the control class (77.08), while written communication scores were 87.99 and 75.38, respectively. In addition, 51.72% of students in the experimental class were categorized as very skilled, whereas no students in the control class reached this category. Learning outcomes also showed significant differences, with the experimental class achieving a higher average score (85.14) compared to the control class (75.85). Most students in the experimental class were in the high (75.86%) and very high (13.79%) categories, while the control class was dominated by the moderate category (84.62%). These findings indicate that the integration of differentiated instruction within the Discovery Learning model is effective in improving students' communication skills and learning outcomes. This approach supports more equitable learning, accommodates diverse student needs, and promotes the development of essential 21st-century skills such as critical thinking, collaboration, and communication.

Keywords: Biology education; Communication skills; Differentiated instruction; Discovery learning; Learning outcomes

Introduction

Education is one of the fundamental aspects that plays a crucial role in improving the quality of human resources. Through education, students are expected to develop learning and innovation skills, as well as the ability to utilize information technology effectively. In the 21st century era, the rapid and limitless advancement of information and communication technology requires students to master relevant skills (Yevira, 2023). One of the essential skills that must be possessed is communication skills, which are included among the twelve key skills required for students (Yunizha, 2022).

Communication cannot be separated from the learning process, as learning essentially involves the exchange of information, both intrapersonal and interpersonal. Intrapersonal communication includes activities such as thinking, remembering, and perceiving, while interpersonal communication occurs through the delivery of ideas, information, and messages to others. For learning to be effective, the

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conveyed messages must be well understood by students. Therefore, communication skills are essential for students to express their ideas clearly and appropriately. Furthermore, communication skills contribute to creating an active learning environment where students have the confidence to present arguments (Ginting et al., 2024).

In modern education, the learning paradigm has shifted toward a student-centered approach. Education that prioritizes students places them as the main focus whose needs must be facilitated to ensure optimal growth and development. In line with the implementation of the Merdeka Curriculum in Indonesia, learning approaches emphasize meeting the diverse needs of students (Ansori et al., 2023; Hunaepi & Suharta, 2024). Each student is considered to have unique potential, interests, and characteristics; therefore, appropriate strategies must be tailored to accommodate these differences.

One of the key characteristics of student-centered learning is differentiated instruction. Differentiated learning is a strategy that allows teachers to adjust content, process, product, and learning environment based on students' readiness, interests, and learning profiles (Mumpuniarti, 2023; Sigalingging, 2023). This approach creates an inclusive, flexible, and effective learning environment, enabling all students to achieve optimal learning outcomes.

In addition to differentiation strategies, the selection of an appropriate learning model is also crucial in improving the quality of learning. One effective model in developing students' scientific thinking and communication skills is Discovery Learning. This model places students at the center of the learning process by providing opportunities to discover concepts or principles independently through exploration, investigation, and inquiry activities (Septiana, 2026). Discovery Learning is grounded in constructivist theory, where knowledge is constructed through direct and reflective experiences (Ozdem-Yilmaz & Bilican, 2025; Sawah & Kusaka, 2023). Thus, this model encourages students to think actively, engage in discussions, and communicate ideas in understanding concepts, thereby improving both conceptual understanding and learning outcomes (Suryobroto, 2009).

The integration of differentiated instruction within the Discovery Learning model is believed to create more effective and meaningful learning experiences. Differentiated instruction provides flexibility in addressing diverse learning needs, while Discovery Learning fosters activeness, curiosity, and scientific thinking skills. The combination of both approaches is expected to create a learning environment that is engaging, challenging, and aligned with students' characteristics.

In the context of biology learning, particularly on the topic of the human movement system, this approach is highly relevant because the material requires deep conceptual understanding, scientific thinking skills, and the ability to communicate observation or experimental results. However, several studies have shown that students' scientific communication skills are still relatively low. Research conducted by Rachmawati et al. (2025) found that high school students' scientific communication skills in biology learning were in the low category, especially in interpreting observational data and presenting conclusions in written form. Students experienced difficulties in connecting theory with practical results and presenting them systematically in reports.

