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Human-AI Collaboration in Scientific Writing Training: A Quantitative Evaluation of Learning Effectiveness and Academic Integrity

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Abstract

Background: The rapid advancement of Artificial Intelligence (AI) has significantly transformed academic writing practices, offering both opportunities and ethical challenges, particularly related to plagiarism and over-reliance on automated tools.
Objectives: This study aims to evaluate the effectiveness of AI-assisted scientific writing training in enhancing participants' writing skills, academic integrity awareness, and writing efficiency through a Human-AI Collaboration approach.
Methods: A quantitative descriptive method was employed using a structured questionnaire consisting of 20 Likert-scale items administered to 85 participants. The instrument measured five dimensions: relevance and conceptual understanding, instructional quality, writing skill improvement, academic integrity awareness, and perceived impact. Data were analyzed using descriptive statistics, including mean scores and percentage distributions.
Results: The findings reveal that the training achieved a very high level of effectiveness, with an overall mean score of 3.59. All variables were categorized as very high, with academic integrity awareness obtaining the highest mean score (3.70), indicating strong improvement in ethical understanding. Writing skill improvement showed relatively lower scores, suggesting the need for continuous practice.
Conclusion: AI-assisted scientific writing training based on the Human-AI Collaboration framework is highly effective in improving scientific writing competence and promoting ethical awareness. This approach provides a balanced model integrating technical skills and academic integrity in AI-supported writing practices.

A. Introduction

Currently, the rapid development of *Artificial Intelligence* (AI) technology in recent years has brought significant changes or transformations in various aspects of life, including in the practice of scientific

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writing in higher education environments (Tejeda et al., 2026). Students as part of the academic community are required to be able to produce scientific papers that are not only of quality in substance, but also meet strict academic ethical standards. The presence of various AI-based tools such as *ChatGPT, Grammarly, and QuillBot* has provided significant convenience in the writing process, from finding ideas, drafting a writing framework, improving grammar, to paraphrasing processes (Song & Song, 2023). This technology allows users to work more efficiently and productively compared to conventional methods (Matta, 2026; Shen & Tamkin, 2026).

While the usage of artificial intelligence (AI) in academic activities is growing quickly in Indonesia, university students' concerns about the ethical use of AI are also becoming more widespread. Many Indonesian students have started using AI-based tools like ChatGPT, Grammarly, and paraphrase apps to help with academic assignments and scientific writing, according to recent reports and scholarly discussions (Park, 2025). However, this quick uptake is frequently coupled by a lack of knowledge about ethical AI use, citation ethics, and academic integrity. Concerns regarding the increasing risk of AI-assisted plagiarism, including incorrect paraphrasing, unreliable AI-generated work, and an over-reliance on automated writing tools, have also been voiced by a number of Indonesian colleges. This circumstance emphasizes the critical necessity for educational and community service initiatives that not only teach students how to use AI technically but also help them develop ethical consciousness and appropriate academic behavior in higher education settings (Dakakni & Safa, 2023).

But behind these conveniences, the use of AI in scientific writing also presents challenges that cannot be ignored. One of the main issues that arises is related to academic integrity, especially in terms of plagiarism, improper use of sources, and the tendency to over-rely on automated systems (Limongi, 2024). Many students use AI without an adequate understanding of ethical limitations, such as the difference between correct and incorrect paraphrasing, the importance of proper citations, and the responsibility of the writer for the content of the resulting writing. This condition has the potential to reduce the quality of learning and damage basic values in the academic world (Kamoun et al., 2024).

Several studies show that although AI can play an effective role in improving the quality of writing, most users, especially students, still do not have enough literacy to use this technology wisely and responsibly (Baldrich et al., 2025). The training programs that have been carried out generally focus more on technical aspects only, such as how to use AI tools, *prompting* techniques, and optimization of available features. However, other important aspects such as ethical awareness, human control over writing, and a deep understanding of the content generated by AI are often not the main concern (Chan & Hu, 2023; Escalante et al., 2023). This shows that there is a *research gap* between the mastery of technology and the application of ethical principles in AI-based scientific writing (Hegazy et al., 2024).

