SPEKTRA: Jurnal Kajian Pendidikan Sains
Vol. 11, No. 2, 2025, pp. 376-388
ISSN: 2548-642X, DOI: 10.32699/nf83a298

EFFORTS TO IMPROVE STUDENTS' WRITTEN COMMUNICATION SKILLS AND SCIENTIFIC ATTITUDES BY USING *THE DISCOVERY LEARNING LEARNING MODEL* AT AL-HASAN MADANI ISLAMIC DORMITORY RIAU

Sara Rahmawati [1], Fakhruddin. Z [2], Dedi Irawan [3]
[1,2,3] Master of Physics Education, Faculty of Teacher Education, University of Riau, Pekanbaru, Riau, Indonesia

Article Information

Article history:
Received 07/10/2025
Received 30/12/2025
Published 06/01/2026

Keywords:
Discovery Learning Model;
Students' Scientific Attitude;
Written Communication Skills

ABSTRACT

Observation results at the Al-Hasan Madani Islamic Boarding School in Riau showed low communication skills, as seen from the lack of active participation in group discussions, difficulty conveying logical arguments, and low courage to ask questions. The results of the needs analysis of 25 students revealed that students still have suboptimal written communication skills, with a percentage of 48%. In addition, scientific attitudes such as curiosity and reflection skills have not developed optimally, with a percentage of 44% being in the low category. This condition is also supported by the learning model that is still teacher-centered. The purpose of this study is to observe the involvement/activities of educators and students during learning activities and to find effective ways in learning by using the discovery learning model *to* improve written communication skills and scientific attitudes of students at the Al-Hasan Madani Islamic Boarding School in Riau. The type of research used is Classroom Action Research (CAR) with 4 stages, namely planning, implementation, observation, and reflection. The subjects of this study were students of class $X_{B.}$ This study conducted at an Al-Hasan Madani Islamic Boarding School in Riau. There were 25 students of class $X_{B.}$ The dependent variable in this study was students' written communication skills and scientific attitudes. While the independent variable in this study was the discovery learning model. Data collection methods included observation sheets of educator and student activities, written communication skills tests, student scientific attitude questionnaires, and documentation. Based on the results of this study, it can be concluded that the application of the discovery learning model at the Al-Hasan Madani Islamic Boarding School in Riau is considered effective, and with increased educator and student activities, it can improve students' written communication skills and scientific attitudes. This increase occurred gradually, starting from the initial data at the pre-cycle stage, cycle I, to cycle II. The percentage of educator activity obtained in the implementation of Cycle I learning was in the good category and the implementation of Cycle II learning was in the very good category. While the percentage of students in the implementation of Cycle I learning was in the good category and the implementation of Cycle II learning was in the very good category.

Corresponding authors:
Sara Rahmawati
Department of Physics Education, Faculty of Teacher Training and Education, University of Riau, Pekanbaru, Riau, Indonesia
Email: sara.rahmawati6899@grad.unri.ac.id

1. INTRODUCTION

The Industrial Revolution 4.0 era and the transition to Industrial Revolution 5.0 have brought about major changes in various aspects of life, including education. Future competencies require students to possess effective communication skills and a strong scientific attitude. These skills are not only crucial for individual success in the workplace but also key to building a knowledge-based society (Trilling, B, and Fadel, 2021). However, global surveys show that many education systems, including Indonesia's, are not yet fully capable of meeting these demands. *Programme for International Student Assessment (PISA)* showed that Indonesian students' literacy skills, particularly in critical thinking, problem-solving, and communication, remain below the OECD average. Indonesian students tend to struggle with analytical-based problem-solving and communicating ideas clearly and effectively. This presents a challenge in facing global competition, which demands high levels of communication, collaboration, and critical thinking skills *(OECD, 2023).*

World *Economic Forum* 's *Future of Jobs* report (2020) , communication skills rank high on the list of 21st-century competencies needed to address global challenges. Effective communication enables individuals to convey ideas, collaborate within teams, and resolve conflicts constructively. In an educational context, these skills play a crucial role in supporting collaborative learning, where students not only receive information but also share ideas and learn from others. At the national level, education in Indonesia is still dominated by conventional learning approaches. In this model, educators play a more information-providing role, while students are passive listeners. This *teacher-centered approach* often limits students' ability to develop higher-order thinking skills, such as analysis, evaluation, and synthesis (Arends, 2020) . This leads to students lacking communication confidence and being reluctant to ask questions, thus hindering the development of the scientific attitudes that should be the foundation of science education.

Written communication skills are a crucial aspect of learning, particularly in conveying ideas, thoughts, and analytical results systematically and clearly. However, in many educational institutions, including Islamic boarding schools, these skills are often suboptimal. Research by Rahmawati, A, and Supriadi (2023) shows that students tend to have difficulty constructing logical and systematic written arguments, particularly in science subjects such as Physics. This obstacle is caused by a lack of exposure to scientific writing practices and limited supporting media. Furthermore, a study by Indrawan (2022) revealed that conventional learning methods provide little room for the development of written communication skills. This results in students focusing solely on memorizing concepts without being able to express them in structured writing. This problem is further exacerbated by low student motivation in writing and a lack of constructive feedback from educators. In the context of the Al-Hasan Madani Islamic Boarding School in Riau, similar challenges are faced.