Similarly, Agustina (2021) reported that the low level of students' communication skills is caused by limited opportunities to actively participate in discussions and presentations. Learning activities are still dominated by lecture methods, resulting in students being less trained in expressing opinions and constructing scientific arguments.

These findings are consistent with the results of observations conducted by the researcher in class XI of SMAN 2 Bantaeng in July 2025, which showed that approximately 40% of students were not actively engaged in discussions, lacked confidence in asking and answering questions, and tended to rely on reading text during presentations without interacting with the audience. This indicates that students' communication skills remain low.

Furthermore, data from the 2025 Education Report of SMAN 2 Bantaeng shows that the learning quality indicator is in the moderate category, with a score of 59, which has decreased compared to the previous year. This condition indicates the need for improvement in learning methods that are more interactive and aligned with students' characteristics to enhance learning quality, particularly in communication skills and learning outcomes. Learning outcomes refer to the abilities acquired by students after undergoing the learning process as a result of their learning experiences.

In line with these needs, several previous studies have shown that the implementation of appropriate learning strategies can improve learning quality. Research by Putri & Wardani (2024) demonstrated that the application of differentiated instruction within the Discovery Learning model significantly improved students' communication skills, with an increase of 89%. Similarly, Basir et al. (2023) found that differentiated learning based on Discovery Learning improved

students' learning outcomes from 75% in the first cycle to 91% in the second cycle.

Based on the above explanation, it can be concluded that the integration of differentiated instruction in the Discovery Learning model has great potential to improve students' communication skills and learning outcomes, particularly in biology learning on the human movement system topic. Therefore, this study aims to examine the effect of implementing differentiated instruction within the Discovery Learning model on students' communication skills and learning outcomes at SMAN 2 Bantaeng.

Method

This study uses a Systematic Literature Review (SLR) to This study employed a quasi-experimental design with a quantitative approach, involving one independent variable and two dependent variables. The research utilized a posttest-only control group design, in which two classes were randomly selected: one as the experimental group and the other as the control group (Sugiyono, 2019). The experimental class was taught using a Discovery Learning model integrated with differentiated instruction (process and product differentiation), while the control class received Discovery Learning without differentiation.

The population consisted of 55 eleventh-grade students, with samples selected through random sampling. Class XI.B was assigned as the experimental group, and class XI.E as the control group. The study was conducted during the 2025/2026 academic year at SMAN 2 Bantaeng.

The independent variable was the implementation of differentiated instruction within the Discovery Learning model, while the dependent variables were students' communication skills and learning outcomes. Communication skills were measured through both oral and written indicators using an observation instrument consisting of 18 items. Learning outcomes were measured using a posttest in the form of 10 essay questions related to the human movement system topic.

The research procedure consisted of three stages: preparation, implementation, and final stage. During the implementation phase, both groups underwent six learning sessions. The experimental group received differentiated Discovery Learning, while the control group experienced standard Discovery Learning. Observations of communication skills were conducted during the learning process, and a posttest was administered at the end.

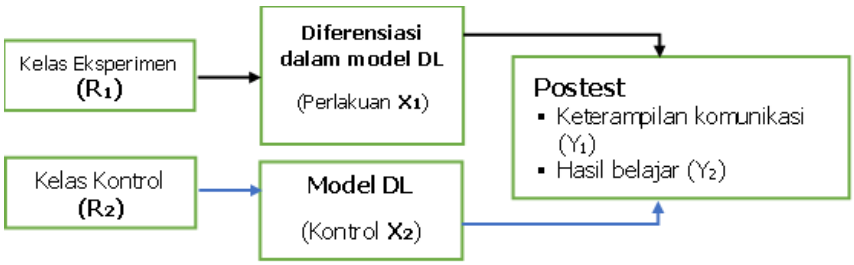

Figure 1. Research Design Diagram

Data were collected using non-test (observation) and test (essay test) techniques. The instruments were validated by experts prior to use. Data analysis included descriptive statistics (mean, standard deviation, percentage, and categorization) and inferential statistics. Prior to hypothesis testing, normality was tested using the Shapiro-Wilk test, and homogeneity was tested using Levene's test and Box's M test. Hypothesis testing was conducted using MANOVA to examine the simultaneous effect of the independent variable on both dependent variables, followed by ANOVA for partial effects, with a significance level of 0.05.

