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AN ANALYSIS OF TRAINING REQUIREMENTS FOR TEACHERS IN THE APPLICATION OF ARTIFICIAL INTELLIGENCE TO SCIENTIFIC WRITING

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Abstract

The advancement of artificial intelligence (AI) presents significant opportunities for teachers to enhance their scientific writing skills. Nevertheless, the optimal use of AI remains limited by insufficient digital literacy, technical proficiency, and a lack of understanding of ethical considerations. To address these challenges, this study investigates the demand for scientific writing training that incorporates AI and identifies barriers to its effective implementation. A mixed-methods approach was employed, utilizing questionnaires with 135 teachers and interviews with 8 to 10 teachers. The findings revealed that 53% of participants require structured training that encompasses writing practice, reflective activities, mastery of key concepts, and the integration of AI into scientific article preparation. To frame these results, the study draws on three theoretical frameworks: experiential learning theory, with 71.25% of responses rated as high; adult learning theory (andragogy), with 83.33% of responses rated as very high; and Asilomar AI theory, with 81.81% of responses rated as very high. In particular, key challenges identified include plagiarism risks, concerns about data accuracy, limited contextual understanding, and issues related to academic ethics. In response, the study proposes a comprehensive training model that integrates experience-based learning, andragogical principles, and AI ethics.

Keywords: *needs analysis; artificial intelligence; teachers; scientific writing training*

INTRODUCTION

The rapid development of artificial intelligence (AI) has reshaped various fields, including education. In the context of academic writing, AI tools such as ChatGPT, Grammarly, QuillBot, and Perplexity offer significant support in generating initial text, improving writing structure, enhancing grammar, and assisting with reference exploration. These technological advancements present important opportunities for teachers, who are increasingly required to produce scientific work to support professional development, rank promotion, and the fulfillment of national education standards. In Indonesia, teachers are expected to publish scientific papers as part of their professional responsibilities, particularly in relation to the Continuing Professional Development (CPD/PKB) program and the implementation of teacher performance appraisal standards. Thus, mastering scientific writing is not only essential for personal competency development but also directly contributes to improving the quality of education.

However, the problem is that AI optimization in scientific writing cannot be achieved without adequate basic competencies. Teachers need to have a thorough understanding of how AI works, the ethical limitations of its use, and technical skills such as prompt engineering in order to direct AI to produce outputs that comply with academic writing rules. The use of AI in scientific writing has become widespread, with its primary function to improve readability, grammar, and text structure. Teachers facing challenges in writing scientific articles have a significant opportunity to enhance the quality of their work with AI assistance (Xu, 2025).

Some literature indicates that despite the urgency, many teachers face substantial challenges in scientific writing. (Anugraheni, 2021) Reported that 52.63% of teachers experienced difficulties in writing scientific articles, and 54.39% faced obstacles in publication. These challenges stem from both internal and external factors, including limited motivation, insufficient guidance on scientific writing, and time constraints. Similarly, (Sari et al., 2024) Found that only 31% of teachers in one institution had ever published scientific work, mainly due to limited understanding of writing procedures and article structure. These studies highlight a broader issue: teachers' capacity to produce scientific papers remains suboptimal and requires systemic support. They also provide an empirical foundation for the present study, which seeks to respond to these gaps by examining how AI-based training can more effectively support teachers' writing needs.

The problem addressed in this study was the optimization of teachers' scientific writing abilities using artificial intelligence. Although digital

technology is increasingly advancing, its use in education remains limited. Thus, the research questions in this study are: (1) What is the level of teachers' need for training in scientific writing using artificial intelligence? (2) What do teachers face the challenges and obstacles in integrating AI into their scientific writing practices?

Several studies emphasise the need for structured AI training in academic writing (Bilal et al., 2025)· Showed that educators require comprehensive training to maintain academic integrity and avoid plagiarism when using AI tools (Kuzu et al., 2025). Found that practical AI-related training must integrate both technical and content knowledge to ensure that teachers can apply AI meaningfully in scientific tasks (Chen & Gong, 2025). Further demonstrated that AI-assisted writing increases learner engagement and writing quality, especially when accompanied by instructor guidance. AI can also enhance critical thinking by helping writers explore alternative perspectives or evaluate their arguments (Elstad, 2024).

