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USE OF AI TOOLS IN DEVELOPING RESEARCH PROPOSALS AMONG PRE-SERVICE SCIENCE TEACHERS: A CASE STUDY

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Abstract:

The integration of Artificial Intelligence (AI) tools into academic research has become increasingly prevalent among higher education students. This case study explores how pre-service science teachers at Penang Teachers' Training Institute utilise AI tools during the development of research proposals in the "Fundamental Research in Science Education" course. A mixed-methods questionnaire was used to explore AI usage patterns, perceived benefits and challenges, and ethical practices. Findings revealed that all students (100%) used ChatGPT, with 53.8% using it daily and 84.6% integrating AI-generated content for less than half their proposals. The data reveals that 76.9% used AI primarily for first drafts, 69.2% for topic exploration, and 53.8% for grammar checking. Students reported high perceived benefits, with 84.6% agreeing that AI enhanced proposal quality, 76.9% cited time savings, and 76.9% found it helpful for idea generation. However, the major challenges emerged with 76.9% encountering inaccurate information and 15.4% noting AI's limited understanding of specialised scientific concepts. Students exhibited strong ethical awareness, with all participants disclosing AI use to instructors, demonstrating transparency. Although only 38.5% expressed full trust in AI outputs, 84.6% actively verified content using academic sources. Open-ended responses further highlighted AI's role in refining language, generating ideas, and clarifying research focus. The study concludes that pre-service science teachers engage thoughtfully with AI tools as supplementary academic supports rather than replacements for critical thinking. It also highlights the importance of integrating AI literacy, ethical guidelines, and institutional support into teacher education programs to foster responsible and effective AI engagement in academic work.

Keywords:

Science Education, Research Proposal Development, AI Tools, Pre-service Teachers

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Introduction

The rapid advancement of artificial intelligence (AI) technologies has transformed the landscape of higher education, including how students engage with academic writing and research development. Among these technologies, tools like ChatGPT, Grammarly, and QuillBot have become increasingly accessible and widely adopted for academic tasks. In teacher education, particularly within science education, the use of AI raises important questions about learning autonomy, research integrity, and the role of educators in guiding responsible use. This study focuses on pre-service science teachers enrolled in the "Fundamental Research in Science Education" course at the *Institut Pendidikan Guru Malaysia Kampus Pulau Pinang* (IPGKPP). As part of their coursework, these students are required to develop research proposals as a task that often involves multiple stages of writing, critical thinking, and methodological planning. With the growing availability of AI tools, many students turn to such platforms for assistance. However, little is known about how these tools are actually used, how students perceive their value, and what challenges they encounter in academic settings. This study aims to address the following research questions:

1. What AI tools do pre-service science teachers use in developing their research proposals?
2. How frequent and for what purposes are these tools used?
3. What are students' perceptions of the benefits and challenges associated with AI usage?
4. What are the implications for ethical AI use in science teacher education?

Literature Review

The growing body of literature on AI in education emphasizes both its transformative potential and the ethical concerns it raises. International studies, such as those by Holmes et al. (2019), Luckin et al. (2016), and Zawacki-Richter et al. (2019), highlight that while AI offers enhanced personalisation and efficiency, it also necessitates pedagogical adjustments and robust ethical frameworks to guide its integration in formal learning environments. Ekundayo et al. (2024) explored the integration of AI tools in academic research, highlighting their role in enhancing productivity and creativity. Similarly, Chan & Hu (2023) documented students' perspectives on AI use, noting significant improvements in writing quality and research efficiency. Additional research, such as Holmes et al. (2019), suggests that AI adoption in education requires pedagogical restructuring to preserve critical thinking and learner autonomy. Research by Luckin et al. (2021) and Baker et al. (2020) emphasises that AI systems should complement, rather than replace, human teaching to support adaptive learning environments effectively. Furthermore, Woolf et al. (2021) argue that AI can help scaffold complex problem-solving skills when integrated thoughtfully with human instruction. However, these benefits are contingent on educators' understanding and acceptance of AI tools (Zawacki-Richter et al., 2019; Holmes et al., 2019).

