PRE-SERVICE CHEMISTRY TEACHERS' KNOWLEDGE, USAGE AND PERCEPTIONS OF ARTIFICIAL INTELLIGENCE IN EDUCATION

Harianti[*1], Asep Kadarohman[2], Sjaeful Anwar[3]

[*1,2,3] Universitas Pendidikan Indonesia

**Corresponding author: harianti12@upi.edu*

Abstract. *This study investigates pre-service chemistry teachers' knowledge, use, and perceptions of AI technology integration in education. Using a survey design, data were collected from pre-service chemistry teachers enrolled in a professional teacher education program. The findings reveal varying levels of AI knowledge, with a majority having sufficient understanding but 20% demonstrating low knowledge. Social media emerged as the primary source of AI information. Participants generally felt confident using AI tools, though usage frequency varied. The study underscores the need for comprehensive AI education in teacher training programs to enhance future educators' AI literacy and integration skills. The results highlight the importance of ethical considerations and balanced AI usage to foster critical and creative thinking in educational practices. Recommendations include integrating practical AI applications, ethical considerations, and strategies for critical engagement with AI into teacher education programs to prepare pre-service teachers for future technological advancements in education.*

Keywords: ***A****rtificial Intelligence (AI), pre-service teachers, chemistry education, AI integration, education technology*

INTRODUCTION

The development of Artificial Intelligence is currently happening in all fields, including education. AI has transformed the world of education, especially in the teaching and learning process. There has been a revolution in the world of education with this technology, where this technology offers personalized learning, administration that can be completed automatically, and designs learning easily and based on existing data [1]. As future educators, pre-service teachers' perspectives on AI are crucial to make the use of this technology in the classroom more effective and appropriate. Therefore, it is necessary to explore the knowledge, use, and perception of AI technology integration in pre-service chemistry teachers so that the readiness of these prospective teachers can be measured [2].

There are several studies regarding the importance of teachers being prepared before teaching or what is known as pre-service. The dimensions that are emphasized are professional knowledge, teaching practice, teacher involvement when learning takes place, and being able to manage oneself as a teacher with his/her duties later [3]. Specifically for chemistry teachers, research has been carried out to integrate chemistry learning with computer technology known as computational chemistry tools in scientific education so that this can increase the science and technology pedagogical knowledge of pre-service chemistry teachers [4]. Apart from that, there is currently quite a lot of research on the use of information and communication technology in the world of education and the result is that prospective chemistry teachers need to develop skills and competencies in integrating learning with AI technology [5].

Apart from that, an important role for pre-service teachers in the teaching profession in education is in teaching practice. These skills in teaching practice will make teaching practice in the classroom more efficient, especially in chemistry lessons; teachers can encourage inquiry, creativity, and intellectual development in students [6]. For this reason, equipping pre-service teachers with the

competencies to navigate the ever-evolving educational landscape, especially in technological developments, is very important [7].

It is very important to carry out a comprehensive check on pre-service teachers' knowledge, attitudes, and self-efficacy by trying to understand the perceptions and readiness of pre-service teachers to face current technological developments, especially AI [5]. Pedagogical scientific language knowledge among pre-service chemistry teachers needs to be explored because these educators can draw interesting implications in improving teacher education programs and research in chemistry education [8]. It is necessary to find strategies not limited to exploration so that AI-based digital learning can enrich teacher training programs by fostering a more adaptive mindset to technology development in the educational environment. Therefore, This research investigated the knowledge, use, and perceptions of AI among pre-service chemistry teachers, focusing on their readiness to incorporate AI into their teaching practice.

METHOD

This research used a survey design for pre-service chemistry teachers to collect comprehensive data regarding participant demographics, knowledge and use of AI that has been carried out so far, as well as perceptions of the integration of AI in learning. This survey aims to discover insights by combining quantitative and qualitative questions [9] This approach aligns with good practice in survey design, namely the importance of writing questions well and applying survey design principles to increase research quality [10]. Additionally, using a mixed methods research design, as demonstrated in research, can provide clear examples and facilitate the effective implementation of research questions [11].

Participant

This research was conducted on pre-service chemistry teachers who were registered in the professional teacher education program specifically for chemistry. With a background in chemistry education, it is hoped that participants will have a basic understanding of chemistry and prepare themselves to become future educators in this field. The survey of pre-service chemistry teachers included demographics, knowledge and sources of AI information, level of confidence in using AI, and its use in chemistry learning. The questions asked included scaled questions, multiple-choice questions, and open questions regarding their views on the role of AI in education and its potential to enhance or hinder learning.