These findings collectively highlight that AI can be an effective partner in scientific writing, provided teachers have appropriate training and support, and they directly motivate the present study's focus on teachers' training needs and AI integration (Lin, 2025). Teachers with a high level of AI literacy can optimise this technology not only to improve language and structure but also to broaden academic perspectives, develop arguments, and compile more comprehensive literature reviews.

A recent study demonstrated that integrating artificial intelligence (AI) into the writing process can enhance critical thinking skills, particularly when teachers employ AI to identify new perspectives or evaluate formulated arguments (Elstad, 2024). Consequently, an effective AI literacy enhancement strategy should address technical, ethical, and creative dimensions. This approach will enable teachers to use AI judiciously and productively, thereby fostering a high-quality academic culture.

Based on these issues, the present study aims to analyse teachers' needs for scientific writing training that incorporates AI and to identify the challenges they encounter in integrating AI into writing practices. Two research questions guide the study:

(1) What is the level of teachers' need for training in scientific writing using artificial intelligence?
(2) What challenges and obstacles do teachers face in integrating AI into scientific writing practices?

This study adopts three theoretical frameworks to analyse training needs comprehensively: Experiential Learning Theory, Adult Learning Theory (andragogy), and the Asilomar AI Principles. These frameworks help explore the extent to which teachers require practical experience, self-

directed learning, and ethical awareness in using AI tools. The findings are expected to contribute to the development of relevant, ethical, and sustainable teacher training programs, particularly in strengthening teachers' capacity to leverage AI responsibly in academic writing.

METHOD

This study employed a mixed-methods approach, integrating quantitative and qualitative data to provide a comprehensive understanding of teachers' needs for scientific writing training using artificial intelligence (AI). Mixed methods allow researchers to explore the scope of a phenomenon numerically while also capturing participants' more profound experiences and perspectives, Creswell & Clark, as cited in (Hakim Nasution et al., 2024).

The research design consisted of three main stages: The first stage, quantitative data were collected through a structured questionnaire comprising 18 items, measured on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). The second stage involved collecting qualitative data. The qualitative component was conducted through an individual, essay-type interview using an open-ended questionnaire delivered via Google Forms. The third stage involved integrative analysis through data triangulation. The study employed methodological triangulation, comparing and cross-validating quantitative findings from questionnaire scores and qualitative themes from interview responses.

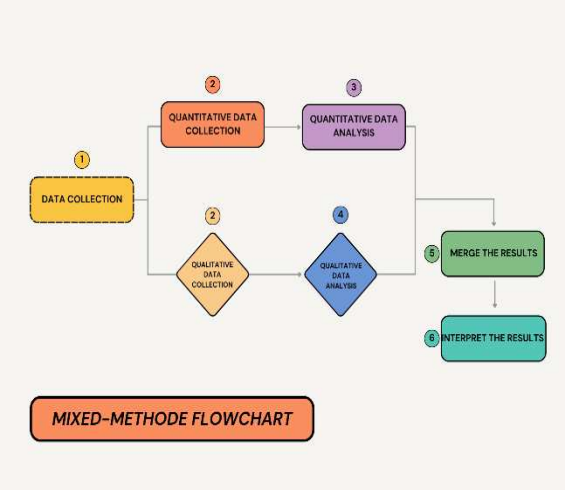

Figure 1. Data collection process using mixed methods

A total of 135 teachers from MI, MTs, and MA institutions within the target area of the Jakarta Religious Training Centre participated in the study's quantitative phase. These respondents were selected using random sampling to ensure adequate representation across demographic backgrounds.

For the qualitative phase, 10 teachers were recruited using purposive sampling, chosen based on two criteria: (1) their level of AI usage in teaching or writing, and (2) their experience (or lack of experience) in producing scientific writing. These participants represent the population segment most relevant to

the study's focus, thereby justifying the sampling strategy.