A learning environment that prioritizes verbal communication tends to neglect the development of written communication skills. Therefore, innovations in learning methods, such as the implementation of *the Discovery Learning model*, are needed to help students develop these skills effectively. Scientific attitudes, such as curiosity and openness to evidence, are essential elements in science learning. These attitudes support students not only in understanding scientific concepts but also in evaluating information based on facts and logic, ultimately strengthening their

critical thinking skills (Koballa, TR, and Tippins, 2019). Research by Sukmawati *et al.* (2021) shows that positive scientific attitudes also enhance students' problem-solving skills and creativity, which are key to success in project-based learning and research. Observations in class X $_B$ at the Al-Hasan Madani Islamic Boarding School in Riau reinforce these findings. Students demonstrated poor communication skills, as reflected in minimal active participation in group discussions, difficulty presenting logical arguments, and a lack of courage to ask questions.

Furthermore, scientific attitudes such as curiosity and reflection skills have not yet developed optimally. This condition indicates that the ongoing learning process does not fully provide space for students to be actively involved, think critically, and communicate effectively. Therefore, a learning approach is needed that can facilitate active student involvement while developing their communication skills and scientific attitudes. In line with these needs, discovery learning is a relevant approach to implement. This approach places students at the center of learning, encouraging them to actively seek, discover, and construct conceptual understanding through exploration and investigation. According to Santrock (2020), discovery learning not only helps students achieve deeper understanding but also encourages collaboration, discussion, and the development of critical thinking and communication skills throughout the learning process.

Discovery learning has been extensively researched and proven to be beneficial in science learning, including physics. Several previous studies have shown that this model can improve students' conceptual understanding, communication skills, and scientific attitudes. For example, Rahmawati, Prasetyo, and Ningsih (2023) reported improved communication skills in students learning about renewable energy through discovery learning. Meanwhile, Sukmawati and Rachmawati (2021) found that this model positively contributes to the development of students' curiosity and reflective thinking skills. However, most of this research still focuses on the general school context and tends to examine only one learning outcome variable in isolation, such as communication skills or scientific attitudes. Furthermore, studies specifically integrating discovery learning into renewable energy topics, emphasizing both written communication skills and scientific attitudes simultaneously, are still relatively limited, particularly in the context of Islamic boarding school-based education.

Based on the research gap, the novelty of this research lies in the application of the discovery learning model in the physics learning of renewable energy material conducted at the Al-Hasan Madani Islamic Boarding School in Riau, as well as in measuring its impact on students' written communication skills and scientific attitudes simultaneously. This research also places the topic of renewable energy as a learning context that is relevant to global sustainability issues and students' daily lives, thus providing a contextual perspective that has not been widely studied in previous research. Thus, this study not only strengthens empirical findings regarding the effectiveness of discovery learning, but also provides new contributions in understanding its application in the context of Islamic boarding school education and in the development of 21st-century skills that are aligned with the Independent Learning policy.

2. METHOD

The type of research used in this study is Classroom Action Research (CAR). CAR is a form of research conducted by educators to improve and strengthen the quality of learning directly in the classroom. CAR is reflective because educators carry out a series of actions and observe their

impact. CAR aims to improve learning practices to be more effective, efficient, and professional (Suwartono, 2024). CAR plays an important role in the development of educator professionalism because through this research process, educators not only become users of learning strategies but also developers of innovations appropriate to their classroom context. This is in line with the opinion of Kemmis and McTaggart who stated that CAR is a form of participatory study in which educators play an active role in planning, implementing, observing, and reflecting on the learning process.

In simple terms, CAR can be defined as action research carried out with the aim of improving the classroom learning process through the application of the Discovery Learning model. CAR refers to Kurt Lewin's model, which consists of four main stages in each cycle: planning, action, observation, and reflection (Saputra, 2021). The research design can be seen in Figure 1 below:

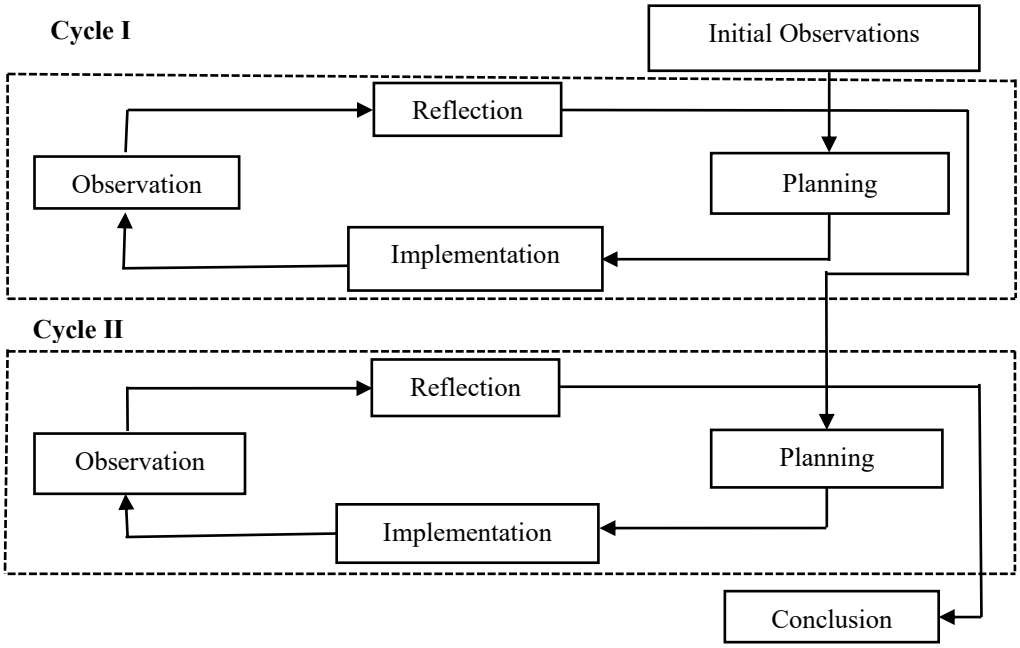

Figure 1. Classroom Action Research Procedure

The Figure 1, type of data required in this study is primary data. Primary data were obtained from the results of the initial needs analysis (students' scientific attitudes questionnaire), instrument validation (learning modules, student worksheets, written communication skills test sheets, and scientific attitudes questionnaire), observations of teacher activities, observations of student activities, and scientific attitudes questionnaire. The subjects of this study were 25 class X B students at the Al-Hasan Madani Islamic Boarding School in Riau in the 2024/2025 academic year. The data collection method was carried out using testing techniques, questionnaires, and observations. The testing method was used to obtain data on communication skills. Students' written data on renewable energy material was collected after the research was conducted in each cycle. The data collection techniques used were initial needs analysis, data on the validity of learning tools (CP, ATP, Teaching Modules and LKPD), and data on formative test questions. Data on teacher and student activities can be seen in Table 1:

Table 1. Data Collection Techniques

No	Data Study	Technique Collection Data
1	Initial Needs Analysis	Technique collection data initial needs analysis with distribution a list of questions to students in the form of a questionnaire sheet.
2	Data validity	Collection data validity Finished with distribution of validity questionnaires to 3 validators expert (teacher).
3	Data activity educators and students , skills datawritten communication	Data collection techniques for educational activities, activities students through observation Communication skills finished writing by using the test.
4	Science student attitude data	Scientific attitude data collection techniques. Questionnaires were given to students at the end of cycle I and cycle II .

In Table 1, data analysis in this study was conducted using several methods, namely qualitative and quantitative analysis. The quantitative method involved calculating scores for the communication skills and scientific attitudes of the participants being taught. Meanwhile, the qualitative analysis was conducted continuously, starting with planning, observation, and reflection in Cycle I to improve learning in Cycle II, thus drawing conclusions from the research results in the Table 2:

Table 2. Written Communication Skills Analysis Categories

No	Activity (%)	Category
1	$85 \leq X < 100$	Very Good
2	$70 \leq X < 85$	Good
3	$55 \leq X < 70$	Quite good
4	$0 \leq X < 55$	Not good

The percentage of the scientific attitude questionnaire of educational participants was analyzed according to the criteria in Table 3:

Table 3. Interval of Students' Scientific Attitude Criteria

Percentage which is obtained (%)	Category
$85 \leq P < 100$	Very Tall
$70 \leq P < 85$	Tall
$55 \leq P < 70$	At the moment
$40 \leq P < 55$	Low
$0 \leq P < 40$	Very Low

3. RESULTS AND DISCUSSION

The research conducted at the Al-Hasan Madani Islamic Boarding School in Riau aims to observe the involvement/activities of educators and students during teaching and learning

activities and to find effective learning methods using the Discovery Learning model to improve students' written communication skills and scientific attitudes at the Al-Hasan Madani Islamic Boarding School in Riau. This research was conducted for 2 cycles from March to May 2025. The learning material in this study is the physics material of class X semester 2, namely renewable energy. This renewable energy material can be completed in 10 meetings with 2 cycles. In the first cycle, the researcher provided material on energy, forms of energy, the law of conservation of energy and energy conversion, as well as the urgency of energy needs problems with a total of 5 meetings consisting of 4 learning meetings and 1 daily test. Furthermore, in the second cycle, the materials used were energy sources, renewable energy sources and non-renewable energy sources, the impact of energy exploration and use, and efforts to meet energy needs consisting of 5 meetings with details of 4 learning meetings and 1 written test.