Data collection

Data were collected via a Google form, allowing participants to complete the questionnaire at their convenience. The survey was distributed via email and academic forums associated with teacher education programs. Quantitative data from the survey was analyzed using descriptive statistics to provide an overview of participant demographics, AI knowledge, and usage patterns. Qualitative data from open-ended questions were analyzed thematically to identify common themes and insights regarding participants' perceptions and experiences with AI.

RESULT AND DISCUSSION

Knowledge about AI

The survey results in Figure 1 show three levels of knowledge about AI among pre-service teachers. There are 4% of pre-service teachers who have a high understanding of AI technology, the majority of other participants show sufficient knowledge of AI, and 20% of pre-service chemistry teachers whose knowledge of AI is relatively low. These results show that comprehensive AI knowledge needs to be considered and integrated into professional teacher education programs.

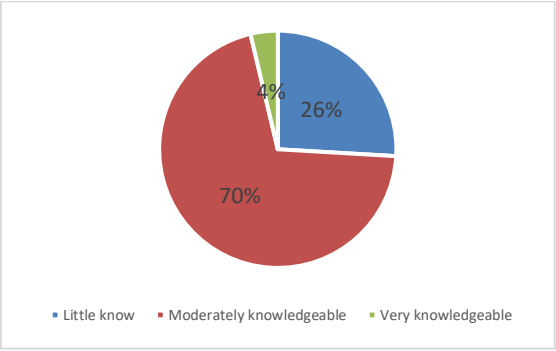

Figure 1 Knowledge about AI

The survey revealed in Figure 1 with varying levels of knowledge about AI among pre-service teachers. While some participants reported high levels of understanding, others demonstrated limited knowledge, highlighting the need for comprehensive AI education in teacher training programs, according to Teng et al. (2022) [12]. Of course, these findings align with the broader educational landscape, namely the need to integrate AI technology in the curriculum, in this case, the field of chemistry, so that the next generation is ready and literate in AI technology [13].

Souce fo AI Information

In this research, participants reported that sources of information about AI were obtained from various sources, namely from lecturers, the second largest, colleagues, although only a few at 11% and social media, which had the largest portion as results in Table 1. These diverse sources of information have demonstrated the importance of providing advanced and easily accessible AI educational materials to support pre-service teachers' learning needs [14]. AI systems have advanced problem-solving and decision-making capacities, which can be a valuable source of information for individuals who wish to deepen their understanding of AI concepts [15].

Tabel 1 Source of AI Information

Source	Frequency	Percentage
Friends	3	11%
Lecturer	6	22%
Social media	17	67%

The source of information about AI technology was mostly obtained from social media. There are 67% of pre-service chemistry teachers said this as shown in Table 1. This result aligns with studies conducted among medical students who often get information about artificial intelligence from the web or social media platforms [16]. This study shows that social media plays an important role as a common source of AI information in many fields. The study results emphasize the significant role of social media platforms in disseminating information related to AI [17].

Confident In Using AI

Based on survey results in Table 2 for pre-service chemistry teachers with postgraduate and undergraduate education backgrounds, the confidence level in using AI in carrying out assignments is the same. On average, they said they were quite confident when completing tasks with the help of AI tools.

Table 2 Confident in using AI

Level of Education	Confidential rate	Frequency
Postgraduate	4	2
	3	4
	2	2
Undergraduate	4	6
	3	8
	2	2
	1	1

In using AI to complete tasks as a teacher, in this case, preparation for learning administration and to get ideas for learning activities, the teacher can consider several aspects. Namely, teachers must be ready for technological pedagogical content knowledge (TPACK) [18], perceptions of AI education, and the effectiveness of the curriculum in this, which is the field of chemistry with AI integration. The importance of increasing pre-service teachers' TPACK will impact teaching skills in AI education.

Additionally, exploring views on the nature of science and technology and developing AI literacy among pre-service teachers can also play an important role in building confidence in using AI for educational purposes [19]. By integrating these educational strategies and programs, pre-service chemistry teachers can develop the skills and confidence necessary to utilize AI technologies in their teaching practices effectively.

