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Students' Perceptions of Scientific Writing Teaching: Implications for Improving Learning Effectiveness

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Abstract

This study aims to analyze students' perceptions of scientific writing learning within an advanced and innovative learning framework. The research employed a descriptive quantitative approach using a Likert-scale questionnaire completed by 202 students. The data were analyzed descriptively to obtain the mean, standard deviation, and percentage distribution across five main aspects: participation and interaction, clarity of materials and use of examples, feedback and collaborative guidance, development of academic skills, and time management and variation in innovative learning methods. The results indicate that all aspects achieved mean scores above 3.00 (on a 1–4 scale), which are categorized as high. The highest scores were obtained for teaching method variation (3.14) and material implementation support (3.14), while the lowest score was found in learning time allocation (3.06). Although the majority of students selected the "Agree" category, the proportion of "Strongly Agree" responses remained relatively low (13–17%), suggesting the need for improvement in time allocation, feedback quality, and diversity of examples provided. This study underscores the importance of interactive learning design, consistent use of formative feedback, and the implementation of innovative learning methods to enhance the quality of students' learning experiences. These findings can serve as a reference for teachers and schools in designing more effective and sustainable scientific writing instruction strategies.

Keywords: advanced learning, collaborative learning, scientific writing learning, innovative learning, project-based learning

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1. Introduction

Writing activities can be viewed as a form of proactive self-therapy as well as a medium of social expression and a manifestation of individuals' need to articulate their thoughts (Miles, 2025). In the context of education, writing skills particularly scientific writing constitute one of the essential competencies that students, especially at the senior high school level, must master as preparation for higher education or to meet the increasingly complex demands of the professional world. This activity not only involves the ability to construct grammatically correct sentences but also encompasses critical, logical, and systematic thinking skills. Such abilities enable students to identify problems, formulate hypotheses, search for and process information, and present it in a written form that is academically accountable. Scientific writing also plays a strategic role in developing information literacy, which refers to the ability to access, evaluate, and utilize information sources ethically and effectively (Gaber & Ali, 2022).

Various research reports and field observations have shown that scientific writing skills among students remain a significant challenge. Many students struggle to begin their writing, organize ideas coherently, use appropriate formal language, and adhere to academic writing conventions. Several studies have also highlighted the lack of structured practical experiences in writing instruction, resulting in students receiving mostly theoretical explanations without sufficient opportunities for continuous practice. According to Hampton et al. (2022) within the school learning context, students' success in mastering these skills is strongly influenced by the teacher's role as a facilitator, motivator, and evaluator throughout the learning process.

Therefore, understanding students' perceptions of scientific writing instruction is crucial. The concept of perception refers to an individual's effort to make sense of experiences and assign meaning to them (Lomsdal et al., 2022). Individuals may perceive the same phenomenon positively or negatively, which in turn shapes their observable behaviors. This indicates that every individual may have a different perspective even within the same learning environment, as the stimuli received and interpreted can vary (Saragih et al., 2020).

Perception can be defined as the process of understanding and attributing meaning to an object, event, or relationship based on sensory stimuli. This aligns with (Zhafira et al., 2020) who assert that perception is the process of interpreting stimuli obtained through observation to construct understanding. Perception involves the act of observing and interpreting complex information within one's environment. Furthermore, Anggianita et al. (2020); Fadhilaturrahmi et al. (2021) emphasize that perception highlights how meaning is assigned to sensory stimuli within cognitive processing.

An individual's perception, including that of students, greatly influences how they respond to a learning experience. In the context of scientific writing, students' perceptions can determine the extent to which they feel supported, motivated, or, conversely, encounter obstacles in understanding the material and completing assignments. Therefore, investigating students' perceptions is essential as it provides a comprehensive understanding of the effectiveness of teachers' instructional practices, the alignment between innovative learning methods and students' needs, and the factors that either facilitate or hinder the learning process. This analysis serves as a foundation for designing more adaptive, innovative learning strategies, ensuring that scientific writing learning in senior high schools becomes more effective and meaningful within an advanced learning environment.

The results of the student perception questionnaire, which form the basis of this study, indicate several aspects of instruction that have been implemented effectively. Most students reported that teachers provided sufficient opportunities for active participation in class, were responsive to questions or problems raised, and were able to explain concepts clearly with relevant examples. Such positive interactions are crucial, as active student engagement and teachers' openness to dialogue are key to fostering a conducive learning environment. Students also acknowledged that engaging in scientific writing activities helped them develop critical thinking skills, improve their language proficiency, and apply previously learned linguistic competencies. Collaborative activities, such as group work or joint projects, were also perceived as beneficial because they not only enhanced writing abilities but also strengthened communication and teamwork skills.

However, the data also reveal several challenges that warrant attention. Some students indicated that the feedback provided by teachers on their writing was not yet optimal. Constructive and targeted feedback is one of the key factors that can help students identify their weaknesses while developing their potential (Wan Yusof et al., 2022). In addition, students perceived that the time allocated for completing scientific writing projects was sometimes insufficient, limiting the revision process and in-depth exploration of the material. This constraint affects the overall quality of the written work, as scientific writing requires iterative processes ranging from planning and drafting to revising and refining the final output.

Another challenge identified in this study is the limited variation of innovative learning methods in certain situations. While some students acknowledged the use of diverse approaches such as discussions, presentations, and technology integration, others perceived the methods as still relatively monotonous. In fact, the implementation of varied advanced learning strategies can enhance motivation, enrich learning experiences, and help students comprehend materials from multiple perspectives (Fernández et al., 2018). Furthermore, several students expressed a desire for more concrete examples of relevant scientific papers that could serve as references for their own writing.

In response to these challenges, several strategic measures can be implemented to improve the quality of scientific writing instruction. First, teachers need to strengthen the provision of feedback that goes beyond technical aspects such as spelling and grammar, by also addressing the substance of ideas, coherence of arguments, and relevance of references. Second, time management within the learning process should be adjusted to allow students sufficient opportunities to revise their work based on the feedback received. Third, innovative learning methods can be diversified through the integration of digital technologies such as online collaboration platforms, shared writing applications, and interactive media that enable students to work synchronously and asynchronously. Fourth, incorporating project-based learning (PjBL) can provide a more authentic learning experience, as students engage with real-world problems and produce final written outputs that can potentially be published (DeCoux Hampton & Chafetz, 2021)

From an academic perspective, this study offers significant novelty compared to previous research. First, it focuses on students' perceptions as the primary indicator for assessing the quality of scientific writing instruction. This approach provides direct insights into students' learning experiences, which are often overlooked when evaluation is limited to the written outputs themselves (Tekindur & Kingir, 2024). Second, the perception questionnaire used in this study encompasses multiple dimensions of learning, including teacher–student interaction, advanced learning strategies, feedback practices, time management, and supporting facilities. This enables a more comprehensive analysis of the factors influencing students' perceptions (Chrdileli & Shulzhenko, 2021). Third, the study was conducted within the context of Indonesian secondary schools implementing the latest curriculum, making it highly relevant to efforts aimed at improving the quality of scientific writing instruction in developing countries and contributing to the still-limited international literature in this area.

This study is expected to make an important contribution to the development of more effective, student-centered, and 21st-century-oriented advanced learning strategies for teaching scientific writing. The findings may serve as a valuable reference for teachers, curriculum developers, and education policymakers in designing interventions that optimize students' potential in academic writing. Moreover, the results are anticipated to enrich the academic discourse on writing instruction in Indonesia, particularly by highlighting students' perspectives as the central focus of investigation.