Result and Discussion

This section presents the results of data analysis obtained from the research instruments, which were analyzed using both descriptive and inferential statistics to answer the research questions and to determine the effect of differentiated instruction within the Discovery Learning model on students' communication skills and learning outcomes. Students' communication skills, both oral and written, were measured after the implementation of the learning treatments, where the experimental class received differentiated instruction integrated into the Discovery Learning model, while the control class was taught using Discovery Learning without differentiation. The descriptive results indicate that students in the experimental class achieved higher levels of oral communication skills compared to those in the control class. In the experimental class, 51.72% of students were categorized as very skilled and 48.28% as skilled, whereas in the control class, 89.66% of students

were categorized as skilled, with none reaching the very skilled category.

This finding is further supported by the mean score of oral communication skills, where the experimental class obtained a higher average score (89.87) compared to the control class (77.08). In addition, the experimental class demonstrated a higher minimum score (82.20 compared to 62.20) and lower variability (SD = 3.81 compared to 5.93), indicating more consistent and evenly distributed performance among students. A similar trend was observed in written communication skills, where the experimental class showed better performance than the control class. In the experimental class, 72.41% of students were categorized as skilled and 27.59% as very skilled, with no students in the lower categories, while in the control class there were still students categorized as fairly skilled (3.45%) and only 10.34% reached the very skilled level. The mean score of written communication in the experimental class (87.99) was also higher than that of the control class (75.38), accompanied by a higher minimum score and lower standard deviation, which indicates a more homogeneous distribution of students' abilities.