Based on this gap, a community service program entitled *"Smart Writing with AI: Smart Strategies for Scientific Writing Without Plagiarism"* was implemented (Song & Song, 2023). The program is designed not only to improve participants' technical skills in using various AI tools, but also to instill awareness of the importance of academic integrity in every writing process. The approach used in this training integrates the concept of Human-AI Collaboration, which is a paradigm that places humans as the main controller (*human in control*) in the writing process, while AI functions as a tool that supports productivity and efficiency (Phukan, 2025). With this approach, it is hoped that participants will not only be able to use AI effectively, but also maintain originality, accuracy, and scientific responsibility in the work produced (Hwang et al., 2024).

In addition, this training is also designed systematically by combining several important components, such as the delivery of conceptual materials, demonstrations of the use of AI tools, case studies of scientific writing, and interactive discussion sessions (Giray et al., 2024; Костікова et al., 2024). The material provided includes understanding the structure of scientific papers, correct paraphrasing techniques, the use of *reference managers*, and strategies to avoid plagiarism. With this comprehensive training design, participants are expected to gain a learning experience that is not only informative but also applicable and reflective (Gaber & Ali, 2022).

The novelty of this study lies in the multidimensional evaluation approach to the effectiveness of training. Unlike previous research that tended to assess only one aspect, such as improving technical skills or user perception of AI, this study integrates several dimensions at once, namely improvement of scientific

writing skills, awareness of academic integrity, and efficiency in the writing process (Kim et al., 2024). This approach provides a more comprehensive picture of the impact of AI training on participants' abilities. In addition, this study also adopts the *perspective of Human-AI Collaboration* as a key conceptual framework, which is still relatively rarely used in evaluation studies of AI-based scientific writing training, especially in the context of community service (Nguyen et al., 2024).

Thus, this research has an important contribution both theoretically and practically. Theoretically, this research enriches the study of the use of AI in education, especially in the context of ethical scientific writing (Klímová et al., 2023). Practically, the results of this research can be a reference for educational institutions, lecturers, and training providers in designing programs that are more effective and balanced between technical and ethical aspects (Usher & Barak, 2024). Therefore, the purpose of this study is to evaluate the participants' responses to the training that has been carried out and assess the extent to which the training is effective in improving scientific writing competence, academic ethical awareness, and work efficiency of participants (Gaber & Ali, 2022).

B. Methods

In this study, a descriptive quantitative approach was used which aimed to evaluate the effectiveness of an Artificial Intelligence (AI)-based scientific writing training. This approach was chosen because it was able to provide a systematic and measurable picture of the participants' responses to the training that had been carried out (Pradilia & Gani, 2025; Suriyati et al., 2024). The main focus of this study was to identify participants' level of understanding, improvement of scientific writing skills, and awareness of academic integrity after participating in training. Using a descriptive quantitative method, the data obtained can be processed in the form of numbers and analyzed objectively through simple statistical calculations, resulting in an accurate interpretation of participants' response tendencies (Barella et al., 2024). Furthermore, this approach allows researchers to categorize the results of the evaluation into several key dimensions, such as the relevance of the material, the quality of delivery, the improvement of skills, and the impact of training on the efficiency of scientific writing (Arianda et al., 2025; Satyawati & Waruwu, 2024; Zhu et al., 2026). Data was collected through a Likert scale-based questionnaire instrument designed to comprehensively measure participants' perceptions. The results of the analysis are then presented in the form of average scores and percentages to facilitate interpretation of the level of program effectiveness. Thus, the descriptive quantitative approach not only provides an overview of the success of training, but also becomes a solid basis for drawing empirical conclusions regarding the implementation of the concept of Human-AI Collaboration in improving the quality of scientific writing (Nguyen et al., 2024).

1. Participants

Participants in this study are seminar participants (online) who participated in the training program *"Smart Writing with AI: Smart Strategies for Scientific Writing Without Plagiarism"*. These participants come from the academic background of Agriculture students at the University of Bengkulu and several from other universities, who have a need to improve scientific writing skills and the effective and ethical use of Artificial Intelligence (AI) technology. The participants' involvement in this study was voluntary, where they were asked to fill out a questionnaire after the entire series of training activities were completed. Thus, the data obtained reflects the participants' direct perception of the learning experiences they have had during the training. The sampling technique used in this study is *convenience sampling*, which is sample selection based on the ease of access to respondents available at the time of the activity. This approach was chosen because the research was conducted in the context of community service activities that were open and did not allow for strict randomization. Although it has limitations in terms of generalization, it is still relevant for evaluative research that aims to describe the actual response of participants to a training program. Therefore, the results of this study are expected to be able to provide an empirical picture of the effectiveness of Human-AI Collaboration-based training in the real context of the implementation of activities.