2. Method

This study employed a quantitative approach using a descriptive survey method. The selection of this approach was based on the research objective, which aimed to describe students' perceptions of the quality of scientific writing learning processes through empirical data. The descriptive survey method enables researchers to obtain direct information from respondents regarding their experiences and evaluations of various aspects of instruction, thereby providing an objective and measurable overview of the phenomenon under study (Mendoza Velazco et al., 2023).

a. Participants

Participants in this study were high school students who had participated in scientific writing lessons in accordance with the applicable curriculum. The total number of respondents was n = 202 students, from four schools in Karanganyar Regency. Respondents were selected using a total sampling technique, where all students participating in the lessons during the study period were invited to participate. Respondent demographic characteristics, such as school origin and gender, were recorded to provide a more complete picture of the participant profile.

b. Research Instruments

The instrument used in this study was a student perception questionnaire designed by the researcher based on a review of relevant literature and indicators of instructional quality in scientific writing. The questionnaire was developed using a four-point Likert scale with the following categories: 1 = Disagree, 2 = Somewhat Disagree, 3 = Agree, and 4 = Strongly Agree. This scale was employed to measure students' levels of agreement with statements encompassing several dimensions of instruction, namely:

1) Participation and interaction,
2) Clarity of materials and use of examples,
3) Feedback and collaborative guidance,
4) Development of academic skills, and
5) Time management and variation of innovative learning methods

Prior to its use, the questionnaire underwent a content validity assessment conducted by two experts in language education and writing pedagogy to ensure the appropriateness of the items in relation to the study's objectives. Reliability testing was performed using Cronbach's Alpha coefficient to evaluate the internal consistency of the instrume (Taber, 2018). The analysis yielded a Cronbach's Alpha value of 0.86, exceeding the threshold of 0.70, indicating good reliability. Furthermore, all corrected item–total correlation values were above 0.30, demonstrating adequate internal consistency across all items. Therefore, the questionnaire was deemed valid and reliable for measuring students' perceptions of scientific writing instruction.

c. Data Collection

Data collection was conducted in July 2025 using a questionnaire. The questionnaire was distributed to students in digital format via Google Forms. The link to the questionnaire was shared with students by the Indonesian language teachers who taught scientific writing materials. Students, as respondents, were asked to complete the questionnaire independently and honestly based on their learning experiences. The data collection process lasted for one week, and the researcher ensured the confidentiality of respondents' identities to maintain the authenticity and integrity of the data obtained.

d. Data Analysis Techniques

The collected data were analyzed using Microsoft Excel and SPSS statistical software. The responses were downloaded in spreadsheet format and processed through two main stages of analysis:

1. Descriptive Quantitative Analysis – The mean, percentage, and standard deviation were calculated for each questionnaire item to obtain an overall picture of students' perceptions regarding each indicator of scientific writing instructional qualit.
2. Category Interpretation – The mean scores were then interpreted according to the following categories:
   1.00–1.75 = Very Low
   1.76–2.50 = Low
   2.51–3.25 = High
   3.26–4.00 = Very High

These categories were used to identify which aspects of instruction were performing well and which required improvement. The results of the descriptive analysis subsequently served as the basis for discussion, in which the findings were compared with previous literature and used to formulate practical recommendations for enhancing the quality of scientific writing instruction in schools.

3. Result and Discussion

The questionnaire was administered to 202 students to examine their perceptions of scientific writing learning. The data were analyzed descriptively to illustrate the distribution and trends of students' responses for each indicator, complemented by data visualizations in the form of tables and charts to enhance interpretability. The findings were categorized into five main aspects: (1) Participation and Interaction, (2) Clarity of Materials and Use of Examples, (3) Feedback and Collaborative Guidance, (4) Development of Academic Skills, and (5) Time Management and Variation of Innovative learning methods.

The discussion of each aspect begins with the presentation of data in tabular form, displaying the mean, standard deviation, as well as minimum and maximum values. The data are then visualized through bar charts or pie diagrams to facilitate clearer interpretation of response distributions. This approach enables readers to gain a comprehensive overview of students' perceptions before engaging with a more detailed analysis and discussion of each aspect.

a. Participation and Interaction

The analysis of the indicator related to students' active participation showed an average score of 3.20 with a standard deviation of 0.40. This value falls within the *high* category, indicating that most students perceived their teachers as providing sufficient opportunities for active involvement in the process of learning scientific writing. Such engagement includes participation in class discussions, expression of ideas, and contributions to collaborative activities. The distribution of scores for this indicator is presented in Table 1 below.

Table 1. Statistics of Active Participation and Teacher Responsiveness

Indicator	Average	Standard Deviation	Minimum Score	Maximum Score
Active Participation	3,2	0,4	3	4
Teacher Responsiveness	3,2	0,4	3	4

The data presented in Table 1 indicate a similar mean score between the indicators of students' active participation and teachers' responsiveness. For the active participation indicator, 80.20% of students selected *Agree*, while 19.80% selected *Strongly Agree*. These findings suggest that opportunities for student engagement in learning activities are already well facilitated, although there remains room for improvement to increase the proportion of students who perceive this aspect as *Very Good*.

A similar trend was observed in the indicator of teacher responsiveness to students' questions or problems, which also obtained a mean score of 3.20 with a standard deviation of 0.40. Most students (79.79%) selected *Agree* and 20.21% selected *Strongly Agree*. Teacher responsiveness plays an essential role in creating a supportive learning environment that encourages students to ask questions and engage more actively in discussions. The distribution of students' responses for both indicators is illustrated in Figure 1 below.

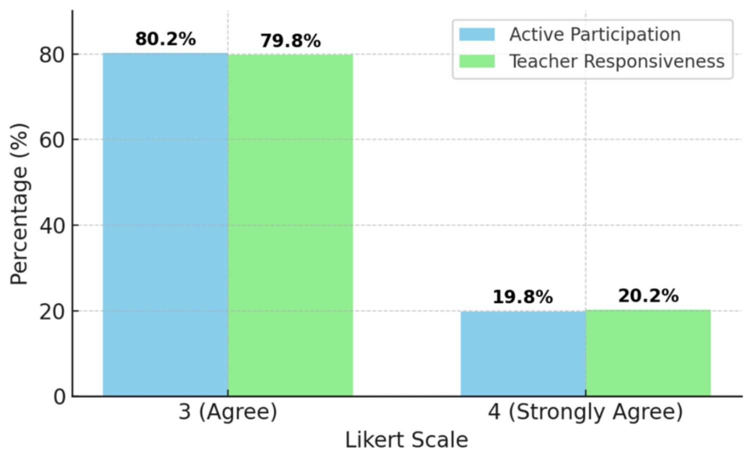

Figure 1. Distribution of Responses for Active Participation and Teacher Responsiveness

When compared, these two indicators demonstrate the consistency of students' perceptions regarding the quality of teacher–student interaction in scientific writing laerning. This consistency supports the findings of Subekti et al. (2019), who emphasized that students' active engagement is closely correlated with teachers' openness and responsiveness.

Although the results are positive, teachers still have opportunities to further enhance the quality of participation and responsiveness, for instance, by providing a wider variety of engagement formats such as peer review, academic debates, or problem-based project (Christidamayani & Kristanto, 2020). Meanwhile, responsiveness can be optimized through timely and personalized feedback, delivered either face-to-face or via digital platforms. Consequently, the level of student engagement and satisfaction with the learning process can be elevated from the "high" category to the "very high" category.

b. Clarity of Material and Provision of Examples

The analysis of the clarity of instructional steps indicator revealed a mean score of 3.15 with a standard deviation of 0.36. This value falls within the high category, indicating that the majority of students perceived the instructional steps provided by the teacher as helpful in understanding and organizing the materials for scientific writing. The relatively small standard deviation suggests a fairly homogeneous perception among students regarding the clarity of the learning sequence.

Meanwhile, for the provision of concrete examples of scientific work indicator, the mean score was 3.13 with a standard deviation of 0.34, also categorized as high. This finding indicates that most students felt the teacher provided relevant examples during instruction, although the variety and quantity of examples could still be improved to enhance comprehension. Similar to the first indicator, the low standard deviation value signifies that students' perceptions were relatively uniform across respondents.

Table 2. Statistics on Clarity of Material and Provision of Examples

Indicator	Average	Standard Deviation	Minimum Score	Maximum Score
Clarity of Learning Steps	3,15	0,36	3	4
Providing Real Examples	3,13	0,34	3	4

Table 2 presents descriptive statistics for two key indicators under the clarity of material aspect: clarity of instructional steps and provision of concrete examples of scientific writing. Both indicators obtained mean scores above 3 on a 1–4 Likert scale, indicating that students generally held positive perceptions of these aspects.