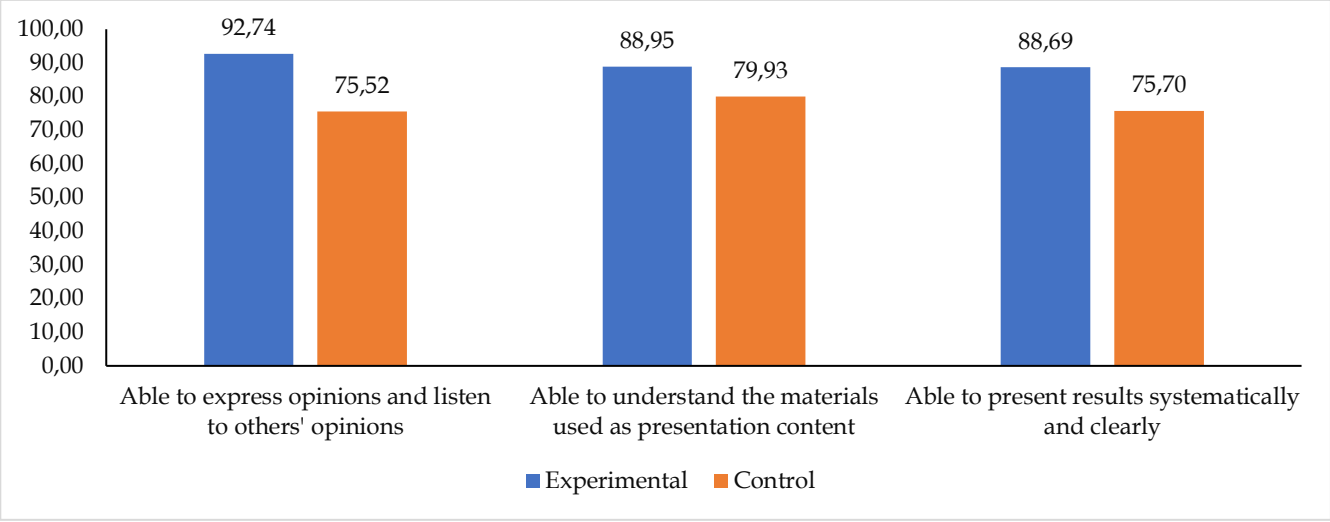

Figure 2. Oral skill

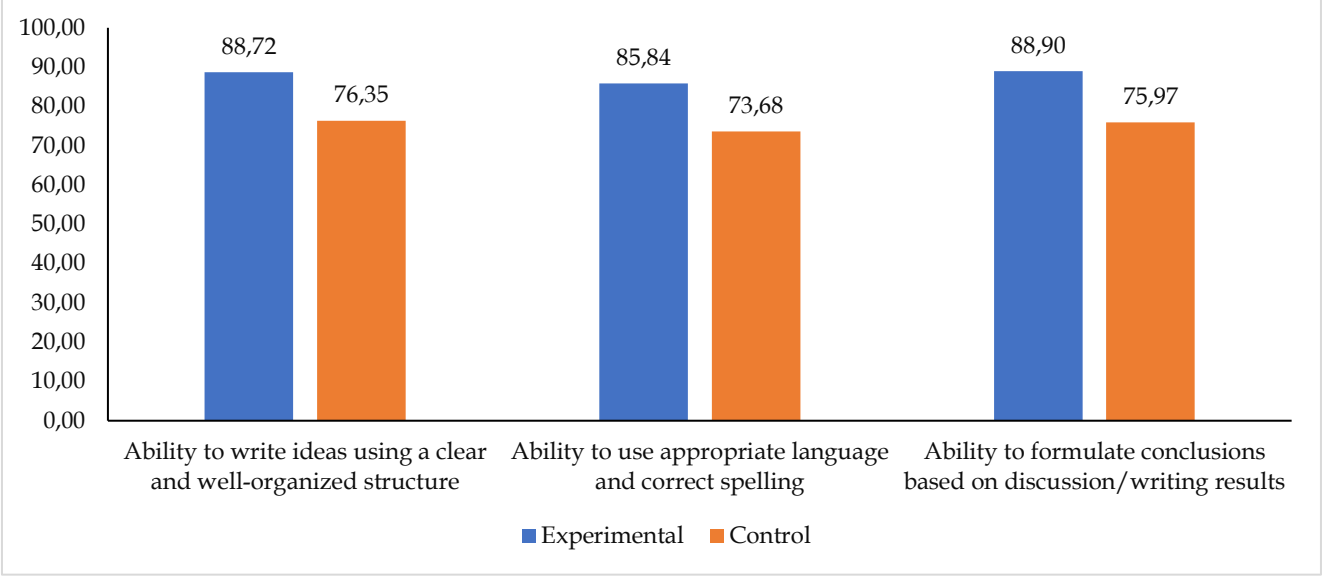

Figure 3. Written Skills

Furthermore, analysis based on communication skill indicators revealed that students in the experimental class consistently outperformed those in the control class across all aspects. The highest oral communication indicator in the experimental class was the ability to express and respond to opinions (92.74%), whereas in the control class the highest score was found in understanding presentation materials (79.93%). In terms of written communication, the highest score in the experimental class was in constructing conclusions

(88.90%), while the control class showed relatively lower performance across all indicators. These findings suggest that the integration of differentiated instruction within the Discovery Learning model contributes to improved and more evenly distributed communication skills among students.