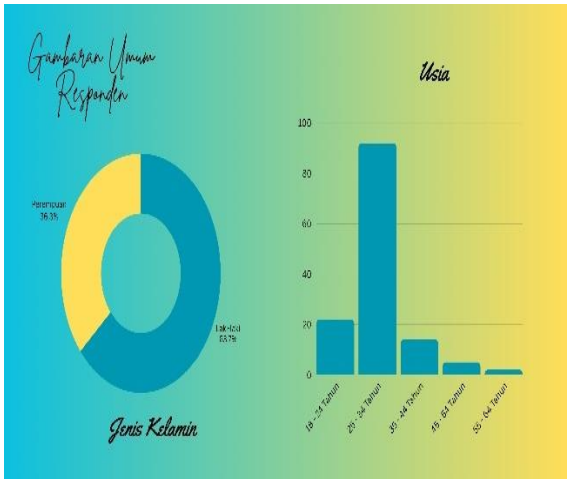

Figure 2. Overview of respondents by gender and age

Figure 2 shows that, of 135 respondents, the majority were female, numbering 86 (63.7%). The remaining 49 people (36.3%) were male. Based on age, the majority of respondents (92) were aged 25–34 years. Additionally, 22 respondents were aged 18–24 years, 14 were aged 35–44 years, five were aged 45–54 years, and two were aged 55–64 years.

RESULTS AND DISCUSSION

The results of the study demonstrated that the need analysis for scientific writing training for teachers was described in several indicators that have undergone instrument validation by expert reviewers. These indicators were obtained from various relevant theories, including 1) experiential learning theory, 2) adult learning theory (andragogy), and Asilomar artificial intelligence principles.

Experiential Learning Theory

Experiential Learning Theory (ELT) is a learning approach that places direct experience at the centre of the learning process. Kolb in (McLeod, 2017) Explains that learning is more effective when learners are actively involved in concrete experiences, then engage in reflective observation, form abstract conceptualisations, and try out new applications through active experimentation.

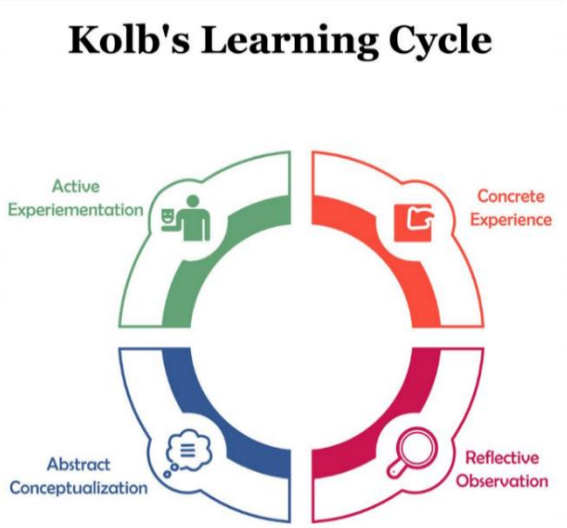

Figure 3. Experiential Learning Theory

This cycle does not rely solely on passive information reception but requires physical, emotional, and cognitive involvement in the learning process.

1. Concrete Experience

Concrete Experience consists of 2 items. Table 1 shows that the item with the highest percentage score is item number 2, "I need direct guidance in the practice of writing scientific articles," with a percentage score of 80.93%. Meanwhile, the item with the lowest

percentage score is item 1, "I have difficulty in systematically structuring scientific articles," at 71.11%.

Table 1. Respondents' responses regarding their concrete experiences.

No	Statements	Total Score	Score Percentage
1	I find it challenging to write scientific articles systematically.	387	71, 11%
2	I need direct guidance in the practice of writing scientific articles.	437	80,93%
	Total	**821**	**76,02%**

Figure 4 shows the summary of respondents' responses regarding their concrete experiences.

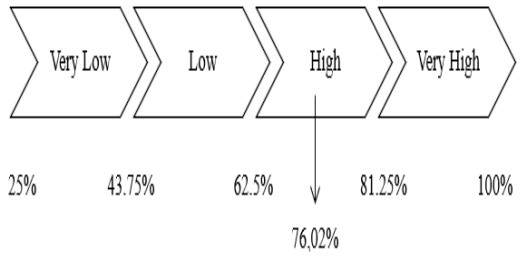

Figure 4. Concrete Experience

Figure 4 shows that the concrete experience indicator falls into the high category, with a percentage of 76.02%, indicating that most respondents experience difficulties and need direct guidance on writing scientific articles.

2. Reflective Observation

Reflective observation consists of one item. Table 2 shows that the item with the highest score percentage is "I am accustomed to reviewing my scientific writing to improve its quality," at 72.59%.

Table 2. Respondents' responses regarding reflective observation.