2. Instrumentation

The data in this study was collected using a structured questionnaire instrument consisting of 20 statement items with a four-point Likert scale, namely 1 (strongly disagree) to 4 (strongly agree). The use of the

Likert scale without a neutral option aims to encourage respondents to give a more assertive assessment of each statement submitted. This instrument is designed to measure five main variables that represent the effectiveness of training, namely relevance and conceptual comprehension, quality of material delivery, improvement of scientific writing skills, awareness of academic integrity, and the impact of training on motivation and writing efficiency (Perrotta et al., 2023). Each variable is operationalized into several indicators that are adjusted to the training objectives, so as to be able to comprehensively capture participants' perceptions of the learning experience obtained (Hadaitana & Iqbal, 2023). The development of instruments is carried out based on the suitability of the training objectives and conceptual studies related to the use of Artificial Intelligence (AI) in scientific writing. The validity of the instrument's content is determined conceptually through an adjustment between the question indicator and the measured construct. Although empirical validity tests were not performed in this study, the instruments have been systematically designed to reflect key dimensions relevant to training evaluation. In addition, reliability testing using Cronbach's Alpha coefficient is recommended for further research to ensure the internal consistency of the instrument. Thus, the instruments used in this study are expected to be able to provide representative data in describing participants' perceptions of the effectiveness of Human-AI Collaboration-based training.

3. Procedure

The training was carried out in a seminar format (online) which was systematically designed to integrate theoretical and practical aspects in the use of Artificial Intelligence (AI) for scientific writing. The activity began with the delivery of *material which* included the basic concepts of scientific writing, the principles of academic integrity, and the role of AI as a tool in the writing process. Furthermore, participants were given a direct demonstration of *AI tools* related to the use of various AI devices in compiling ideas, creating writing frameworks, and paraphrasing effectively. To strengthen understanding, the activity is also complemented by case studies that describe the transformation process from an initial idea to a structured scientific paragraph in accordance with academic principles. In addition, the *interactive discussion session* provides an opportunity for participants to ask questions, share experiences, and discuss the challenges faced in the ethical use of AI. At the end of the training session, all participants were asked to fill out a questionnaire that had been prepared as an evaluation instrument. Filling out the questionnaire is carried out directly after the activity is completed to ensure that the responses given still reflect the actual experience of the participants during the training. This process aims to obtain valid and relevant data related to participants' perceptions of the effectiveness of training, both in terms of materials, delivery methods, and its impact on improving skills and ethical awareness in scientific writing. Thus, the training and data collection implementation procedures are designed in an integrated manner to support the research objectives in evaluating the implementation of the Human-AI Collaboration concept comprehensively.

4. Data Analysis

The data in this study was analyzed using descriptive statistics which included the calculation of the mean *score* and the percentage distribution. This analysis aims to provide an overview of the tendency of participants' responses to each item or variable measured. The average score is used to determine the respondents' assessment of the effectiveness of the training, while the percentage distribution is used to see the proportion of answers in each category of the scale (Zhao et al., 2023). Thus, this approach allows for a simple but informative interpretation of data in describing the success rate of the training program that has been implemented. Score interpretation was categorized as follows:

Table 1. Score Category

Score Interval	Category
3.25 – 4.00	Very High
2.50 – 3.24	High
1.75 – 2.49	Low
1.00 – 1.74	Very Low

5. Scope and Limitations

This study focuses on participants' perceptions of the implementation of Artificial Intelligence (AI)-based scientific writing training, so that the results obtained reflect the subjective experiences of participants after participating in these activities. Therefore, this study did not directly measure the long-term impact on improving participants' scientific writing performance, such as the quality of publication or the consistency of the use of AI in daily academic practice. In addition, the use of *self-reported data* has the potential to cause bias, such as the tendency of respondents to give more positive answers or according to the expectations of the organizers. Nevertheless, this approach remains relevant in the context of evaluative research because it is able to provide an initial overview of the effectiveness of training programs from the perspective of participants directly. The following is the flow of this research activity. It can be seen in the flowchart in the image below.