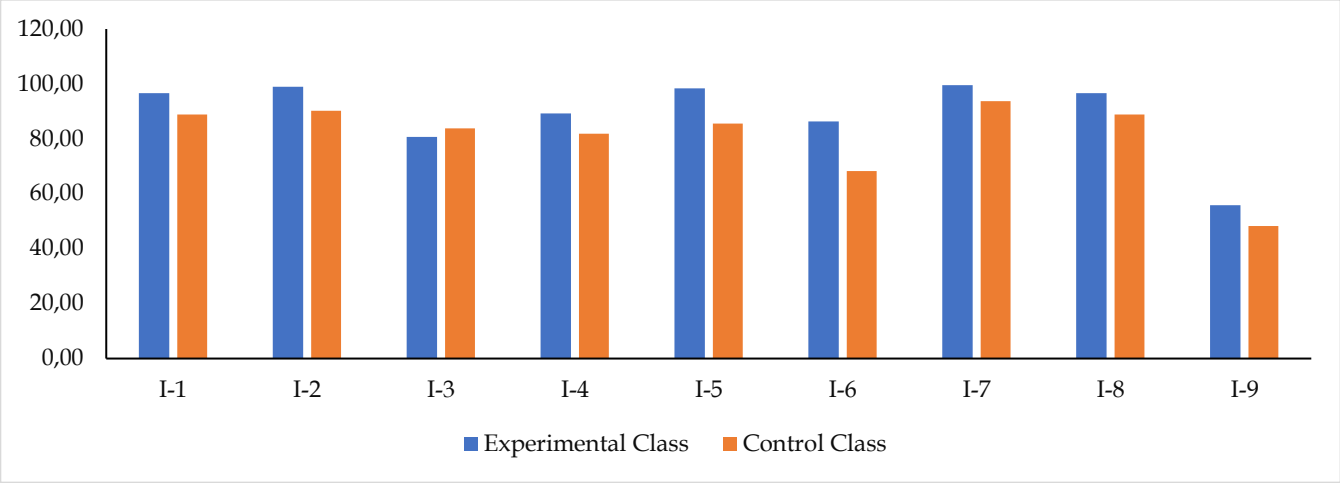

Figure 4. Learning Outcomes per Indicator in the Experimental Class and Control Class

Students' learning outcomes were measured through a posttest administered after the implementation of the learning treatments, where the experimental class received differentiated instruction integrated into the Discovery Learning model, while the control class was taught using Discovery Learning without differentiation. The descriptive results indicate a clear difference in learning outcomes between the two groups. In the experimental class, the majority of students were categorized in the high achievement level (75.86%), followed by those in the very high category (13.79%), and only a small proportion in the moderate category (10.34%), with no students classified in the low or very low categories. In contrast, the control class was predominantly in the moderate category (84.62%), with only 15.38% reaching the high category and none achieving the very high category. This distribution suggests that students in the experimental class demonstrated better mastery of the learning material compared to those in the control class. This finding is further supported by the mean scores, where the experimental class achieved a higher average score (85.14) than the control class (75.85).

Additionally, the experimental class recorded a higher maximum score (91 compared to 83) and a higher minimum score (76 compared to 69), indicating that not only high-achieving students benefited from the treatment, but also those with lower initial abilities were able to reach better outcomes. In terms of data distribution, the standard deviation of the experimental class (4.04) was slightly higher than that of the control class (3.50), although both values indicate relatively homogeneous data. The relatively similar variance and range between the two groups suggest that the observed differences in learning outcomes were primarily influenced by the learning treatment rather than initial differences in student ability. Furthermore, analysis based on learning indicators revealed that students in the experimental class consistently outperformed those in the control class across most indicators, particularly in higher-order thinking skills such as analysis and evaluation. However, both groups showed relatively lower performance on the most complex indicator, indicating that certain topics remained challenging for students regardless of the instructional approach. Overall, these findings demonstrate that the implementation of differentiated instruction within the Discovery Learning model contributes to higher and more evenly distributed learning outcomes among students compared to the use of Discovery Learning without differentiation.

Discussion

This study aims to determine the effect of implementing differentiated instruction within the Discovery Learning model on students' communication skills and learning outcomes. The results indicate a significant difference between the experimental class (Differentiated Discovery Learning) and the control class (conventional Discovery Learning), suggesting that the differentiation treatment has a positive impact.