The following is a description of the research results obtained. This research is a PTK (Public Test of Knowledge) using the *discovery learning model* to improve participants' written communication skills and scientific attitudes. This research was conducted in class X_B at the Al-Hasan Madani Islamic Boarding School, Riau. The research activities began after observation and the administration of participant scientific attitude questionnaires and a pre-cycle written communication skills test. The research implementation consisted of two cycles with four meetings in each cycle. The subjects of this study were students of class X_B at the Al-Hasan Madani Islamic Boarding School in Riau. Cycle I began on Tuesday, April 15, 2025 for the first meeting, the second meeting on Thursday, April 17, 2025, the third meeting on Tuesday, April 22, 2025, and the fourth meeting on Thursday, April 24, 2025. While Cycle II began on Saturday, May 3, 2025 for the first meeting, the second meeting on Tuesday, May 6, 2025, the third meeting on Thursday, May 8, 2025, and the fourth meeting on Thursday, May 15, 2025. The fifth meeting in each cycle was a written communication skills test and the distribution of students' scientific attitude questionnaires.

3.1. Pre-cycle

The pre-cycle stage in this study aims to obtain initial information regarding students' written communication skills and scientific attitudes before implementing corrective actions through the discovery learning model. This stage is the basis for developing relevant and effective learning strategies in improving the quality of student learning processes and outcomes on renewable energy material in class X_B of Al-Hasan Madani Islamic Boarding School, Riau. Data collection methods used in the pre-cycle stage include learning observations, written communication skills essay tests, scientific attitude questionnaires, and documentation. The number of students in the class is 25 students.

The pre-cycle results showed that students' scientific attitudes were in the "low" category, with a percentage of 44%. The number of students in the very high, high, and moderate categories was only 7 people or 28%. Meanwhile, the results of the pre-cycle test of students' written communication skills were in the "low" category, with a percentage of 48%. The number of students in the very good, good, and sufficient categories was only 9 people with an average percentage of 36%. The number of students with poor written communication skills was 16 people or 64%.

3.2.Activities of Educators and Students in Cycles I and II

The increase in the average percentage of educator activity was due to the average of each indicator of educator activity in cycle II increasing from cycle I. Based on the results of observations of educator and student activities that had been carried out, in cycle I showed an average percentage of educator activity of 78% (Good Category). Meanwhile, student activity was 65% (Good Category). However, this percentage of activity has not met the criteria for successful student activity as previously determined, where the minimum percentage of activity is 75%. Therefore, cycle II is necessary. Based on the results of the first action cycle, the first reflection cycle was conducted as an effort to ensure improvements in the second cycle. The first reflection cycle resulted in improvements that were implemented in the second cycle. The learning process implemented in the second cycle ran smoothly. This was evidenced by the increase in the average percentage of teacher and student activities in the second cycle to 92% (very good category) for teacher activities and 83% (very good category) for student activities.

The average increase in teacher activities in the first and second cycles was 14%. The increase in the average percentage of student activities in the first and second cycles was 20%. Following this chart, the educator improvement activities in cycle I and cycle II can be seen in Figure 2:

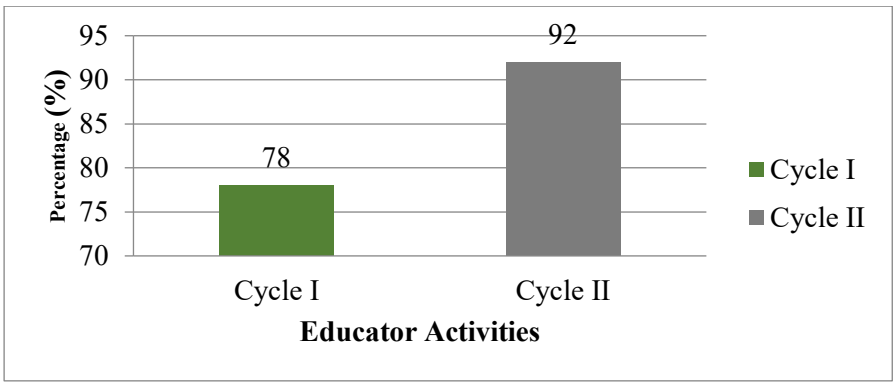

Figure 2. Educator Activities in Cycle I and Cycle II

The Figure 2, increase in the average percentage of educational activity participants was due to the average of each indicator of student activity participants in cycle II increasing from cycle I. The graph of the increase in student activity participants in cycle I and cycle II can be seen in Figure 3:

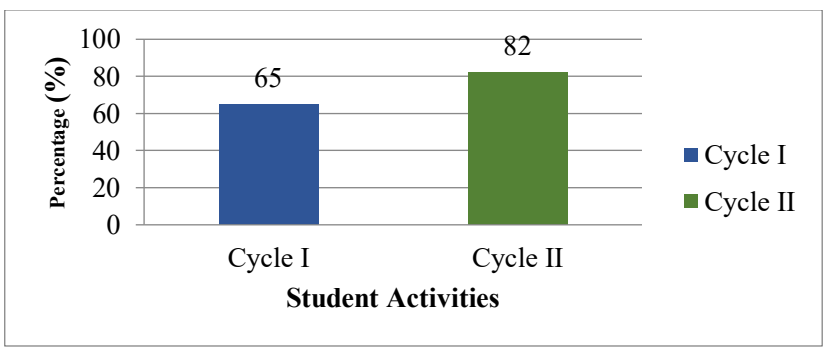

Figure 3. Student Activities in Cycle I and Cycle II

3.3. Students' Scientific Attitude

A scientific attitude refers to behaviors that underlie rational, evidence-based thinking in answering questions or solving problems. A scientific attitude encompasses curiosity, objectivity, thoroughness, and persistence in data collection, as well as humility in accepting evidence that contradicts existing hypotheses or theories. In physics learning, this scientific attitude is reflected in how students structure conversations, collect experimental data, and draw conclusions based on evidence in the Table 4:

Table 4. Indicators Scientific Attitude

No	Scientific Attitude Indicators	Information
1.	Curiosity	Ask relevant questions, seek additional information, and engage in scientific exploration.
2.	Be critical of evidence	Analyze, evaluate, and verify the information or evidence obtained.
3.	Using Logic in Drawing Conclusions	Develop arguments and draw conclusions based on the data and evidence obtained.
4.	Openness to Revision of Opinions	Accept changes in opinion based on new evidence and value input from others.
5.	Accuracy and Precision in Observation	Making careful and precise observations in experiments or other scientific situations.
6.	Reflection Ability	Reflect on the results of the experiment, assess the process performed, and identify areas for improvement.

In the scientific student attitude assessment questionnaire, the assessment criteria on the questionnaire sheet consist of six indicators, as previously explained. The total number of statements in the scientific student attitude questionnaire is 30. The following is a chart of the improvement in scientific student attitudes in the pre-cycle, cycle I, and cycle II in the Figure 4:

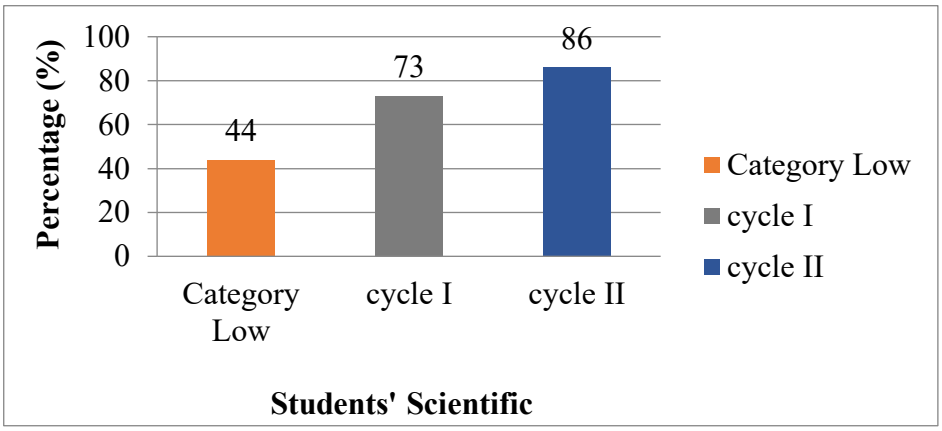

Figure 4. Students' Scientific Attitude

Figure 4 shows that the increase in students' scientific attitudes from pre --cycle to cycle II as indicated by the questionnaire data is not merely a statistical figure, but rather reflects the

process of developing scientific thinking competencies strengthened by the stages of *Discovery Learning*. Theoretically, this approach allows students to be directly involved in exploration, problem formulation, data investigation, and reflection, thereby fostering scientific attitude characteristics such as openness to evidence, curiosity, and thoroughness in decision-making. This is in line with the findings of Ulil Hidayah *et al.* (2025) who stated that *Discovery Learning* is consistently associated with an increase in students' scientific attitudes in physics learning, including in the process of reflective thinking and understanding of meaningful concepts in the context of contemporary science.

In the pre-cycle stage -, the low percentage of students' scientific attitudes indicated that previous learning had not effectively facilitated students' active involvement in scientific activities. After the intervention in cycle I, significant improvements occurred because students began to directly experience the stages of discovery, such as formulating questions, seeking evidence through observation, and discussing to draw conclusions. This finding is supported by recent quasi-experimental research showing that the implementation of the *Discovery Learning model* has a positive effect on students' scientific literacy and scientific attitudes, with an increase in scientific attitude scores after discovery-based learning compared to the initial conditions (Nur Winda *et al*. 2025). Then in cycle II, after reflection and refinement of the learning implementation, the scientific attitude of students increased to the very high category.