No	Statement	Total Score	Percentage
3	I am accustomed to reviewing my scientific writing to improve its quality.	392	72, 59%
	Total	**392**	**72,59%**

Figure 5 shows the summary of respondents' responses regarding reflective observation.

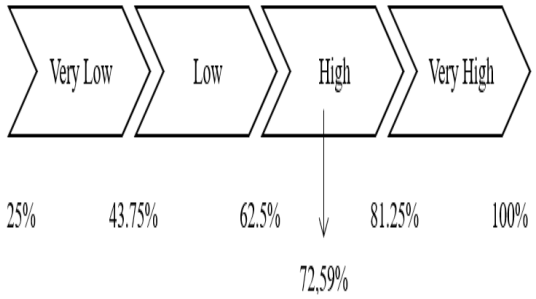

Figure 5. Reflective Observation

Figure 5 shows that the reflective observation indicator is in the high category, at 72.59%, indicating that most respondents are highly motivated to improve the quality of their writing.

3. Abstract Conceptualization

Abstract Conceptualization consists of 2 items. Table 3 shows that the item with the highest percentage score is item 4, "I am unable to explain the general structure of a scientific article conceptually," at 59.07%. Meanwhile, the item with the lowest percentage score is item 1, "I am unable to connect the theory with the findings in my writing," at 52.04%.

Table 3. Respondents' responses regarding abstract conceptualization.

No	Statements	Total Score	Score Percentage
4	I am unable to explain the general structure of a scientific article conceptually.	319	59, 07%
5	I am unable to connect the theory with the findings in my writing.	281	52,04%
	Total	**600**	**55,56%**

Figure 6 shows the summary of respondents' responses regarding abstract conceptualization.

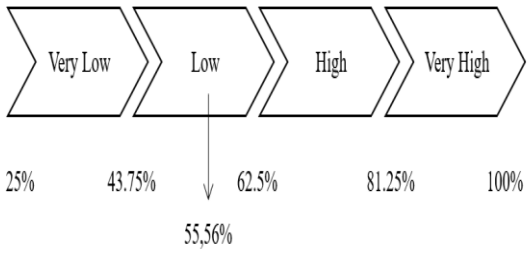

Figure 6. Abstract Conceptualization

Figure 6 shows that the abstract conceptualization indicator falls in the low category, with a percentage of 55.56%, indicating that some respondents already have prior knowledge of the general structure of scientific articles and can connect theory to writing. This condition is normal, given that the respondents are adults in the teaching profession who already have at least some experience and knowledge in writing scientific papers.

4. Active Experimentation

The Active Experiment consists of 2 items. Table 4 shows that the item with the highest percentage score is item number 7, "I am interested in integrating AI into scientific writing", with a percentage score of 81.30%. Meanwhile, the item with the lowest percentage score is item number 6, "I am actively seeking new technologies and methods to assist in scientific writing", with a percentage score of 76.67%.

Table 4. Respondents' responses related to active experiments.

No	Statements	Total Score	Percentage
6	I am actively seeking new technologies and methods to assist in scientific writing.	414	76, 67%
7	I am interested in integrating AI into scientific writing.	439	81,30%
	Total	**853**	**78,98%**

Table 7 summarizes respondents' responses regarding the active experiment.

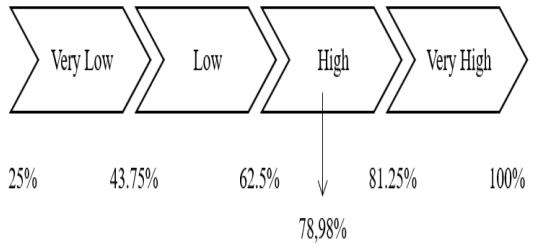

Figure 7. Active Experiment

Figure 7 shows that the Active Experiment indicator is in the high category, at 78.98%. It demonstrates that most respondents are interested in integrating AI into the writing process for scientific articles.

In relation to training in scientific writing, this theory can be optimized by applying the principles of **Experiential Learning Theory (ELT)**, as the writing process is not merely a matter of memorizing rules or structures but involves direct experience, reflection, and repeated application. In this training, the concrete experience stage is achieved through participants' direct involvement in writing activities, such as drafting articles or research proposals on specific themes. Furthermore, in the **reflective observation** stage, participants are invited to reflect on their writing experiences, for example, by identifying difficulties, analyzing instructor feedback, and comparing their work against the standards of good scientific work.