For the clarity of instructional steps indicator, the mean score was 3.15 with a standard deviation of 0.36. This suggests that most students perceived the instructional steps delivered by the teacher as clear, facilitating their understanding of the material and helping them organize ideas in writing scientific papers. The minimum value of 3 (Agree) and maximum of 4 (Strongly Agree) indicate that no respondents selected lower categories, implying consistent recognition of good instructional clarity. The relatively small standard deviation further suggests homogeneous perceptions, indicating that the teacher employed a uniform and easily comprehensible delivery method.

Meanwhile, the provision of concrete examples of scientific work indicator yielded a mean score of 3.13 with a standard deviation of 0.34. Although slightly lower than the first indicator, this score still falls into the high category. This finding implies that most students believed their teacher provided relevant examples that supported the learning process, though the frequency and variety of examples could be further improved to enrich the learning experience. Similar to the previous indicator, no respondents chose lower categories, indicating overall positive evaluations (Kuralay et al., 2025; Septriana et al., 2025).

Overall, the data in Table 2 demonstrate that both indicators make a substantial contribution to the quality of scientific writing learning. *Clarity of instructional steps* assists students in understanding the workflow from planning, data collection, and analysis to report writing (Oktavia, 2023). In contrast, the *provision of concrete examples* serves as a model or reference that students can emulate in terms of structure, language style, and the presentation of data in a scientific manner. The distribution of student responses for both indicators is illustrated in Figure 2.

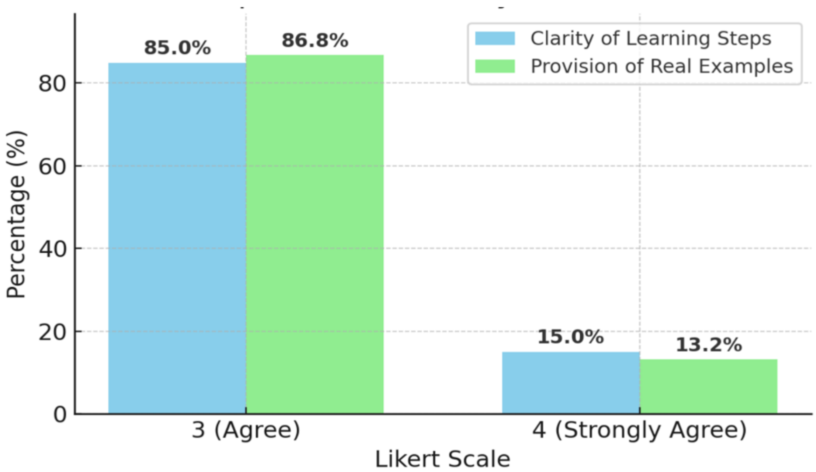

Figure 2. Distribution of Responses for Clarity and Provision of Examples

Figure 2 presents the distribution of students' responses to the indicators of clarity of instructional steps and provision of concrete examples of scientific writing, based on data from 202 respondents. For the indicator of instructional step clarity, 84.97% of students selected Agree and 15.03% selected Strongly Agree. Meanwhile, for the indicator of providing concrete examples of scientific writing, 86.84% of students chose Agree and 13.16% selected Strongly Agree. These findings indicate that the majority of students hold a positive perception of both aspects, with more than 84% agreeing that the instructional steps provided by the teacher were clear and that the concrete examples presented helped them better understand the learning material.

The data distribution, which shows no responses in the lower categories (*1 = Disagree*, *2 = Somewhat Disagree*), indicates that nearly all students evaluated both aspects positively. This finding serves as strong evidence that the overall quality of instruction is good, while also highlighting opportunities for further optimization to ensure that more students experience a highly satisfying learning process. As noted by Syamsuddin et al. (2021) even minor differences between the two indicators warrant attention. The *Strongly Agree* score was slightly higher for the indicator of instructional step clarity compared to the provision of concrete examples, suggesting that teachers should further enhance the quality and diversity of scientific writing examples to help students better understand how theoretical concepts are applied in writing practice.

The findings presented in Figure 2 confirm that both the clarity of instructional steps and the provision of concrete examples fall within the *high* category, thereby supporting the achievement of scientific writing learning objectives. Nevertheless, to increase the proportion of students who selected *Strongly Agree*, teachers are encouraged to clarify instructional stages through visual media such as concept maps or flow diagrams, and to provide a wider range of contextual examples, including scientific papers from various disciplines or exemplary works produced by previous students. These strategies have the potential to shift students' perceptions from merely *agreeing* to *strongly agreeing*, thereby contributing to the continuous improvement of scientific writing learning quality.

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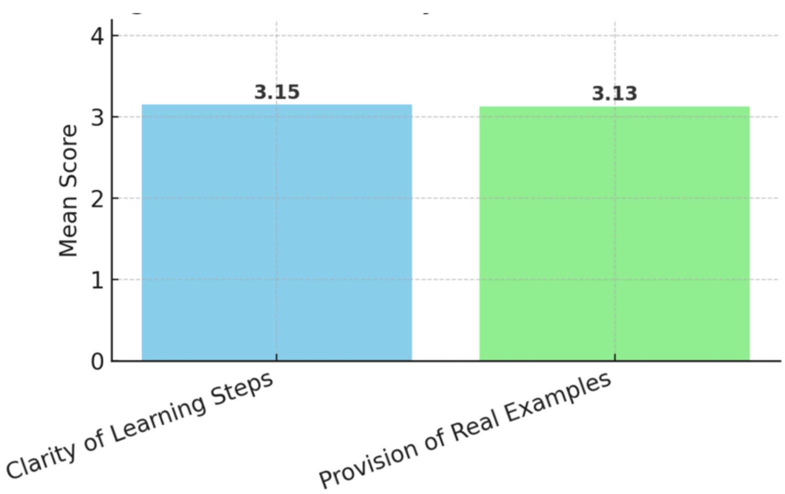

Figure 3. Average Scores for Clarity and Provision of Examples

Figure 3 presents a comparison of the mean scores for two key indicators within the aspect of material clarity: the *clarity of instructional steps* and the *provision of concrete examples of scientific writing*. The mean score for the clarity of instructional steps was 3.15, while the mean score for the provision of concrete examples was 3.13 on a 1–4 Likert scale. Both values fall within the *high category*, indicating that the majority of students gave positive evaluations for both aspects. The difference between the two indicators was minimal (0.02 points), suggesting that students' perceptions were relatively consistent regarding both the clarity of the instructional process and the examples provided by the instructor.

According to Slamet et al. (2019), although the difference is small, the slightly higher mean score for instructional step clarity can be interpreted as students perceiving that the teacher's presentation of learning stages was marginally more helpful than the examples provided. This finding aligns with Hayuana et al. (2024), who emphasized that the clarity of instructional guidance is a fundamental element that helps students comprehend the logical flow and structure of scientific writing. Nevertheless, the small gap in scores also signals a need to enhance the provision of examples in terms of variety, quality, and depth of discussion so that students have richer references for emulating format, linguistic style, and data presentation in scientific work.

The visualization in Figure 3, which juxtaposes the two mean scores, enables readers to easily observe the similarity in students' perception patterns. The uniformity of these scores reinforces the conclusion that the teacher delivered instruction that was both clear and relevant. However, mean values ranging from 3.1 to 3.2 also indicate an opportunity to elevate learning outcomes to the *very high* category through more innovative interventions. Recommended strategies include the use of modeling or think-aloud techniques to demonstrate cognitive processes in writing, as well as providing annotated exemplars of scientific papers that explicitly explain why certain examples are considered effective. Write-aloud/think-aloud lessons where teachers verbalize planning, selecting evidence, monitoring, and revising improve students' writing skills and strategy use, especially within a gradual release framework (Alston et al., 2021; Pratt & Hodges, 2024; Sandra et al., 2024).

Figure 3 thus reinforces the findings from Table 2 and Figure 2, confirming that both indicators received positive perceptions but still require optimization to shift students' responses from *Agree* toward *Strongly Agree*. Enhancing the quality and diversity of concrete examples, alongside more systematic presentation of instructional steps, is expected to raise the average scores and, in turn, improve the overall quality of scientific writing learning positively influencing students' academic writing competence (Hermita et al., 2022).

c. Collaborative Feedback and Guidance

Feedback and collaborative guidance are crucial elements in learning to write scientific papers, as they serve as mechanisms for strengthening understanding and motivation to learn (Areskoug Josefsson et al., 2024). Teacher feedback helps students identify strengths and weaknesses in their writing, enabling them to make more targeted revisions. Meanwhile, facilitating collaborative activities and guiding the implementation of materials allows students to interact, discuss, and collaborate in developing ideas, ultimately fostering their critical thinking and communication skills (Dharmayanti et al., 2024).