However, the literature also cautions against uncritical adoption. Zhai (2022) emphasises the importance of ethical literacy and highlights the risks of plagiarism and misinformation when AI is used without proper verification. Chan & Hu (2023) found that although university students frequently use AI tools, many lack the skills to critically evaluate the outputs of these tools. Kasneci et al. (2023) and Chan & Hu (2023) noted the dual nature of AI tools, which can both support learning and hinder the development of essential academic competencies if over-relied upon. Selwyn (2020) similarly warns that over-reliance on AI-generated content risks deskilling students and reducing deep learning engagement. Moreover, Luckin et al. (2021)

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argue that effective AI use in education hinges on aligning AI capabilities with pedagogical intentions. Chan & Hu (2023) proposed a framework for verifying AI-generated content, suggesting strategies such as triangulation with academic sources and consultation with instructors. Collectively, these studies underscore the importance of integrating AI literacy into academic programs, particularly for pre-service teachers who will guide the next generation of learners. Despite these insights, little is known about how pre-service science teachers in Malaysian teacher education institutions perceive and use AI tools. This study aims to fill that gap.

Methodology

Participants

The study involved 13 pre-service science teachers from IPGK Penang. All participants were enrolled in the *"Fundamental Research in Science Education"* course and majoring in science education. While the sample size is relatively small, it is justified because the participants represent a complete cohort of students undertaking the course during the study period. This purposive selection ensures that the sample is highly relevant to the research objectives, as these individuals are the immediate population most directly engaged with AI tools in the development of research proposals. In line with case study methodology, the intention was not to generalize findings to a wider population but rather to obtain in-depth insights into the experiences and perceptions of this specific cohort (Yin, 2018).

Instrumentation

Data were collected using a structured questionnaire. The instrument was adapted from previous studies (Su & Yang, 2023; Chan & Lee, 2023; Gimpel et al.,2024; and Mitrovic et al., 2023). The questionnaire consists of four section which are Part A: AI tool usage patterns (4 items of multiple-choice), Part B: Perceptions and attitudes (9 items of 5-point Likert-type), Part C: Benefits and challenges (3 items of multiple-choice) and Part D: Open-ended questions on beneficial experiences, ethical use, and implication (4 items). The questionnaire was adapted from prior validated studies on AI usage in education (Su & Yang, 2023; Chan & Lee, 2023; Gimpel et al., 2024; Mitrovic et al., 2023). To establish content validity, the instrument was reviewed by two experts in educational technology and research methodology, ensuring that the items were aligned with the study objectives and context. Face validity was further enhanced through pilot testing with a small group of non-participating students, who confirmed the clarity and comprehensibility of the items.

Regarding reliability, internal consistency of the Likert-scale items (Part B) was measured using Cronbach's alpha, which yielded a coefficient of 0.82, indicating high reliability (Nunnally, 1978). Furthermore, triangulation was achieved by incorporating both quantitative (Likert-scale and multiple-choice) and qualitative (open-ended responses) data, thus enhancing the trustworthiness of the findings (Creswell & Plano Clark, 2018).

Data Collection and Analysis

The questionnaire was administered to all 13 participants at the end of their research proposal development process. Quantitative data (closed-ended items) were analysed using descriptive analysis to determine frequencies and percentages (Part A and Part C). While for Part B, the analysis is based on a 5-point Likert-type scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), which determines central tendency (median and mode), frequency

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distributions, and cumulative agreement percentages (ratings of 4-agree and 5-strongly agree). These descriptive statistics help summarise ordinal data without assuming normal distribution, making them suitable for Likert-type responses in small-N studies (Jamieson, 2004; Boone & Boone, 2012; Noordin & Nazarudin, 2024). This approach avoids the limitations of inferential statistics in small samples while still offering meaningful insights (Nardi, 2018; Nazarudin & Noordin, 2023b) in a case study. Qualitative data (open-ended responses) were analysed thematically to identify common beneficial experiences, ethical use, and implications (Part D). Ethical considerations were addressed by ensuring voluntary participation and confidentiality (Nazarudin & Noordin, 2023a). No identifying information was collected, and the study was used solely for academic and educational improvement purposes.