The repetitive process in structured scientific activities allows students to strengthen scientific skills such as hypothesis testing, evidence evaluation, and systematic communication of findings. This is in accordance with the results of classroom action research which shows that the implementation of *Discovery Learning* can gradually improve students' scientific attitudes from the first cycle to the second cycle through planned observation and reflection on learning activities (Syarif, E., Syamsunardi, & Saputro, A. (2025). Based on the results of the scientific student attitude questionnaire data that has been carried out, in the pre-cycle it shows an average percentage of 44% (Low Category). Meanwhile, in cycle I it shows an average percentage of the scientific attitude of students educated at 73% (High Category), after the actions in cycle I were analyzed and reflections were carried out on cycle I as an effort to ensure an increase in cycle II so that in cycle II it shows an average percentage of 86% (Very High Category).

This percentage has met the criteria for the success of scientific student attitudes that have been previously determined so that there is no need for cycle III actions. Data from the questionnaire sheet that has been presented in the research results shows that the scientific attitude of students after carrying out the learning process using the Discovery Learning learning model has been running well and has met the success indicators, namely the percentage of students who are in the strong and very strong categories ≥ 75.00%. Based on the results of the questionnaire data, there is an increase in the scientific attitude of students after using the Discovery Learning learning model. This is also reinforced by other researchers (Risnawati, M., Sudraja, A., and Rahayu, 2022) who said that the implementation of *Discovery Learning* can improve students' scientific attitudes. Thus, the improvement in students' scientific attitudes in this study can be explained scientifically as a result of learning that develops authentic learning experiences, students' active involvement in the scientific inquiry process, and continuous reflection that improves students' understanding and scientific responses to scientific phenomena.

3. 4. **Written Communication Skills**

Communication skills are the ability to communicate various things related to learning materials, both verbally and in writing (Wilhalminah, A and Rahman, 2017) . Communication is also used to build deeper and closer relationships between teachers and students, as well as to share knowledge, thoughts, and experiences (Assabai and Rahman, 2018; Patriot, 2018; Pramesti and Astutik, 2020; Sari and Kurniasih, 2017) . Effective communication in physics involves conveying ideas and experimental findings through discussions, presentations, and scientific reports (Bertolini, M and Araujo, 2023) . Written communication skills consist of four indicators, as discussed previously. The written communication skills test consists of four questions in each cycle. These questions are administered before the cycle (pre-cycle) and at the end of the cycle in the Table 5:

Table 5. Indicators of Scientific Communication Skills

Oral	Written
1. Ask a question 2. Answer the questions 3. Expressing ideas 4. Responding to ideas 5. Presentation	1. Create a table of experimental results 2. Change the data presentation from a table to a form chart or other relevant diagram. 3. Analyze and read tables or graphs. 4. Make written conclusions based on the results of data processing.

The Table 5, based on this chart, the improvement of written communication skills, education of participants in pre-cycle, cycle I, and cycle II in the Table 5:

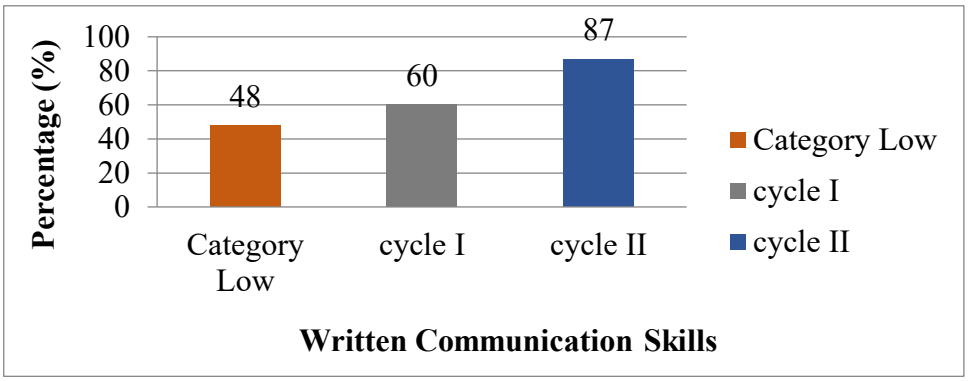

Figure 5. Students' Written Communication Skills

Figure 5 shows that the improvement in students' written communication skills from pre-cycle to cycle II can be scientifically explained through the application of the Discovery Learning model, which positions students as active subjects in learning. Theoretically, discovery-based learning encourages students not only to passively receive information, but also to formulate questions, develop arguments, convey ideas in writing, and evaluate findings through a reflective process (Santrock, 2020). In the pre-cycle, students' written communication skills were relatively low, indicating that previous learning did not provide sufficient opportunities for students to express ideas in writing and in a structured manner. Improvements in cycle I occurred because

students began to become accustomed to activities that required them to present their exploration results in written form, such as experimental reports and group discussion summaries.