To assess students' perceptions of these three aspects, a descriptive analysis was conducted of questionnaire items related to feedback provision, collaborative facilitation, and assistance with material implementation. Table 3 below presents descriptive statistics for three key indicators reflecting the quality of feedback and collaborative guidance in learning to write scientific papers. The mean, standard deviation, and minimum and maximum scores are presented to provide an overview of students' perceptions of each indicator.

Table 3. Collaborative Feedback and Guidance Statistics

Indicator	Average	Standard Deviation	Minimum Score	Maximum Score
Providing feedback	3,1	0,3	3	4
Facilitating collaborative activities	3,13	0,34	3	4
Assistance with material implementation	3,14	0,34	3	4

Table 3 presents the descriptive statistics for three indicators related to instructional support: *feedback provision*, *facilitation of collaborative activities*, and *assistance in material implementation*. All three indicators obtained mean scores above 3.00 on a 1–4 Likert scale, placing them within the *high category*. The highest mean score was recorded for the indicator *assistance in material implementation* (M = 3.14), suggesting that students perceived the teacher's guidance in applying learning materials to the actual practice of scientific writing as considerably helpful. The indicator *facilitation of collaborative activities* achieved a mean of 3.13, indicating that the teacher actively promoted teamwork and collaborative projects. Meanwhile, *feedback provision* received a mean score of 3.10 still within the high category but the lowest among the three indicators. This finding implies that the quality or frequency of feedback could be further enhanced to more effectively help students identify weaknesses and refine their academic writing skills.

The relatively small standard deviations across the three indicators (ranging from 0.29 to 0.34) reflect a high level of consistency in students' perceptions, suggesting that these results represent the collective experience of most respondents. The absence of responses below the score of *3 (Agree)* further reinforces that nearly all students evaluated these instructional aspects positively. However, since the mean scores have not yet reached the 3.25 threshold, there remains room for improvement to elevate students' perceptions toward the *very high* category.

Figure 4 illustrates the comparative distribution of students' responses in the *Agree* and *Strongly Agree* categories for the three indicators. This visualization provides insight into the proportion of students who expressed strong satisfaction with the teacher's practices in *feedback provision*, *collaborative facilitation*, and *guidance in material implementation*. Observing these proportions allows for identifying which instructional components most effectively foster student engagement and confidence in scientific writing.

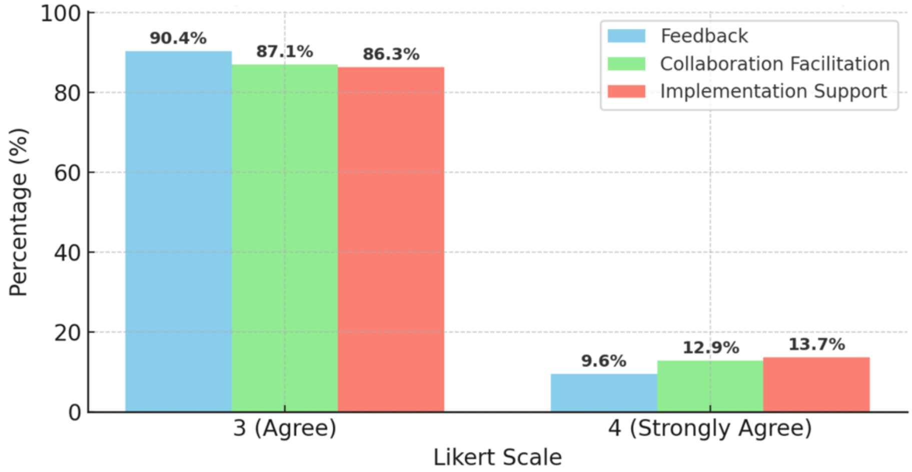

Figure 4. Distribution of Responses: Feedback, Collaboration, and Implementation

Figure 4 illustrates the percentage distribution of student responses in the *Agree* and *Strongly Agree* categories across three indicators: *feedback provision*, *facilitation of collaborative activities*, and *assistance in material implementation*. The results show that for all three indicators, more than 80% of students selected *Agree*, while the proportion of *Strongly Agree* responses ranged between 15–18%. This pattern indicates that students' overall perceptions were positive, yet the majority remained at the "agree" level and had not reached the highest level of satisfaction.

Among the three indicators, *assistance in material implementation* recorded the highest proportion of *Strongly Agree* responses, suggesting that students perceived the teacher's guidance as particularly beneficial during the process of completing scientific writing tasks. *Facilitation of collaborative activities* followed closely, demonstrating that the teacher had provided adequate support for group work, though opportunities remain to enhance the quality of collaborative interaction (Wan Yusof et al., 2022). Conversely, *feedback provision* displayed the lowest proportion of *Strongly Agree* responses, which is consistent with the mean scores reported in Table 3. This finding suggests that although feedback was present, students may expect feedback that is more detailed, personalized, and frequent throughout the writing process.

Analyzing this distribution is essential because it provides insights not only into the average scores but also into the spread of students' perceptions, thereby identifying which aspects require priority improvement (Eppler et al., 2021). Enhancement efforts could focus on implementing more *constructive feedback strategies*, including detailed written comments, revision discussion sessions, and *feedforward* activities that guide students toward future improvement (Marmoah et al., 2020).

Following the examination of the percentage distribution in Figure 4, the subsequent analysis compares the mean scores of the three indicators visually. Figure 5 presents this comparison in the form of a bar chart, enabling readers to easily identify which indicators received the highest and lowest levels of perceived effectiveness from the students' perspective.

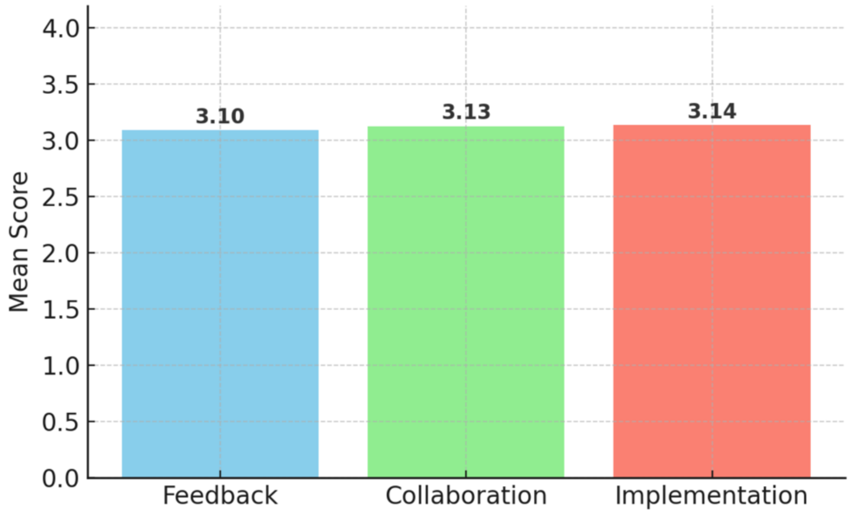

Figure 5. Average Scores for Feedback, Collaboration, and Implementation

Figure 5 presents a comparison of the mean scores for the three indicators: *feedback provision*, *facilitation of collaborative activities*, and *assistance in material implementation*. The results show that the average scores are relatively similar, with the highest mean observed for *assistance in material implementation* (3.14), followed by *facilitation of collaborative activities* (3.13), and the lowest for *feedback provision* (3.10). Although the difference in mean values is small, it provides an important signal regarding which aspects should be prioritized for improvement. The relatively higher score for *assistance in material implementation* confirms that students perceived tangible support from the teacher when applying theoretical concepts into the practical task of writing scientific papers (Wingard et al., 2020). This finding underscores the effectiveness of a contextual and application-oriented learning approach.