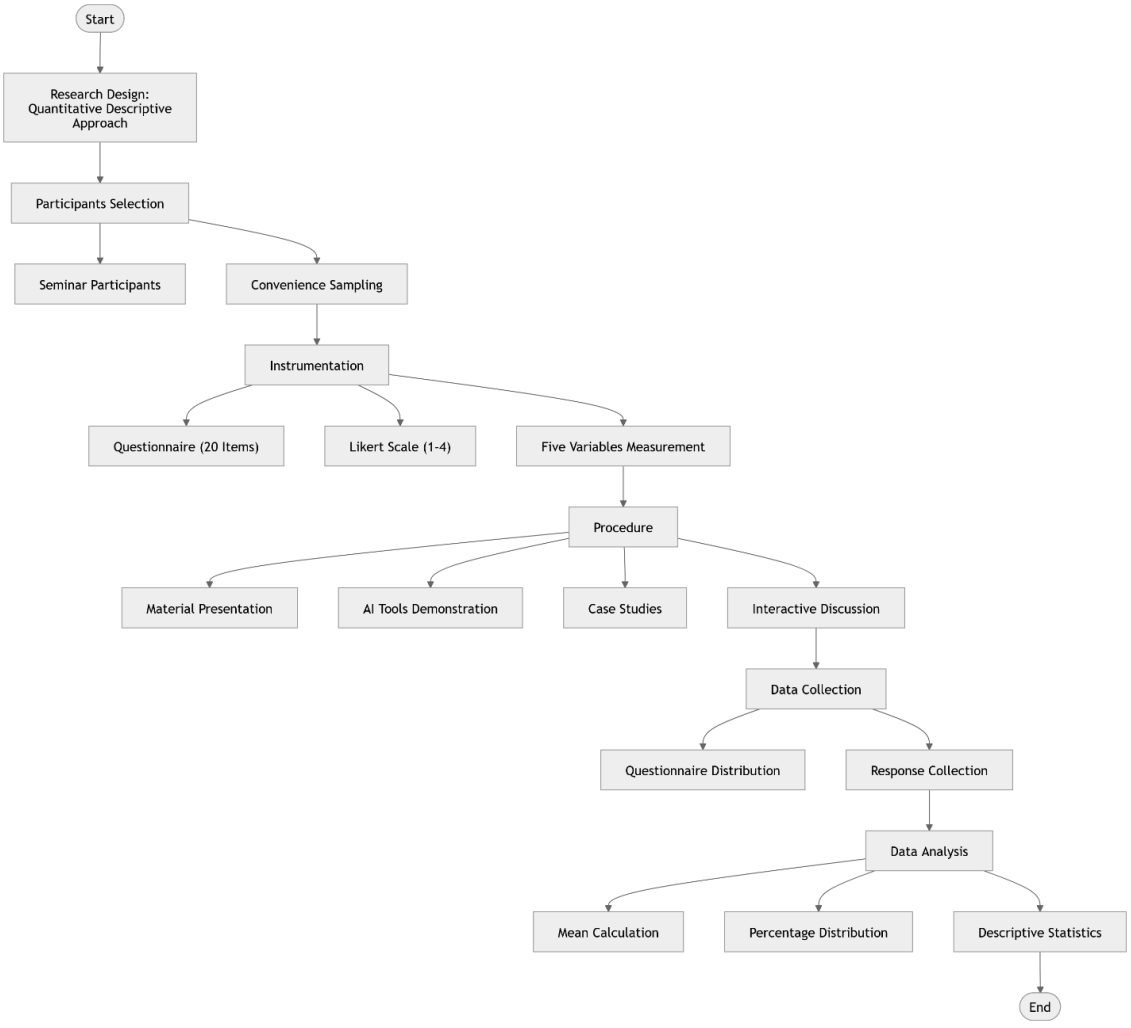

Figure 1. Drawing Design Research

C. Results and Discussion

1. Results

Based on the results of the questionnaire data processing, as many as **85 respondents** were obtained who filled out a complete questionnaire with a total of 20 statement items. Analysis of the distribution of answers showed that most respondents rated it in the high category, which was dominated by scores of 3