This process enabled students to organize ideas, connect concepts with evidence, and enhance their critical and logical thinking skills in conveying ideas. These findings align with recent research by Nur Winda, Jayanti, and Sholehah (2025), which showed that the implementation of Discovery Learning significantly improved students' scientific literacy and scientific communication skills in the context of science learning. Furthermore, reflection and improvements made after cycle I contributed to further improvements in cycle II. With improved methods and more systematic guidance, students were able to construct written arguments more clearly, formulate conclusions based on data analysis, and communicate scientifically according to applicable rules. These results are supported by research by Syarif, Syamsunardi, and Saputro (2025), who reported that the gradual implementation of Discovery Learning was able to improve students' scientific communication skills, both in conveying ideas and in preparing systematic written reports.

Thus, the improvement in students' written communication skills in this study can be explained as the result of active learning, exploratory experiences, and continuous reflection, which have been empirically proven effective through Discovery Learning interventions. The average percentage of written communication skills was 48% (low category), then in cycle I showed an average percentage of written communication skills of 60% (sufficient category). After the actions in cycle I were analyzed and reflections were carried out on cycle I as an effort to ensure there was improvement in cycle II. The reflection on cycle I resulted in improvements that were implemented in cycle II. The average percentage of students' written communication skills in cycle II was 87% (very good category). This means that all education participants already have good written communication skills. This percentage has reached the established success indicators so that there is no need for action in cycle III.

This study aligns with other research conducted by Azhari, RP, and Nurita (2021) which states that *the Discovery Learning model* is effective in improving the scientific written communication skills of educational participants because it emphasizes critical thinking processes, evidence-based data collection, and scientific communication in the form of group discussions and presentations. Research by Yenti et al., (2022) also states that the application of the *Discovery Learning* model not only improves written communication skills but also shapes the scientific character and attitudes of educational participants through *structured and reflective* Discovery Learning activities .

3. CONCLUSION

The activities of educators and students in the implementation of cycle I still had several weaknesses that were corrected through a small evaluation conducted and optimized in the implementation of learning cycle II. The percentage of educator activities obtained in the implementation of learning cycle I was in the good category and the implementation of learning cycle II was in the very good category. Meanwhile, the percentage of students in the implementation of learning cycle I was in the good category and the implementation of learning cycle II was in the very good category. Therefore, by increasing the activities of educators and students, students' written communication skills and scientific attitudes can be improved. The

implementation of the Discovery Learning model in class X $_B$ at the Al-Hasan Madani Islamic Boarding School in Riau was deemed effective in improving students' written communication skills and scientific attitudes. This improvement occurred gradually, starting from the pre-cycle stage, cycle I, and cycle II. Thus, learning that integrates Discovery Learning improves written communication skills and students' scientific attitudes towards physics learning.

REFERENCE

Arends, R. I. (2020). *Learning to Teach (10th ed.)*. Mc Graw-Hill Education.

Assabai, MA, dan Rahman, MT (2018). Efforts to Increase Student Learning Motivation through Teachers' Interpersonal Communication Skills. *Jurnal Pendidikan Manajemen Perkantoran 3*(2), 190-200. https://doi.org/10.17509/jpm.v3i2.11764.

Azhari, RP, dan Nurita, T. (2021). Implementation of the Discovery Learning Model to Improve Students' Communication Skills. *PENSA: E-Jurnal Pendidikan Sains 9*(3), 386-393. https://doi.org/10.26740/pensa.v9i3.40359.

Bertolini, M., dan Araujo, F. (2023). The Role of Communication Skills in Physics Education: Effective Methods for Sharing Scientific Ideas and Findings. *Jurnal Internasional Komunikasi Sains 9*(2), 97-112.

Forum, WE (2020). *Laporan Masa Depan Pekerjaan 2020.* Forum Ekonomi Dunia.

Hidayah, U., Meliati, Z. N., Nahla, Z., dan Simanjuntak, M. P. (2025). Literature Study: Optimization of the Discovery Learning Model in Improving Students' Conceptual Understanding, Scientific Attitudes, Critical Thinking, and Cognitive Outcomes in Physics Material. *Jurnal Pengabdian Masyarakat dan Riset Pendidikan 4*(2), 8140-8147. https://doi.org/10.31004/jerkin.v4i2.3027.

Indrawan, R. (2022). Analysis of Critical Thinking Skills and Written Communication in Physics Learning. *Jurnal Inovasi Pendidikan 15*(3), 201-212.

Koballa, TR, dan Tippins, DJ (2019). *Pendidikan Sains: Perspektif dan Praktik* . Springer.

Murniayudi, H., Mustadi, A., dan Jerusalem, MA (2018). Reciprocal Teaching: A 21st-Century Learning Innovation to Improve PGSD Students' Conceptual Understanding. *Premiere Educandum : Jurnal Pendidikan Dasar Dan Pembelajaran 8*(2), 173. https://doi.org/10.25273/pe.v8i2.3308.