Meanwhile, the slightly lower mean score for *feedback provision* reinforces previous findings that students may expect more intensive, detailed, and continuous forms of feedback. Teachers can enhance this aspect by providing more frequent formative feedback not only on the final product but also at various stages of the writing process (Haiyudi & Art-In, 2021). Such a strategy allows students to identify and address weaknesses earlier, thereby improving the overall quality of their scientific writing progressively.

The visualization in Figure 5 clearly illustrates that although all three indicators fall within the “high” category, there remains substantial room for improvement to elevate the scores toward the “very high” category (>3.25). This can be achieved by optimizing more personalized mentoring approaches, leveraging digital platforms for timely feedback, and strengthening the dynamics of collaborative group work to enhance learning effectiveness.

To further identify which specific aspect most strongly contributes to students’ highest satisfaction levels, the analysis proceeds by examining the proportion of respondents selecting *Strongly Agree* for each indicator. Figure 6 displays this comparison in the form of a pie chart, allowing readers to easily visualize which indicator received the greatest proportion of top-level ratings from students.

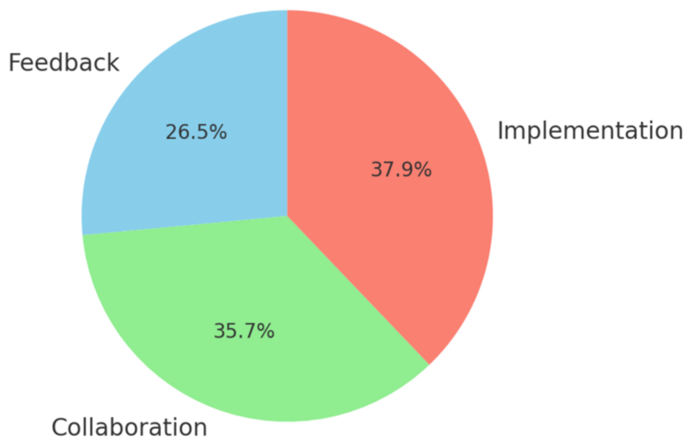

Figure 6. Proportion of "Strongly Agree" Responses

Figure 6 illustrates the proportion of respondents who selected the *Strongly Agree* category for the three indicators within the *Feedback and Collaborative Guidance* dimension. The results reveal that *assistance in material implementation* recorded the highest percentage of *Strongly Agree* responses, followed by *facilitation of collaborative activities*, while *feedback provision* received the lowest proportion. This pattern reinforces the findings presented in Table 3 and Figure 5, indicating that students perceived the greatest positive impact from teachers' guidance in applying learning materials to the practical task of writing scientific papers. Such findings suggest that teachers have successfully fostered an *experiential and contextual learning environment*, thereby enhancing students' confidence in transferring theoretical knowledge into practice (Evidiasari et al., 2019).

Although the proportion of *Strongly Agree* responses for *facilitation of collaborative activities* is also relatively high, the lower score on *feedback provision* highlights an area for improvement. The feedback provided by teachers may still be general or concentrated at the final stage of writing, offering limited opportunities for students to revise and refine their drafts progressively (Adhantoro et al., 2025). To address this, teachers could incorporate more structured *peer review* sessions under guided supervision, provide detailed written comments on early drafts, and conduct brief face-to-face or online consultations to discuss necessary revisions.

The analysis of Figure 6 provides valuable insight for designing targeted strategies to enhance instructional quality. By capitalizing on the strength demonstrated in *assistance in material implementation* as a *best practice*, teachers can apply similar approaches to improve the effectiveness of feedback processes (Chang et al., 2023). For instance, teachers may adopt a more personalized guidance model during the initial stages of writing, offer *feedforward* to support students' future improvement, and integrate feedback as a continuous learning mechanism. These measures are expected to increase the proportion of *Strongly Agree* responses, thereby optimizing students' learning experience and improving the overall quality of their academic writing outcomes (Oktavia, 2023).

d. Academic Skill Development

Academic skill development constitutes one of the core objectives of scientific writing learning. Through writing activities, students are expected not only to produce texts that adhere to academic conventions but also to develop higher-order competencies such as *critical thinking*, *language proficiency*, and *communication skills*. These dimensions form a crucial foundation for students' readiness to navigate academic challenges in higher education and to adapt to professional demands in an increasingly knowledge-based society (Slamet et al., 2019). To assess students' perceptions of how writing instruction contributes to the development of these competencies, a descriptive analysis was conducted based on questionnaire items measuring linguistic ability, critical thinking, and communication skills (Harjanto et al., 2018).

Table 4. Academic Skills Development Statistics

Indicator	Average	Standard Deviation	Minimum Score	Maximum Score
Language skills development	3,16	0,35	3	4
Critical thinking development	3,16	0,36	3	4
Communication skills development	3,17	0,35	3	4

Table 4 presents the mean scores for the three indicators of academic skill development *language proficiency*, *critical thinking*, and *communication skills*. All three indicators obtained mean scores above 3.00 on a 1–4 Likert scale, indicating a *high category*. The highest mean score was observed for the *communication skill* indicator (M = 3.17), suggesting that students perceived scientific writing activities as effective in helping them articulate ideas in a more structured and coherent manner. Both *language proficiency* and *critical thinking* indicators yielded identical mean scores (M = 3.16), implying that students also recognized the benefits of writing in refining their linguistic competence and enhancing their analytical reasoning skills (Emara et al., 2021).

The standard deviations across the three indicators were relatively small (approximately 0.35–0.36), indicating a high degree of homogeneity in students' perceptions. None of the respondents selected options below a score of 3, meaning that nearly all students agreed that writing instruction contributed positively to their academic skill development. Nevertheless, as the mean values were only slightly above 3, these results also suggest that the perceived contribution of writing instruction has *not yet reached the "very high" category*. This indicates the need to further enrich advanced learning strategies that foster *higher-order thinking skills* and more sustained academic growth.

Figure 7 visually illustrates this distribution, showing the proportion of students who strongly agreed that writing instruction significantly enhanced their *language proficiency*, *critical thinking*, and *communication skills*.

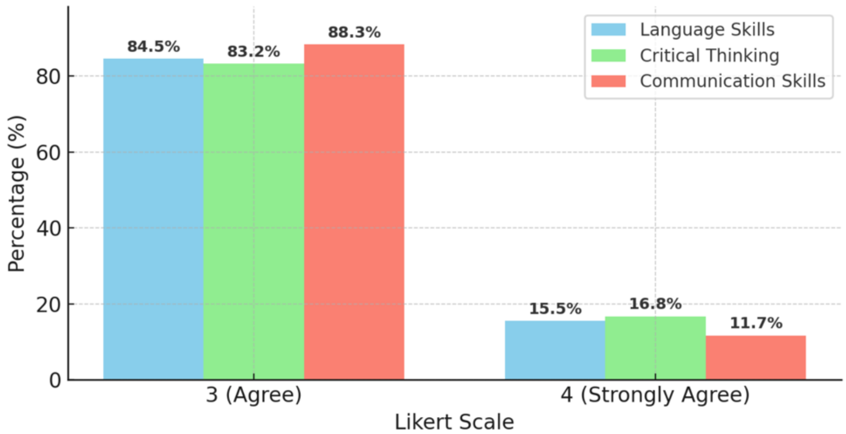

Figure 7. Distribution of Responses: Language, Critical Thinking, Communication

Figure 7 displays the distribution of student responses within the *Agree* and *Strongly Agree* categories for the three indicators of academic skill development. It can be observed that across all indicators, more than 80% of students selected *Agree*, while the proportion of *Strongly Agree* responses ranged between 14% and 17%. This pattern indicates that the majority of students hold positive perceptions regarding the contribution of scientific writing instruction to the development of their *language*, *critical thinking*, and *communication* skills. However, the dominance of the *Agree* category over *Strongly Agree* also signals that while the perceived impact of instruction is favorable, it has not yet reached a level that generates very high satisfaction or transformative learning outcomes.

The distribution in Figure 7 further reveals that the indicator related to *communication skills* obtained a slightly higher proportion of *Strongly Agree* responses compared to the other two indicators. This finding suggests that scientific writing activities most effectively enhance students' ability to articulate ideas and express opinions in an organized and persuasive manner. Meanwhile, the indicators of *critical thinking* and *language development* show nearly identical distribution patterns, indicating that students perceived comparable benefits in these two aspects (Andrini & Yusro, 2021).