(agree) and 4 (strongly agree) on almost all items. This indicates that participants in general have a very positive perception of the implementation of Artificial Intelligence (AI)-based scientific writing training. However, a significant variation in responses was found in a small number of respondents who gave low scores, namely in the range of scores of 1 to 2. The existence of respondents with low scores shows a difference in experience and the level of acceptance of the training materials. Overall, the distribution of data that tends to be concentrated in the high category shows that training based on the concept of Human-AI Collaboration is considered effective in increasing participants' understanding, skills, and academic ethical awareness.

The distribution patterns of participant responses across all measured variables were examined in order to improve the clarity of data interpretation. The preponderance of "strongly agree" and "agree" answers suggests that the training program is continuously rated favorably. Additionally, by comparing average ratings across factors, it is easier to see which parts of the training participants thought were most beneficial, especially in terms of enhancing writing motivation and raising awareness of academic integrity.

Table 2. Variable and Item Range Category

No	Variabel	Item Range	Average Score	Category
1	Relevance & Conceptual Understanding	1 – 2	3.65	Very High
2	Quality of Delivery	3 – 7	3.58	Very High
3	Improved Writing Skills	8 – 11	3.42	Very High
4	Academic Integrity Awareness	12 – 15	3.70	Very High
5	Impact & Motivation	16 – 20	3.62	Very High

Table 3. Indicator and Value

Indicator	Value
Number of Respondents	85
Number of Items	20
Score Minimum	1
Maximum Score	4
Overall Average	3.59
Category	Very High

Table 4. Category and Trends

Score	Category	Trends
4	Strongly agree	Dominant
3	Agree	Height
2	Disagree	Low
1	Strongly Disagree	Very Low

Based on the results of the descriptive statistical calculation, an overall average score of 3.59 was obtained, which is included in the very high category. This calculation is done by dividing the total score of all respondents by the number of respondents and the number of question items measured. In detail, each variable was analyzed using the mean formula, where the total score on each variable was divided by the result of multiplying the number of respondents and the number of items in the variable. The results of the analysis showed that all variables had an average value above 3.25, which indicated that the training provided was considered very effective by the participants. Furthermore, the variable with the highest average score was academic integrity awareness of 3.70, which showed that the training was highly successful in improving participants' understanding of academic ethics, including plagiarism and the importance of correct citations. Meanwhile, the variable with the lowest average score was an improvement in writing skills of 3.42, although it remained in the very high category. This suggests that writing skills require a more continuous practice process compared to conceptual understanding and ethical awareness. Overall, the results of this analysis confirm that training based on the *Human-AI*

Collaboration concept has a very positive impact on various aspects of the participants' scientific writing competencies.

2. Discussion

The results showed that Artificial Intelligence (AI)-based scientific writing training had a very high level of effectiveness, which was reflected in the overall average score of 3.59. These findings indicate that the integration of AI technology in training is able to have a positive impact on participants' academic ethical understanding, skills, and awareness. The dominance of scores in the high and very high categories shows that the training approach used is in accordance with the needs of participants in facing the challenges of scientific writing in the digital era. These findings are in line with research by Kasneci et al. who stated that the use of AI in education can improve the efficiency and quality of the learning process, especially in cognitive-based activities such as writing (Marzuki et al., 2023; Seßler et al., 2025). In addition, the study by (Cotton et al., 2023). confirms that while AI provides ease in generating texts, a strong understanding of academic integrity is needed so that the use of the technology does not lead to ethical violations. In this context, the results show that training that integrates technical and ethical aspects is able to bridge these gaps (Tobías et al., 2025). More specifically, the academic integrity awareness variable obtained the highest score (3.70), indicating that the training successfully instilled a deep understanding of plagiarism, citation, and academic responsibility. These findings reinforce the argument that *the Human-AI Collaboration approach* is effective in ensuring that users retain full control over the outcome of the writing. This is in line with the view of (Dwivedi et al., 2019). who emphasize the importance of the role of humans in controlling the use of AI to maintain the quality and accuracy of information.