Results And Discussion

Types of AI Tool Usage

The data collected from 13 pre-service science education students indicate a dominant reliance on ChatGPT for support in developing their research proposals. As shown in Table 1, 100% of respondents (n = 13) reported using ChatGPT. This suggests that ChatGPT is the most recognised and widely adopted AI tool among the cohort. Interestingly, while none of the participants selected other listed tools such as Google Bard/Gemini, Claude, Bing Chat/Copilot, Elicit, QuillBot, or Zotero AI features, two students specified additional tools under the "Other (please specify)" category: one used Deepseek, and another used Grammarly. This indicates that although the primary choice was ChatGPT, a small number of students are exploring supplementary tools, possibly to meet more specific needs like grammar correction or targeted information retrieval. This strong preference for ChatGPT suggests that it is perceived as the most accessible, effective, or user-friendly tool for academic support, aligning with recent trends in higher education where ChatGPT is often favored due to its conversational interface and broad functionality (Dwivedi et al., 2023; Kasneci et al., 2023). The low uptake of other tools may point to a limited awareness or familiarity with alternative AI applications among students (Zawacki-Richter et al., 2019).

Table 1: Types AI Tools Usage

AI Tool	Frequency (n=13)	Percentage (%)
ChatGPT	13	100.0
Google Bard/Gemini	0	0.0
Claude	0	0.0
Bing Chat/Copilot	0	0.0
Grammarly	0	0.0
Elicit	0	0.0
QuillBot	0	0.0
Zotero AI features	0	0.0
I have not used any AI tools	0	0.0
Other (please specify)	2	15.4
Deepseek	1	7.7
Grammarly	1	7.7

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Frequency and Purpose of AI Tool Usage

The data on frequency of AI tool usage (Table 2) indicates that the majority of the students (53.8%) used AI tools daily, while an additional 30.8% used them 2–3 times per week. A smaller group (15.4%) reported using AI tools multiple times daily. This high frequency of use illustrates that AI tools were deeply integrated into students' academic routines, especially during intensive academic writing. The findings align with studies showing that when AI tools like ChatGPT are perceived as not only accessible but also effective, students integrate them into their academic writing needs (Kasneci et al., 2023; Dwivedi et al., 2023).

Table 2: Frequency of AI Tools Usage

Frequency of AI Tool Usage	Responses (n=13)	Percentage (%)
Multiple times daily	2	15.4
Daily	7	53.8
2–3 times per week	4	30.8
Once a week	0	0.0
Only occasionally	0	0.0
Never	0	0.0

Further analysis of specific tasks (Table 3) offers deeper insights into the purposes for which students leverage AI tools. The most frequent use of AI was for writing first drafts (76.9%), followed by topic exploration/selection (69.2%) and grammar/style checking (53.8%). This suggests that students leveraged AI primarily at the early and generative stages of research proposal development. AI tools appeared to serve as a form of brainstorming support and a writing catalyst, particularly for tasks requiring language fluency and idea expansion. These roles are consistent with prior findings that generative AI tools help reduce writing anxiety and improve initial productivity (Smutny & Schreiberova, 2020). Other notable tasks included literature search and review (46.2%), formulating research questions (46.2%), and outlining/structuring the proposal (46.2%). These uses indicate that students see AI tools not just as writing aids but also as cognitive partners in planning and conceptualizing their research However, less frequent use of AI for research design (23.1%) and data analysis planning (15.4%) suggests that students are more hesitant to rely on AI for tasks that require methodological reasoning or disciplinary expertise. This finding may point to a perceived boundary between creative support and academic rigour, as noted in Zawacki-Richter et al.'s (2019) review of AI in higher education. The data also suggest that students' AI literacy is task-dependent, with stronger proficiency observed in writing and brainstorming activities.

Table 3: Purpose of AI Tools Usage

Challenge	Number of Responses	Percentage
Topic exploration/selection	9	69.2%
Literature search and review	6	46.2%
Formulating a research question	6	46.2%
Research design/methodology	3	23.1%
Outlining/structuring the proposal	6	46.2%
Writing first drafts	10	76.9%

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Revising/editing content	5	38.5%
Grammar/style checking	7	53.8%
Reference formatting	4	30.8%
Data analysis planning	2	15.4%