It is noteworthy that no respondents selected the lower categories, reflecting a uniformly positive perception of the course. Nevertheless, to shift more responses from *Agree* to *Strongly Agree*, instructors may consider enriching their pedagogical strategies by incorporating *critical reflection exercises*, *argument-building tasks*, and *peer-review activities* to foster higher language awareness and deeper analytical engagement (Adipat, 2021). Figure 8 provides a comparative bar chart illustrating which indicators received the highest perceptions and which still hold potential for further enhancement.

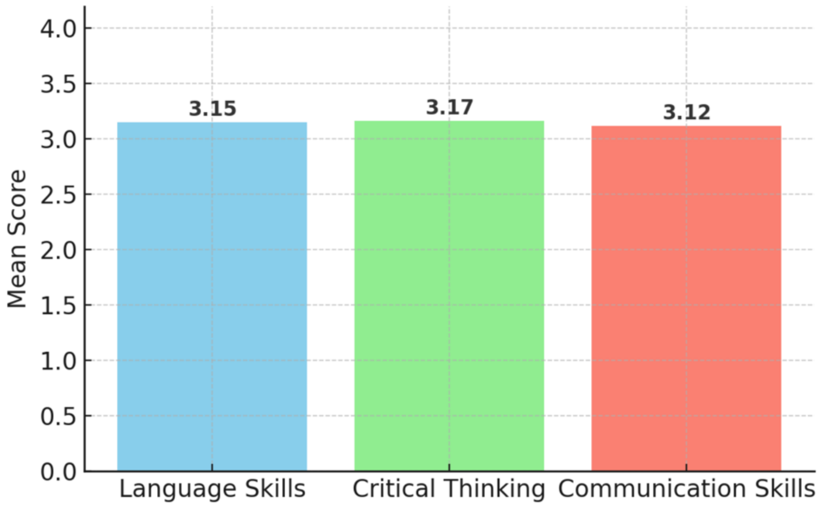

Figure 8. Average Scores: Language, Critical Thinking, Communication

Figure 8 presents the comparison of mean scores for the three indicators of academic skill development: *language proficiency*, *critical thinking*, and *communication skills*. It is evident that the average scores across all three indicators are nearly identical, ranging between 3.15 and 3.17. The highest mean score is observed for *communication skills* (3.17), indicating that students perceived the strongest positive impact of scientific writing instruction on their ability to articulate ideas and engage effectively in academic interactions. Meanwhile, both *language proficiency* and *critical thinking skills* share comparable mean values (3.16), suggesting that writing instruction contributed relatively evenly to the enhancement of both dimensions.

The uniformity of these mean scores demonstrates that the implementation of scientific writing instruction does not emphasize a single skill domain but rather promotes a balanced development of students' academic competencies in a holistic manner (Rasul et al., 2024). Although the overall results fall within the *high* category, the means slightly above 3.00 suggest that there remains room for improvement, particularly in activities designed to stimulate higher-order thinking skills such as argument analysis, idea synthesis, and text evaluation.

According to Zou et al. (2022), instructors may integrate *problem-based learning* or *project-based learning* strategies to further cultivate critical thinking, while providing more in-depth linguistic feedback to enhance precision and clarity in students' language use. Figure 9 visualizes this comparison in a pie chart format, enabling readers to easily identify which indicators received the highest satisfaction levels and which aspects should become the focus of future pedagogical enhancement.

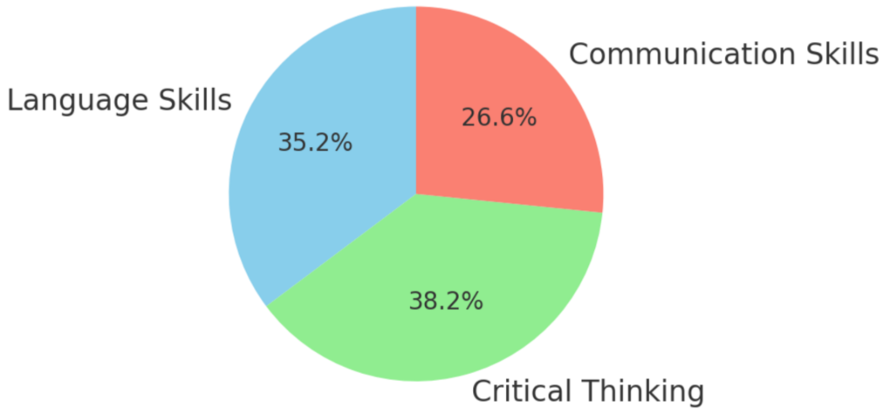

Figure 9. Proportion of "Strongly Agree" Responses

Figure 9 illustrates the proportion of students who selected the *Strongly Agree* category for the three indicators of academic skill development. The results reveal that the indicator of *communication skills* recorded the highest proportion of *Strongly Agree* responses, followed by *critical thinking skills* and *language proficiency*. This finding reinforces the results presented in Figure 8, confirming that students perceived the most tangible contribution of scientific writing laering to lie in the enhancement of their ability to communicate effectively. This outcome is reasonable, as the writing process inherently requires students to organize ideas, construct arguments, and articulate them clearly activities that naturally foster communication competence (Nobre et al., 2020).

The relatively lower proportion of *Strongly Agree* responses for *language proficiency* indicates that although writing activities assist students in improving linguistic competence, some learners may still encounter challenges related to grammar, vocabulary, or sentence structure. Teachers can address these issues by incorporating more language-focused exercises, providing exemplary models of effective academic writing, and offering targeted feedback on language-related errors in students' manuscripts.

Meanwhile, the moderate proportion of *Strongly Agree* responses for *critical thinking skills* suggests that while many students benefit from writing tasks that stimulate analytical reasoning, not all have yet reached an optimal level of critical awareness. To strengthen this dimension, teachers may design writing assignments that require deeper analysis, literature comparison, and data-driven argumentation thus cultivating students' ability to process information criticall (Adhantoro et al, 2025).

Overall, Figure 9 confirms that scientific writing learning has made a positive contribution to students' academic skill development. However, there remains scope for pedagogical refinement to encourage a larger proportion of students to express *Strongly Agree* evaluations. Enriching advanced learning strategies, diversifying writing tasks, and providing more intensive supervision could further enhance these outcomes, ensuring that writing instruction not only produces high-quality written products but also significantly strengthens students' critical thinking, linguistic, and communicative competencies (Ramandanis & Xinogalos, 2023).

e. Time Management and Method Variation

Time management and methodological variation are key factors influencing the effectiveness of the learning process, particularly in the context of scientific writing learning. Adequate time allocation enables students to complete writing projects more effectively, while sufficient time for group discussions fosters peer interaction and collaborative learning. At the same time, the use of diverse instructional methods such as discussions, presentations, practical tasks, and technology integration is essential to sustain student motivation and accommodate different learning styles (Parsazadeh et al., 2021). To examine how students perceived these aspects, a descriptive analysis was conducted on questionnaire items related to *learning time allocation*, *discussion and collaboration time*, and *variety of innovative learning methods* employed by the instructor. Table 5 presents the calculated mean scores, standard deviations, and minimum–maximum values, providing an overview of students' general evaluation tendencies toward these three instructional components.

Table 5. Time Management Statistics and Method Variations

Indicator	Average	Standard Deviation	Minimum Score	Maximum Score
Learning time allocation	3,06	0,25	3	4
Discussion/collaboration time	3,1	0,3	3	4
Variation of learning methods	3,14	0,35	3	4

Table 5 shows that all three indicators under the aspect of *time management and instructional method variation* achieved mean scores above 3.00 on a 4-point Likert scale, indicating a high category. The indicator *variation of instructional methods* obtained the highest mean score (3.14), suggesting that the instructor has effectively utilized diverse teaching approaches such as discussions, presentations, practical assignments, and learning technologies to support the process of scientific writing. The indicator *discussion/collaboration time* achieved a mean of 3.10, indicating that most students perceived the time provided for discussions and group projects as sufficiently adequate. Meanwhile, the indicator *allocation of learning time* recorded the lowest mean (3.06), although it still falls within the high category. This finding implies that some students may perceive the allotted time for certain topics as needing optimization, particularly when dealing with complex materials or writing tasks that require more intensive practice.