Nasir, M., Fahruddin, F., dan Nehru, N. (2025). Evaluation of the Application of Formative Assessment in Science Learning for Junior High School Students. *JUPEIS: Jurnal Pendidikan dan Ilmu Sosial 4*(3), 45-60. https://doi.org/10.57218/jupeis.Vol4.Iss3.1803.

OECD. (2023). *PISA 2022 results (Volume I): The state of learning and equity in education*. OECD Publishing.

Patriot, E. A. (2018). Analysis of Students' Understanding Levels of Work and Energy Concepts through the Application of Interactive Conceptual Learning with a Multi-Representation Approach. *Jurnal Pendidikan Fisika Indonesia*, *14*(2), 123-130. https://doi.org/10.19109/jifp.v3i1.3227.

Rahmawati, A., dan Supriadi, R. (2023). Improving Written Communication Skills in Science Learning. *Jurnal Pendidikan Sains 11*(2), 115-128.

Rahmawati, D., Prasetyo, ZK, dan Ningsih, R. (2023). Application of the Discovery Learning Model to Improve Communication Skills in Renewable Energy Learning. *Jurnal Pendidikan*

Fisika Indonesia 19(2), 130-140. http://dx.doi.org/10.20961/bioedukasi-uns.v10i1.10142.

Riduwan, dan Sunarto. (2017). *Metode dan Teknik Menyusun Proposal Penelitian Untuk Mahapeserta didik S-1,S-2 dan S-3* . Alfabet.

Risnawati, M., Sudrajat, A., dan Rahayu, A. (2022). Application of the Discovery Learning Model to Improve Scientific Attitudes and Science Learning Outcomes on the Material of Changes in the State of Objects. *JESA: Jurnal Edukasi Sebelas April 6*(2), 113-118. https://ejournal.unsap.ac.id/index.php/jesa.

Santrock, JW (2020). *Psikologi Pendidikan*. McGraw-Hill.

Saputra, I. G. P. E., Sukariasih, L., Nursalam, L. O., dan Sudarman, S. (2022). The effect of Scientific Literacy Approach with Discovery Learning Model Toward Physics Concepts Understanding. *Jurnal Pendidikan Fisika 10*(2), 144-153. https://doi.org/10.26618/jpf.v10i2.7769.

Sari, D. P., dan Kurniasih, I. (2017). The Role of Communication in Teacher and Student Interaction. *Jurnal Pendidikan Dan Kebudayaan 3*(1), 45-56.

Sugiyono. (2020). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D.* Alfabet.

Sukmawati, N., dan Rachmawati, I. (2021). The Influence of Scientific Attitudes on Students' Problem-Solving Abilities and Creativity. *Jurnal Ilmiah Pendidikan Sains 11*(3), 425-434.

Suwartono, T. (2024). Classroom Action Research: Between Theory and Practice. *Nusantara: Jurnal Pendidikan Indonesia 4* (1). https://orcid.org/0000-0002-9615-2257.

Syarif, E., Syamsunardi, S., dan Saputro, A. (2020). Implementation of discovery learning to improve scientific and cognitive attitude of students. *Journal of Educational Science and Technology 6*(1), 23-31. https://doi.org/10.26858/est.v6i1.11975.

Taufanny, FA, Mardapi, D., dan Fauziah, FN (2020). Development of an Assessment Instrument for Students' Scientific Communication Skills in Science Learning. *Jurnal Penelitian Dan Evaluasi Pendidikan 24*(1), 78-89. https://doi.org/10.47213/bp.v3i1.79.

Trilling, B., dan Fadel, C. (2021). *Keterampilan Abad ke-21: Pembelajaran untuk Kehidupan di Zaman Kita.* Wiley.

Wilhalminah, A., dan Rahman, M. (2017). Improving Students' Communication Skills Through the Application of Learning Models. *Jurnal Pendidikan Indonesia 6*(2), 123-134.

Winda, N., Jayanti, E. T., dan Sholehah, N. (2025). The Influence of the Discovery Learning Model on Students' Scientific Literacy Skills and Scientific Attitudes at MTs Miftahul Ishlah Tembelok, Mataram City. *Otus Education: Jurnal Biologi dan Pendidikan Biologi 3*(1), 21-29. https://doi.org/10.62588/otusedu.2025.v3i1.067.

Yasinta, A. (2018). The Effectiveness of Project-Based Learning Model to Improve Students' Scientific Communication Skills. *Jurnal Inovasi Pendidikan IPA 4*(2), 112-119. https://doi.org/10.20961/jkc.v11i1.71789.

Yenti, N., Ramadhanti, D., dan Laila, A. (2022). The Effect of Using the Discovery Learning Model on Communication Skills in Writing Expository Texts. *Jurnal Pembelajaran Bahasa dan Sastra 1*(1), 93-102. https://doi.org/10.55909/jpbs.v1i1.16.