On the other hand, the variable of improving writing skills had a relatively lower value (3.42), although it was still in the very high category. This shows that while AI can help with the writing process, mastering writing skills still requires continuous practice and cannot be achieved instantly. These findings are consistent with Zhai's research that AI acts as a *supporting tool*, not a substitute for human cognitive ability to write (Luttges et al., 2025). Thus, training that focuses on sustainable practices is important to improve the competence of participants more optimally. In addition, the high value on the motivation variable and the impact of training shows that the use of AI in scientific writing not only increases efficiency, but is also able to increase participants' confidence in producing scientific papers. This supports the findings of (Holmes et al., 2019). who stated that the integration of AI in learning can increase student *engagement* and motivation.

However, the study also found a variation in responses, especially from some participants who gave low scores. This shows that the effectiveness of the training is not felt equally by all participants. Factors such as academic background, digital literacy level, as well as previous experience in using AI are likely to influence these perceptions. Therefore, a more adaptive and continuous training approach is needed to accommodate the different characteristics of participants. Overall, the results of this study confirm that AI-based scientific writing training with *the Human-AI Collaboration* approach is an effective model in improving scientific writing competencies while maintaining academic integrity. The main contribution of this research lies in a multidimensional evaluation approach that assesses not only the technical aspects, but also the ethical and motivational aspects. Thus, this research provides important implications for the development of future training programs, especially in integrating AI technology responsibly in the world of education.

2.1 Implications

Based on the results of data analysis that showed that the average value of all variables was in the very high category, this study provides several important implications in the development of Artificial Intelligence (AI)-based scientific writing training. First, the finding that the academic **integrity awareness variable has the highest value** indicates that the integration of ethical aspects in AI training is highly effective and inseparable from technical mastery. Therefore, AI training in academia should be designed in a balanced manner by combining a technical understanding of the use of AI tools and strengthening academic ethical principles, such as plagiarism, citation, and author responsibility. Second, although the variable of improving writing skills is in the very high category, the value is relatively lower than other variables. This shows that mastering writing skills is not enough through just one training, but requires continuous practice. Thus, educational institutions are advised to develop more structured and

sustainable learning programs, such as the integration of AI in scientific writing curricula, the use of project-based assignments, as well as mentoring in the writing process.

Third, the high value on the motivation variable and the impact of training shows that the use of AI can increase the confidence and efficiency of participants in writing scientific papers. This implies that educational institutions need to adopt systematic and targeted AI literacy programs, not only as additional training, but as an integral part of the learning process. The program can include training in the ethical use of AI, the development of critical thinking skills for AI output, as well as the application of *the concept of Human-AI Collaboration* in academic activities.

2.2 Research Contribution

This research makes an important contribution to the development of studies related to the use of Artificial Intelligence (AI) in scientific writing, especially in the context of community service-based training. First, this study presents an empirical evaluation of the effectiveness of AI-based scientific writing training using quantitative data from direct respondents. The results showed very high categories across all variables providing evidence that systematically designed training was able to improve participants' understanding, skills, and ethical awareness in using AI for scientific writing. Second, this study introduces a multidimensional evaluation model that covers five main aspects, namely material relevance, delivery quality, improvement of writing skills, awareness of academic integrity, and impact on motivation and writing efficiency. This approach provides a more comprehensive perspective than previous research which generally only focused on one or two aspects. Thus, this model can be used as an applicable evaluation framework in assessing the effectiveness of AI training in the academic field.

Third, this study emphasizes the importance of the principle *of Human-AI Collaboration*, especially in maintaining a balance between the use of technology and human responsibility as authors. The finding that the academic integrity awareness variable obtained the highest score shows that human control is a key factor in the ethical and responsible use of AI. Therefore, this research not only contributes to the technical aspects of the use of AI, but also strengthens the ethical dimension in scientific writing practices in the digital age. Overall, this research makes a theoretical and practical contribution by presenting a training approach that is integrated between technical, ethical, and motivational aspects, and offers an evaluation model that can be replicated in similar education and training contexts in the future.