The relatively low standard deviations (ranging from 0.25 to 0.35) across the three indicators indicate a high level of consistency in students' perceptions, suggesting that the data reliably represent the general student experience. No respondents selected the lower categories (1 = *Strongly Disagree*, 2 = *Disagree*), implying that students generally view the time allocation, discussion opportunities, and instructional variety positively. However, since the mean scores remain slightly below 3.25, these findings highlight the potential for further enhancement through more diversified and in-depth learning strategies. Figure 10 presents the distribution of responses in a bar chart, allowing a clearer visualization of the proportions of respondents who selected *Agree* and *Strongly Agree* for each indicator.

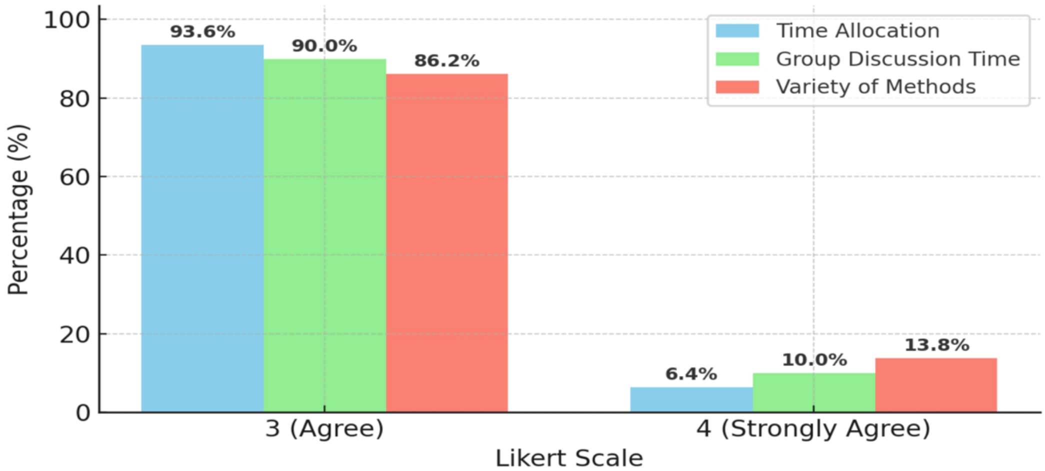

Figure 10. Distribution of Responses: Time Allocation, Discussion, Methods

Figure 10 displays the percentage distribution of student responses in the Agree and Strongly Agree categories for the three indicators of time management and method variation. It can be seen that for all three indicators, more than 80% of students chose Agree, while the proportion of Strongly Agree ranged from 13–16%. This distribution indicates that most students have a positive perception of the allocation of learning time, discussion/collaboration time, and the variety of learning methods used by the teacher. However, the dominance of responses in the Agree category indicates that student satisfaction remains at the "agree" level, with not many feeling very satisfied (Strongly Agree).

Of the three indicators, the variety of learning methods had a slightly higher proportion of Strongly Agree responses than the other two indicators, indicating that the teacher's innovation in varying learning approaches was relatively favorably perceived by students. This finding reflects the implementation of innovative learning, in which teachers move beyond conventional instructional practices by integrating diverse strategies that encourage active participation, creativity, and learner centered engagement. Conversely, the allocation of learning time had the lowest proportion of Strongly Agree responses, consistent with the average scores in Table 5. This indicates the need for improvements in learning time management to provide students with greater opportunities to delve deeper into the material and optimally complete writing assignments. rom the perspective of innovation education, effective time allocation is a crucial systemic component, as educational innovation not only concerns innovative learning methods but also involves structural and managerial adjustments that support meaningful learning experiences. More production time generally improves performance, although the effect is small–moderate and depends heavily on how much time is spent (Andersen et al., 2016; Kraft & Novicoff, 2024).

The visualization in Figure 10 helps clarify priorities for improvement. Teachers can consider increasing the duration of writing exercises or providing additional consultation sessions outside of class hours to ensure students have sufficient time. Such strategies align with innovative learning environments that emphasize flexibility, personalization, and extended learning opportunities beyond formal classroom settings. Furthermore, the use of more varied learning methods can be maintained or even expanded, for example by utilizing interactive technology and digital media to increase student engagement. The integration of digital tools represents an essential dimension of innovation education, where technology is leveraged not merely as a supplement but as a transformative medium that reshapes pedagogical practices and enhances students' higher-order thinking skills. Figure 11 presents this average comparison in bar chart form, so readers can easily see which indicators have the highest perceptions and which indicators still require more attention. Overall, these findings suggest that sustained innovation in both learning practices (innovation learning) and broader educational design (innovation education) is necessary to achieve balanced improvements across pedagogical, temporal, and technological dimensions of the learning process.

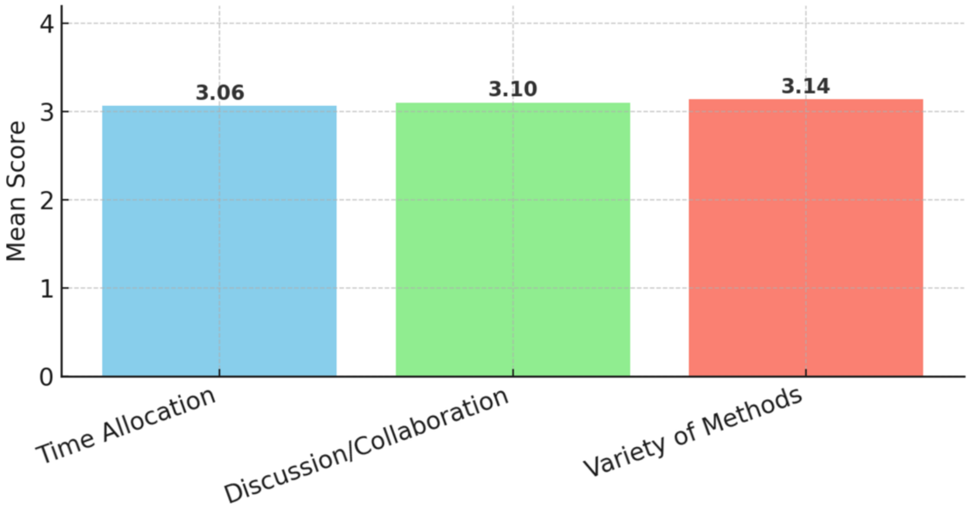

Figure 11. Average Scores: Time Allocation, Discussion, Methods

Figure 10 presents the distribution of students' responses in the *Agree* and *Strongly Agree* categories for the three indicators of time management and instructional method variation. Across all indicators, more than 80% of students selected *Agree*, while the proportion of *Strongly Agree* responses ranged between 13% and 16%. This distribution suggests that most students hold positive perceptions of the allocation of learning time, opportunities for discussion and collaboration, and the variety of instructional methods used by the instructor. However, the dominance of responses in the *Agree* category indicates that students' satisfaction remains at a "positive but moderate" level, with relatively fewer expressing a very high level of satisfaction.

Among the three indicators, *variation of instructional methods* recorded a slightly higher proportion of *Strongly Agree* responses compared to the other two, reflecting that the instructor's efforts to diversify learning approaches were perceived more favorably by students. Conversely, *allocation of learning time* showed the lowest proportion of *Strongly Agree* responses, which is consistent with the mean values reported in Table 5. This finding highlights the need for improvement in time management, ensuring that students have sufficient opportunities to explore materials in depth and complete writing tasks optimally.