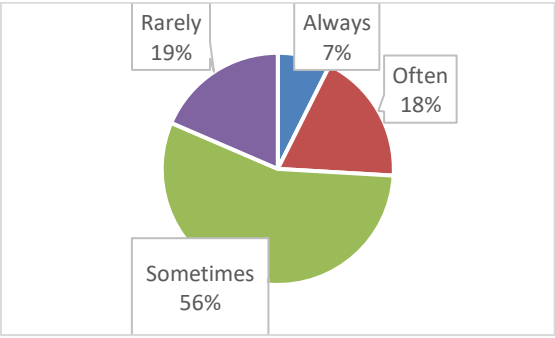

Figure 2 Frequency of AI Usage

Pre-service teachers' comfort in using this currently impacts the frequency of AI use. The frequency of use of AI among pre-service

teachers varies, as seen in Figure 2. Figure 2 shows that most teachers use AI technology in the occasional category, namely 56% of pre-service teachers. A study by Makarenko (2024) discussed that AI in education can increase learning efficiency. Therefore, Tang (2023) [20] emphasizes the importance of transparency in declaring the responsible use of AI. When pre-service teachers integrate AI into learning and introduce it to students, it is hoped that it will increase students' independence, creativity and learning performance, as stated by Wang et al. (2022) [21].

The greatest use of artificial intelligence tools in the context of pre-service chemistry teachers was 92% using ChatGPT. The use of ChatGPT for several purposes is illustrated in Figure 3.

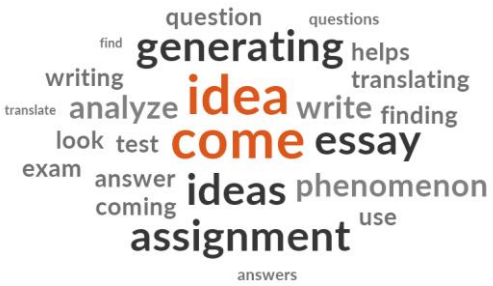

Figure 3 Tasks Frequency Query

Most users are to look for ideas, especially when working on assignments. Ideas are fundamental when doing something, including planning and learning. With ChatGPT, it will shorten the teacher's time when preparing lessons. Utilizing intelligence tools in the context of chemistry, teachers need to consider the importance of exploring existing literature on AI applications in higher education and educational research so as not to copy-paste [22]. In a study conducted by Zhu (2024) [23], the future trend of AI in the world of education and learning will expand not only to finding ideas or completing assignments. However, innovations will emerge in integrating AI technology into teachers' teaching practices.

Perceived Benefits and Challenges

Based on the survey results in Table 3 with open-ended questions, pre-service chemistry teachers revealed three categories of responses regarding the impact of using AI for teachers themselves: positive responses, negative responses and balanced responses between positive and negative.

Table 3 Summary of Responses on AI's Impact on Critical and Creative Thinking

Response Type	Summary
Positive Responses	Idea generation: AI Provides numerous ideas that can be criticized, analyzed, and developed into broader perceptions. Inspiration: AI triggers initial ideas and inspiration, making it easier to string words or sentences together and solve problems. Critical Evaluation: AI encourages users to critically evaluate its answer and compare various pieces of information before acceptance. Creative training: AI offers alternative solutions and assists in developing lesson plans and discussions, forstering creative thinking Broadening Thinking: AI contributes to broader, critical, and innovative development of student thinking by providing a space for analysis
Negative responses	Dependency and Laziness: AI makes some users lazy and dependent, reducing the opportunity for independent idea generation and literacy Immediate answers: the immediacy of AI's answers can hinder critical and creative thinking by removing the need for deeper research Reduction in skills: AI primarily serves as an aid, potentially reducing critical and creative thinking skills by making tasks easier. Surface- level Thinking: AI may lead to superficial information gathering without developing user's own thoughts or ideas.
Balanced Views	Conditional usefulness: AI can develop ideas outside traditional thinking but may cause laziness and dependency if miused Combined approach: some users gather initial ideas from AI but enrich them with personal understanding and additional research.

It was said that AI can improve critical thinking skills for positive responses because AI can encourage users to question assumptions and evaluate responses from the chatbot. This

interaction helps develop skills that analyze, evaluate, and solve problems. In addition, AI tools have been proven to increase creativity by generating new ideas and improving the quality of initial concept thinking. This augmentation can help users be creative professionally.

However, there are concerns about dependence on AI tools. AI programs provide opportunities for someone when facing a problem, not having to think and try to find a solution, because the answer has been provided. This condition can weaken a person''s thinking power. For this reason, educators need to balance the use of AI by implementing learning innovations so that AI users also practice critical thinking and the risk of dependency can be overcome.