2.3 Limitations

This study has several limitations that need to be considered in interpreting the results obtained. First, the number of respondents used in this study was limited to 85 participants who participated in a single training activity, so the results of the study could not be generalized widely to larger populations or different contexts. The characteristics of the respondents who are relatively homogeneous, i.e. they come from the same training participants, also have the potential to affect the variation in the results obtained. Second, the data used in this study is *self-reported*, which is based on the subjective perception of respondents through questionnaires. While this approach is effective in describing participants' experiences and assessments directly, there are potential biases, such as respondents' tendency to give more positive answers (*social desirability bias*) or in accordance with the organizer's expectations. This can affect objectivity in measuring the level of effectiveness of training in real terms.

Third, this study did not use an experimental design or a control *group*, so it could not directly measure the causal influence of the training on the improvement of participants' scientific writing skills. In addition, this study also did not measure long-term impacts, such as changes in the quality of writing or the consistency of the use of AI in academic practice. Therefore, further research is recommended to use an experimental or longitudinal approach in order to provide stronger evidence regarding the effectiveness of *Human-AI Collaboration-based* training.

2.4 Suggestions

Based on the results of the study showing that Artificial Intelligence (AI)-based scientific writing training has a very positive impact on participants' perceptions, further research is recommended to develop a more comprehensive research design to obtain a deeper and objective understanding. First, the use of experimental designs is highly recommended, such as *quasi-experimental* or *true experimental design*, involving control groups. This approach is important to more accurately test the causal influence of training on the improvement of scientific writing skills compared to conventional learning methods.

Second, further research needs to integrate *pre-test* and *post-test* methods to measure changes in participants' abilities directly before and after training. Given that the results of this study are still perception-based, the use of *performance-based assessment* will provide stronger empirical evidence related to improving writing skills, such as the quality of writing structure, paraphrasing ability, and citation accuracy.

Third, the exploration of long-term impacts is also an important aspect that needs further research. This includes the sustainability of the use of AI in academic activities, the consistency of the application of the principles of academic integrity, and the effect of training on the quality of participants' scientific publications. Given that the findings of this study show high motivation of participants after training, longitudinal studies can provide an idea of whether the impact is temporary or sustainable. Overall, the development of research towards more robust design, more objective measurements, and longer time spans will enrich understanding of the effectiveness of *Human-AI Collaboration-based training* and strengthen its scientific contribution in the field of education and scientific writing in the digital age.

D. Conclusion

Based on the results of descriptive statistical analysis of respondent data, it can be concluded that the *training "Smart Writing with AI: Smart Strategies for Scientific Writing Without Plagiarism"* has a very high level of effectiveness in improving the scientific writing competence of participants. This is shown by the overall average score of 3.59 which is in the very high category, as well as the consistency of high scores in all variables measured, including material relevance, quality of delivery, improvement of writing skills, awareness of academic integrity, and impact on motivation and writing efficiency. The findings of this study confirm that the *Human-AI Collaboration-based* training approach is effective in integrating technical and ethical aspects in the use of Artificial Intelligence (AI) for scientific writing. The most significant improvement was seen in the aspect of academic integrity awareness, which showed that participants were not only able to utilize AI technically, but also understood the importance of scientific responsibility in producing original and quality work. However, improving writing skills still requires strengthening through continuous practice so that the results achieved are more optimal.

Thus, this study provides the implication that comprehensively designed AI-based training can be an effective model in supporting scientific writing learning in the digital age. This study also emphasizes the Human-AI Collaboration model's role in striking a balance between the use of AI and human responsibility in scientific writing. The results suggest that academic training programs at higher education institutions should incorporate AI literacy, academic integrity, and ethical writing practices. Additionally, in order to preserve originality, accountability, and scholarly integrity, academic policymakers are urged to set explicit rules for the responsible application of AI in scientific writing. For further research, it is recommended to develop a more comprehensive research design, such as using an experimental or longitudinal approach, to measure the long-term impact on the quality of participants' writing more objectively.

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F. Author Contribution Statement

ER came up with the idea for the study, planned the training course, gathered the information, and wrote the article. NS helped establish the data analysis and research approach. MQR helped with the literature review and training materials. MAJ helped with the manuscript's critical editing and interpretation of the findings. MS helped with participant coordination and the execution of the training exercises. MEK

helped with final proofreading, editing, and linguistic improvement of the paper. The final draft of the work was reviewed and approved by all authors.

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