The visualization in Figure 10 provides clarity on the priorities for pedagogical enhancement. Instructors may consider extending writing practice sessions or offering additional consultation hours outside class time to provide students with adequate time for completion and reflection. Moreover, the use of varied instructional methods should be maintained and further expanded for instance, through the integration of interactive technologies and digital media to enhance student engagement and learning motivation. Figure 11 presents a comparison of the mean scores in a bar chart, allowing readers to easily identify which indicators received the highest perceptions and which require greater instructional attention

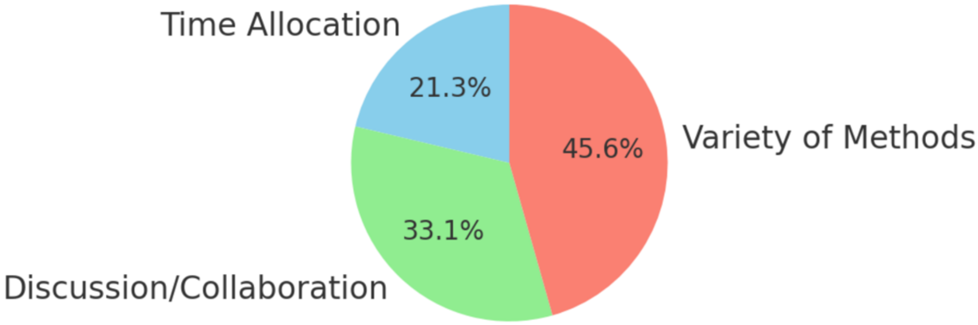

Figure 12. Proportion of “Strongly Agree” Responses

Figure 12 illustrates the proportion of respondents who selected the *Strongly Agree* category for the three indicators under Point 5 namely, *allocation of learning time*, *discussion/collaboration time*, and *variation of instructional methods*. The highest proportion was recorded for *variation of instructional methods*, indicating that students most appreciated the instructor’s innovation in employing diverse approaches such as discussions, presentations, practical assignments, and educational technologies. This finding aligns with the mean scores presented in Figure 11, where this indicator also attained the highest value. In other words, the instructional variety implemented by the instructor has generated tangible positive effects perceived by the students. A variety of teaching activities enhance creativity and explain theory with practice, thereby improving learning outcomes and innovation (Bhuttah et al., 2024; Kulachai et al., 2025; Tanveer, 2025).

The *discussion/collaboration time* indicator ranked second in the proportion of *Strongly Agree* responses, suggesting that students were generally satisfied with the time provided for group collaboration. Nevertheless, this aspect could be further strengthened by offering more structured guided discussions, brainstorming sessions, or reflective group activities that encourage deeper idea development. Meanwhile, the *allocation of learning time* indicator obtained the lowest proportion of *Strongly Agree* responses, reinforcing the signal that time management remains an area for improvement (Puccio et al., 2020). This can be addressed by clarifying lesson schedules, balancing time between content delivery and writing practice, and providing additional sessions such as writing consultations or clinics beyond regular hours. These measures would allow students more opportunities to explore ideas, compose drafts, and produce higher-quality revisions. Overall, Figure 12 underscores that the primary area for pedagogical enhancement lies in time management, while maintaining the already effective instructional variety. Increasing the proportion of students who express *Strongly Agree* in time related indicators is expected to elevate overall perceptions of instructional effectiveness and, consequently, enhance learning outcomes.

The results of this study on students' perceptions of scientific writing learning indicate that, overall, all assessed aspects fall into the *high category*, with mean scores exceeding 3.00 on a 1–4 Likert scale. This reflects a generally positive perception of the quality of teaching provided by the instructor.

In terms of participation and interaction, most students felt they had sufficient opportunities for active engagement and received adequate responses to their questions and challenges. However, the dominance of *Agree* over *Strongly Agree* suggests a need for more interactive pedagogical strategies, such as group discussions, peer review, and problem-based projects, to foster higher levels of engagement and autonomy. For clarity of instruction and use of examples, findings reveal that students perceived the instructional steps as clear and that the instructor provided relevant examples of scientific writing. Yet, the relatively low proportion of *Strongly Agree* responses implies that students desire more diverse and contextual examples. Incorporating concept maps, flow diagrams, and exemplars from different disciplines may enhance students' understanding and engagement. So learning will be better if you teach using real examples (Krause-Wichmann et al., 2025; Micallef & Newton, 2024; Weinstein et al., 2018).

Regarding feedback and collaborative guidance, all three indicators received positive evaluations, with the highest mean for *assistance in implementing concepts*. This suggests that instructor guidance effectively supports students in translating theoretical knowledge into practical writing performance. Nevertheless, *feedback provision* emerged as a key area for improvement. Implementing more intensive and personalized formative feedback, along with *feedforward* strategies, can help students improve their writing progressively. Studies on academic and legal writing show that targeted guidance and formative support help students transform abstract criteria or legal rules into more structured, higher-quality texts (Peungcharoenkun & Waluyo, 2023; Schillings et al., 2023; Weber et al., 2025)

In the area of academic skill development, results confirm that scientific writing learning contributes positively to students' linguistic, critical thinking, and communication skills, with relatively balanced mean scores across these dimensions. This demonstrates the holistic impact of writing instruction in equipping students with essential academic competencies. Still, more cognitively demanding activities such as literature analysis, idea synthesis, and reflective discussions should be incorporated to further enhance critical thinking development. Integrating critical thinking explicitly into writing tasks (e.g., argumentative/problem-solution essays, evidence-based reasoning) yields significant improvements in both writing quality and critical thinking performance and engagement (Al Herz, 2025; Hilario et al., 2025)

Finally, in the time management and instructional variation dimension, *variation of methods* received the highest score, while *time allocation* scored the lowest. This suggests that although innovative learning methods are already diverse, students perceive the time provided for writing and discussion as limited. Improving time management through better scheduling and additional consultation sessions is expected to enhance learning experiences and writing performance. From an advanced learning perspective, adequate time allocation is essential to support deep learning processes, such as critical analysis, iterative drafting, and reflective revision, which are core characteristics of higher-level academic writing instruction.

In summary, this study confirms that scientific writing learning in the classroom has been effectively implemented and has yielded positive impacts on students' academic skill development. Nevertheless, the findings also reveal areas for pedagogical improvement particularly in feedback intensity, diversity of examples, and management of instructional time. These areas are closely related to advanced learning environments, which emphasize continuous formative feedback, exposure to complex and authentic models, and flexible learning structures that accommodate individual learning trajectories. By adopting more interactive, personalized, and contextual learning strategies, it is expected that student perceptions will shift from *Agree* toward *Strongly Agree*, thereby optimizing the overall effectiveness of scientific writing learning. Such strategies align with the principles of advanced learning, where learners are positioned as active knowledge constructors and are supported through scaffolding, metacognitive guidance, and sustained engagement with challenging academic tasks.

4. Conclusion

This study provides a comprehensive overview of students' perceptions of scientific writing instruction based on data from 202 respondents. Overall, the findings indicate that students hold highly positive perceptions of the instructional process across all measured dimensions, with mean scores exceeding 3.0 on a 1–4 Likert scale. These results suggest that instructors have successfully fostered active participation and meaningful interaction, delivered well-structured and clear learning procedures, and provided effective guidance and collaborative facilitation during the writing process. Furthermore, students acknowledged that the writing activities significantly contributed to the development of their linguistic, critical thinking, and communication skills, thereby reinforcing the role of writing instruction as a holistic academic skill-building medium. However, the proportion of students selecting the Strongly Agree category remained relatively low (13–17%), indicating the need to optimize teaching strategies so that students' satisfaction levels can progress from "agree" to "strongly agree."

Key areas for improvement include time allocation for writing practice, the quality and frequency of feedback, and the diversity of instructional examples provided. Enhancements may be achieved by integrating more intensive formative feedback cycles, supplying annotated exemplars of scientific writing, and allocating additional time for writing exercises and collaborative discussions. These findings carry important pedagogical implications. Instructors are encouraged to adopt more interactive and learner-centered approaches, such as project-based learning, peer review sessions, and staged assignments with explicit scaffolding. Such strategies are expected to enhance student engagement while fostering higher-order thinking and academic communication skills. Future research is recommended to examine the long-term impact of these strategies on students' writing quality and to conduct cross-context comparisons to assess the consistency of outcomes. Overall, this study underscores that systematically and variably designed scientific writing instruction not only improves students' technical writing competence but also supports their cognitive and communicative development. Strengthening feedback mechanisms, optimizing time management, and diversifying instructional methods represent strategic directions for further enhancing the quality and effectiveness of scientific writing pedagogy in the future.

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