In the experimental class, differentiation was carried out by adjusting the learning process and products based on students' learning styles. Students received materials in various forms (handouts, videos, and PowerPoint presentations) and presented their

learning outcomes in diverse formats, such as oral presentations, written work, and visual media. Meanwhile, the control class applied a uniform approach without variation in instructional strategies.

The findings show that both oral and written communication skills of students in the experimental class were higher than those in the control class. In terms of oral communication, the experimental class was dominated by the "very skilled" category (51.72%), while the control class was only in the "skilled" category. The average score of oral communication in the experimental class (89.87) was higher than that of the control class (77.08). A similar pattern was observed in written communication, with the experimental class achieving a higher average score (87.99) compared to the control class (75.38). In addition, the higher minimum scores and lower standard deviation in the experimental class indicate a more evenly distributed development of students' abilities.

These findings suggest that differentiated instruction provides opportunities for students to learn according to their needs, interests, and readiness levels. This is in line with Tomlinson (2017), who states that differentiation is an effort to adjust the learning process and products based on students' characteristics. Process differentiation allows students to be more active in exploration and discussion, while product differentiation enables them to express their understanding optimally. Furthermore, Mayani et al. (2023) states that the ability to communicate scientific ideas is positively correlated with conceptual understanding and cognitive learning outcomes.

In terms of learning outcomes, the experimental class also demonstrated higher achievement compared to the control class. Most students in the experimental class were in the high and very high categories, with an average score of 85.14, while the control class was in the moderate category with an average score of 75.85. This indicates that differentiated instruction within the Discovery Learning model helps students understand concepts more deeply through exploratory processes tailored to their characteristics.

These results are supported by previous studies, such as Putri & Wardani (2024), which reported an increase in communication skills up to 89%, as well as studies by Apriyantini & Sukendra (2023); Reski et al. (2025), which found that differentiated learning in Discovery Learning improves student engagement and learning outcomes. Additionally, Afriani et al. (2025) reported an increase in learning outcomes from 75% to 91% after implementing differentiation strategies.

Overall, this study confirms that the integration of differentiated instruction within the Discovery Learning model is effective in improving students' communication skills (both oral and written) as well as their learning outcomes. This approach not only enhances average achievement but also promotes a more equitable distribution of student abilities and supports the development of 21st-century skills such as critical thinking, collaboration, and communication.

Conclusion

This study concludes that the implementation of differentiated instruction within the Discovery Learning model has a significant positive effect on students' communication skills and learning outcomes. Students in the experimental class demonstrated higher performance in both oral and written communication compared to those in the control class. This is reflected in higher mean scores of oral communication (89.87 in the experimental class vs. 77.08 in the control class) and written communication (87.99 vs. 75.38), a greater proportion of students in the "very skilled" category (51.72% in oral communication), and more evenly distributed abilities, as indicated by lower standard deviation values. These findings suggest that differentiated instruction supports not only high-achieving students but also those with lower initial abilities. In terms of learning outcomes, students taught using differentiated Discovery Learning achieved better results than those taught using conventional Discovery Learning. The majority of students in the experimental class reached high (75.86%) and very high (13.79%) achievement levels, compared to the control class, which was dominated by the moderate category (84.62%). The experimental class also obtained higher mean scores (85.14 vs. 75.85), as well as higher maximum scores (91 vs. 83) and minimum scores (76 vs. 69). This indicates that differentiated instruction enables deeper conceptual understanding through learning processes that are aligned with students' needs, interests, and learning profiles. Overall, the integration of differentiated instruction and Discovery Learning creates a more effective, inclusive, and student-centered learning environment. This approach not only improves students' communication skills and academic achievement but also promotes a more equitable distribution of learning outcomes and supports the development of essential 21st-century skills, including critical thinking, collaboration, and communication.

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