Much research has been carried out regarding the balance of approaches to using AI in education with creative tasks. Combining AI capabilities with critical analysis and personal opinion can enhance their critical and creative thinking skills, avoiding the potential pitfalls of dependency and shallow thinking. In chemistry education itself, studies conducted by Kasneci et al. (2023) [24] and Adıgüzel et al. (2023) [25] have explored the transformational potential of AI in the world of education and highlighted the same thing, namely the impact that is a future challenge in the world of education, just as some of these pre-service chemistry teachers are worried about. Another study was conducted by Owan (2023) [26] and Jiang (2023) [27], which used AI tools to become an educational assessment tool. These AI tools will increase the accuracy of assessments, provide personalized feedback, and be adapted for teaching to meet student needs. Chiu et al. (2022) have introduced a primary AI curriculum framework, highlighting the transformative potential of AI in education. These studies collectively have opened up insight for pre-service chemistry teachers if they want to utilize AI to combine benefits and challenges to make learning more efficient and effective for students, especially in chemistry learning that still emphasizes students' inquiry abilities.

Therefore, it is very necessary to consider the ethical use of AI in education, as done by Akgün & Greenhow (2021) [28]. They conducted a study on the ethical considerations of using AI in education. This study discusses the benefits of AI systems in supporting student learning processes and the ethical dilemmas that may arise. Alasdair Baiz (2023) [29] discusses opportunities, concerns, and solutions related to generative AI in education and research, explaining the benefits and challenges of AI applications.

Perceived Ethics

The survey results in Table 4 highlight the diversity of opinions regarding the ethics of using AI, especially in educational environments. Some respondents view AI as helping generate and reference important, critical things, including helping evaluate assignments/assessments. Another perspective is that using AI to answer exam questions could be cheating. Finally, it is said to be cheating if it is used to complete assignments by copying and pasting without analyzing them. The use of AI should align with research integrating AI into education as a complementary tool and encourage students to engage critically in search results with AI tools.

Table 4. Summary of Responses on AI and Cheating in Lectures

Response Type	Summary
Not cheating	Many respondents argue that using AI is not cheating if it is used as a reference or tool to generate ideas. AI helps students find information, think critically, and paraphrase content according to their understanding.
Conditional cheating	Some believe AI's use depends on context; if AI is used to generate ieas or as a discussin partner, it is acceptable. However, using AI to answer exam questions directly is considered cheating.
Potential for cheating	A few responses highlight that AI can be misused for cheating, especially if studens rely solely on AI – generated answers without proper analysis or understanding
Balanced Views	Some respondents emphasize the importance of critical use, where AI aids in idea generation but does not replace original thinking. They suggest AI should be used to supplement knowledge rather than as a primary source for assignments.

When considering the ethics of using AI in education, the most important thing is to consider the background of various studies [22], [30], [31] and Nguyen et al. (2022) [32] opens the perspective that it is important to adopt an ethical framework when integrating AI in the world besides that there needs to be a monitoring mechanism according to Tuomi (2023) , Qadhi (2024), and Huang et al. (2023) [33], [34], [35].

CONCLUSION AND RECOMMENDATION

A study of the perceptions of pre-service chemistry teachers pursuing their education through a survey shows that only 4% of pre-service chemistry teachers have a fairly high level of understanding, while the majority are in the medium category. There are still 20% who are in the relatively low category. These findings indicate a need for education that comprehensively integrates AI tools through teacher training programs. It is also very important to insert AI knowledge into the curriculum to prepare future generations to become literate in AI, as proposed by Teng et al. (2022) [12] and Chiu & Chai (2020) [13].

Thus, pre-service chemistry teachers will feel confident enough to use AI tools to complete assignments regardless of their educational background. Their confidence in using AI is critical to effectively integrating AI into teaching practices. Research by Kim (2024) [18] and Spittle et al. (2022) [19] indicates that increasing teachers' technological pedagogical content knowledge (TPACK) and AI literacy is critical to building confidence and competence in using AI in educational settings.

In conclusion, pre-service chemistry teachers need to increase AI literacy, so it is recommended that comprehensive AI training be integrated into teacher education programs. This training should include practical applications of AI in teaching, ethical considerations, and strategies for critical engagement with AI tools. Additionally, creating accessible educational resources and professional development opportunities will help educators stay abreast of AI developments, ultimately increasing their confidence and effectiveness in using AI to support student learning. Equally important, however, is the need to discuss some of the challenges that may arise, such as how the ready availability of AI answers could weaken critical thinking skills in students. Teachers should be prepared with methods to foster independent problem-solving and analytical reasoning so that AI is used to augment, not replace, the learning process. Additionally, awareness of the ethical implications of using AI should be enhanced on data privacy, bias in AI systems, and responsible consumption of AI-generated content. This will go well with the findings and recommendations from the literature review, which sought to present AI in a balanced way, emphasizing ethical use in education while limiting the possible downsides.

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