This aligns with the results of a survey conducted among respondents comprised of MI, MTs, and MA teachers in the working area of the Jakarta Religious Training Centre. It can be concluded that the responses collected and analyzed regarding the Experiential Learning Theory fall into the high category, with a percentage of 71.25%. It indicated that this theory is relevant to the implementation of scientific writing training utilising AI.

Andragogy: Adult Learning Theory

The concept of adult learning or andragogy was first popularised by Malcolm Knowles, who emphasised that adult learning differs fundamentally from child learning (pedagogy). The core of this theory is the view that adults learn based on practical needs, life experiences, and stronger intrinsic motivation. This model has since evolved into one of the most influential theories in adult education across various formal and non-formal contexts. (McGrath, 2009).

In practice, recent research shows that andragogy principles can serve as guidelines for designing training and competency development programs. A study (Knapke et al., 2024) Applied an andragogy framework to train a team of biomedical scientists. The results indicate that when training is tailored to participants' needs, experiences, and practical orientations, learning effectiveness significantly improves. It emphasizes the relevance of andragogy in a workplace that demands interdisciplinary collaboration.

A study by (Yahya et al., 2023) Showed the application of andragogy principles in adult education, particularly in religious higher education institutions. This study found that life experience, religious motivation, and practical needs are the main factors influencing learning effectiveness. Thus, the application of andragogy in the local context should be adapted to cultural characteristics and expected learning objectives.

As it has developed, researchers have emphasized that andragogy is not merely a set of teaching techniques, but rather a conceptual framework that governs how educators understand the characteristics of adult learners. Knowles identified six basic assumptions: (1) the need to know, (2) self-concept, (3) prior experience, (4) readiness to learn, (5) orientation to learning, and (6) motivation to learn. These principles have since been widely applied in adult education, professional training, and community-based learning. (Loeng, 2018).

Using the six adult learning indicators, the results of data processing are shown in Table 5.

Table 5. Respondents' responses related to active experiments.

No	Statements	Total Score	Percentage
1	Need to Know	947	87,69%
2	Self-Concept	452	83,70%
3	Prior Experience	372	68,89%
4	Readiness to Learn	880	81,48%
5	Orientation to Learning	918	85,00%
6	Motivation to Learn	931	86,20%
	Total	**4500**	**83,33%**

Based on Table 5 regarding Adult Learning Theory: Andragogy, which comprises six indicators, the indicator with the highest score percentage is the need-to-know indicator (87.69%). Meanwhile, the indicator with the lowest score percentage is the prior experience indicator (68.89%).

Figure 8 shows the summary of respondents' responses regarding Adult Learning Theory: Andragogy.

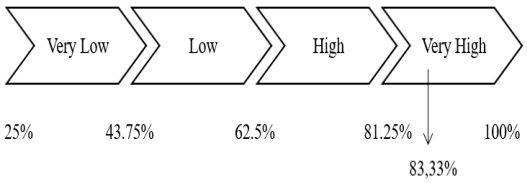

Figure 8. Summary of Adult Learning Theory: Andragogy

Figure 8 shows that respondents' responses regarding Adult Learning Theory: Andragogy were in the very high category (83.33%). It indicates that most respondents have a high level of curiosity and believe that AI training can improve the quality of scientific article writing.

The Asilomar Artificial Intelligence Principles Concept

Artificial Intelligence (AI) is a field of study that examines how computer systems can mimic human intelligence in thinking, decision-making, and problem-solving. Philosophically, AI is not only seen as a technological

advancement but also as a phenomenon that raises ethical questions about autonomy, morality, and social responsibility. According to philosophical studies, AI presents both opportunities and challenges for human civilization because these systems can act as agents with analytical and decision-making capabilities without direct human intervention (Adriyansa et al., 2024).

In education, AI is seen as a tool to improve the quality of learning. One application is the intelligent tutoring system, designed to tailor material, methods, and learning pace to individual needs. This intelligent tutoring system enables more adaptive personalization of learning, allowing teachers and educational institutions to facilitate the learning process more effectively and efficiently. (Putra et al., 2024).

From a social perspective, AI has a significant impact on people's lives. The presence of this technology has influenced various fields, including health, the economy, communication, and even daily activities. Recent studies show that the use of AI accelerates work completion, increases productivity, and, at the same time, raises dependence and community readiness in facing technological change. (Tri Widyastuti Ningsih, Zulkifli et al., 2023)

Thus, AI is not just a technology but a multidimensional concept that encompasses philosophical, educational, social, and cultural aspects. In other words, AI is not only improving efficiency but also challenging human perspectives on learning processes, decision-making, and the dynamics of life in the digital age.

The Asilomar Artificial Intelligence Principles indicators underpin this study, consisting of: (1) safety, (2) transparency, (3) privacy, (4) usefulness, and (5) human control, as shown in Table 6.

Table 6. Respondents' responses regarding the Asilomar Artificial Intelligence Principles.

No	Statements	Total Score	Percentage
1	Security	835	77,31%
2	Transparency	872	80,74%
3	Privacy	448	82,96%
4	Usefulness	865	80,09%
5	Human Control	956	88,52%
	Total	**3976**	**81,81%**

The Asilomar Artificial Intelligence Principles comprises five indicators. Table 6 shows that the indicator with the highest score percentage is the Human Control indicator (88.52%). Meanwhile, the indicator with the lowest score percentage is the Safety indicator (77.31%).

Figure 9 shows a summary of respondents' responses regarding the Asilomar Artificial Intelligence Principles.

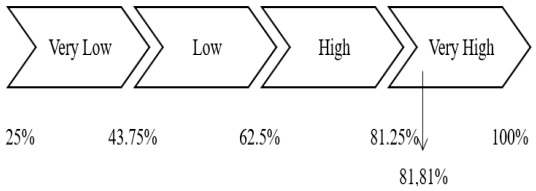

Figure 9. Summary of Adult Learning Theory: Andragogy

Figure 9 shows that respondents' responses regarding the Asilomar Artificial Intelligence Principles fell into the very high category, at 81.81%. This indicated that most respondents need AI to assist with writing scientific articles. However, they hold the principle that AI is only a tool, not a substitute for the primary author.

DISCUSSION

Teachers' Need for Training in Scientific Writing Using Artificial Intelligence

The development of artificial intelligence (AI) technology has opened up new opportunities for teachers to improve the quality of their scientific writing. However, research shows that many teachers continue to face obstacles, including low intrinsic motivation, limited scientific writing skills, and limited knowledge of supporting tools. (Side et al., 2024). The findings of the present study are consistent with this, as teachers in our sample reported similar challenges. Evidence from both quantitative and qualitative data confirms this alignment: low scores on Abstract Conceptualization indicate difficulties understanding the structure of scientific writing. At the same time, interview responses reveal limited familiarity with AI-based writing tools and uncertainty about their practical application. These parallels show that the obstacles highlighted by Side et al. are also present among teachers in this study.

A systematic review by (Aljemely, 2024) Showed a gap in teacher training on the use of AI. The training is still rare, and has not explored the challenges and best practices for enabling teachers to use AI effectively. It shows that although educational literature emphasises the importance of AI literacy, teachers have not received structured, relevant training.

A total of 135 teachers were surveyed to identify their needs for scientific writing training using artificial intelligence, as shown in Figure 10.

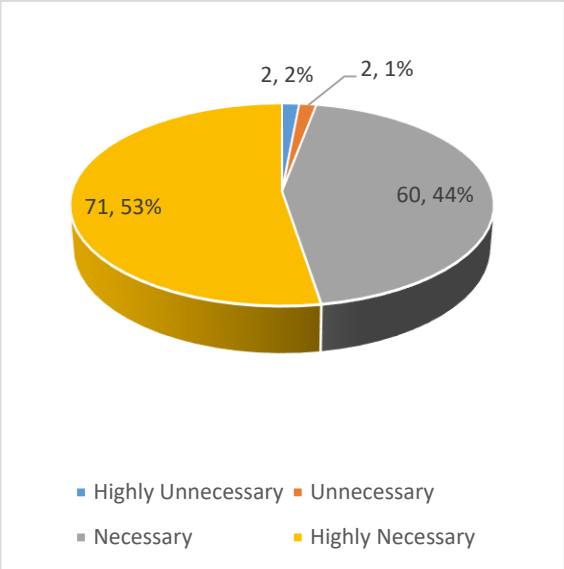

Figure 10. The need for training in scientific writing using AI

Figure 10 shows that, of 135 respondents, 71 (53%) stated that they

really needed training in scientific writing using AI. Additionally, 60 respondents (36%) need AI-assisted scientific writing training. Meanwhile, two respondents stated they did not need such training, and two others stated they strongly did not need scientific writing training using AI.

Figure 11 shows an overview of the frequently used AI tools for scientific writing.

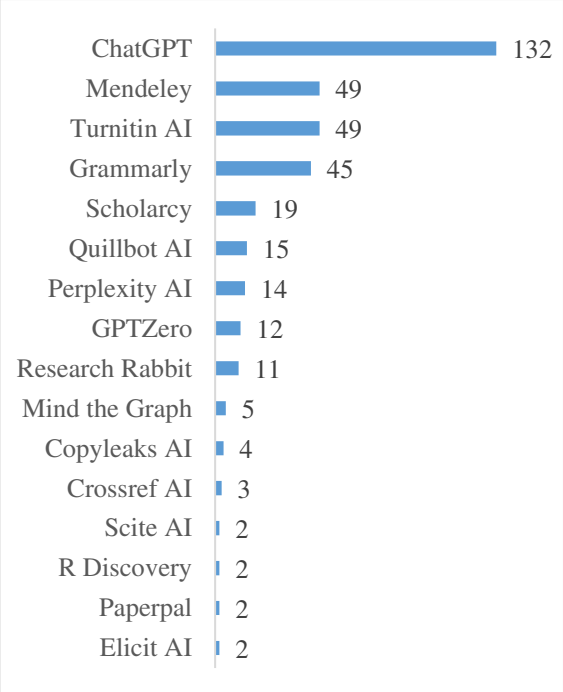

Figure 11. Diagram of frequently used AI tools

Figure 11 shows that, among 135 respondents, the most widely used AI tools for scientific writing are ChatGPT (132 people), Mendeley (49 people), and Turnitin AI (49 people). Meanwhile, the least frequently used AI tools for scientific writing are Scite AI (2 people), R Discovery (2 people), Paperpal (2 people), and Elicit AI (2 people).

Challenges and Obstacles in Integrating AI into Scientific Writing Practices

The integration of artificial intelligence into scientific writing practices presents both opportunities and challenges. While AI improves efficiency, accuracy, and reference management, numerous obstacles also arise, ranging from limited digital literacy and uneven technical skills to ethics and originality issues. These obstacles highlight the need for a more comprehensive support strategy to ensure that AI can function optimally as a tool that enhances the quality of scientific work, rather than creating new problems.

Based on the results of open interviews with several respondents who work as teachers, the challenges and obstacles faced by the majority of respondents are:

1. The Risk of Plagiarism and Originality in Writing. Many respondents stated that AI-generated writing could potentially lead to plagiarism. It raises ethical and academic concerns.
2. Clarity and Accuracy of Information. Information generated by AI is not always accurate or factual, so it requires verification by the author.
3. AI's Limited Understanding of Context. AI is not fully capable of capturing the depth of methodology, theoretical

frameworks, or specific research contexts.

4. Limitations of the Users' Digital Literacy and Skills. Not all users have the digital skills needed to create effective prompts and achieve the desired results.
5. Ethics and Academic Integrity. The integration of AI in academic writing necessitates careful oversight to uphold ethical standards, ensure transparency, and preserve the writer's independent critical judgment.

CONCLUSION

The results of this study indicate a significant need for training in scientific writing using artificial intelligence (AI) among teachers. Of the 135 respondents, 71 (53%) emphasize the importance of structured and continuous training. These results align with the research objective to analyse the level of need, barriers, and opportunities for utilising AI to support teacher professionalism through scientific publications.

This study advances the literature by integrating andragogy, experiential learning, and Asilomar AI principles to develop a comprehensive training model for writing instruction.

This study recommends developing training programs that address not only technical AI skills but also ethical literacy and reflective practice, using hands-on methods to help teachers become more adaptive and productive. Further research should evaluate the effectiveness of AI-based training in improving the quality of teachers' scientific publications and compare different AI tools for academic writing. These findings offer both practical and theoretical contributions to advancing a higher-quality academic culture in the digital age.

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