Table 4 presents the extent of artificial intelligence (AI) tool usage among pre-service science teachers during the development of their final research proposals. The responses are categorised into four modes of AI involvement: *written entirely without AI*, *written by you with minimal AI assistance*, *generated by AI but heavily edited by you*, and *entirely generated by AI*, with frequencies and percentages indicating content generated either above or below the 50% threshold. The findings indicate that the majority of participants (84.6%) reported using AI for less than half of their proposal content in the *category of proposals entirely generated by AI*, suggesting a prevailing reluctance to allow AI to take full control of the academic writing process. Only 15.4% of students acknowledged generating more than 50% of their proposal entirely through AI tools. This finding aligns with previous studies indicating that students tend to use AI tools as a form of scaffolding rather than full content generators (Smutný & Schreiberová, 2020). The limited reliance on fully AI-generated content may reflect concerns about academic integrity, originality, and the quality of AI outputs (Flanagin et al., 2023). Both the *categories written by you with minimal AI assistance and generated by AI but heavily edited by you* show an identical pattern: 76.9% of students used AI tools for less than half of their content, while only 23.1% used them beyond the 50% threshold. This suggests that even when AI was utilised, it was often in a limited and controlled manner. Such patterns reflect responsible use, aligning with existing recommendations that AI should support, not displace the human writing process in academic settings (Luckin et al., 2016). In contrast, only 30.8% of students generated more than 50% of their proposals *written entirely by you without AI*, while the remaining (69.2%) reported using some form of AI assistance.

This indicates that AI tools have become integrated into students' research writing practices. Nevertheless, the fact that most students used AI for less than half of their content implies a mindful, measured approach to its use (Kasneci et al., 2023). Thus, the data suggest that these pre-service science teachers are not merely passive adopters of AI technologies but are demonstrating reflective, controlled, and ethically grounded use. Their tendencies to either minimise AI contributions or engage in significant editing of AI-generated content highlight an emerging AI literacy that prioritises human oversight, originality, and disciplinary norms. As Flanagin et al. (2023) emphasise, maintaining transparency in authorship and editorial control is essential to uphold scholarly standards in an era of increasingly sophisticated generative technologies.

Table 4: AI Tools Usage In Research Proposal Content

Content Generation Category	Percentage >50%	Frequency >50%	Percentage <50%	Frequency <50%
Written entirely by you without AI	30.8%	4	69.2%	9
Written by you with minimal AI assistance	23.1%	3	76.9%	10

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Generated by AI but heavily edited by you	23.1%	3	76.9%	10
Entirely by AI	15.4%	2	84.6%	11

Perceptions and Attitudes Toward AI

This section presents the descriptive analysis of students' responses regarding their perceptions, attitudes, and ethical preparedness in using AI tools for research proposal development. The analysis is based on a 5-point Likert-type scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The results are interpreted using measures of central tendency (median and mode), frequency distributions, and cumulative agreement percentages (ratings of 4 and 5). The findings in Table 1 indicate that the majority of participants perceived AI tools as beneficial to their research proposal development. For the statement *"AI tools enhanced the quality of my research proposal"*, the median and mode were both 4, with 84.6% of students agreeing or strongly agreeing, indicating a very high level of agreement. Similarly, 76.9% agreed that *"AI tools helped me generate ideas I wouldn't have otherwise"*, and the same percentage believed that *"AI tools saved significant time in the research process"*. These results suggest that students perceive AI as a valuable support mechanism for enhancing the efficiency and creativity of their academic writing (Zawacki-Richter et al., 2019; Kasneci et al., 2023). These benefits appear to position AI tools as scaffolding aids, particularly for novice researchers. The high median (4) and mode (4) values support this interpretation. This aligns with Luckin et al. (2016), who noted that AI's role in education is most powerful when used to improve students' learning processes rather than replace them. Student attitudes toward trusting AI-generated content revealed more cautious perspectives.

The item *"I trust the information provided by AI tools"* had a median and mode of 3, with only 38.5% agreement, indicating a low level of trust. However, responses to *"I verify information provided by AI before using it"* were notably different, with a median and mode of 5 and an agreement rate of 84.6%, categorised as very high agreement. This indicates a critical and responsible approach to AI integration, highlighting the importance of verification and human oversight in AI-supported academic tasks. As has been highlighted by Bender et al. (2021), students are willing to use AI, but do so with caution, recognising potential inaccuracies or biases in the output. Interestingly, the item *"I'm concerned about becoming overly dependent on AI tools"* had a median and mode of 3, with only 15.4% of respondents expressing agreement. This very low level of concern may reflect either a limited awareness of dependency risks or high confidence in managing their use of AI tools effectively (Luccioni et al., 2023).

Students' perceptions regarding ethical readiness expressed strong self-efficacy. The statement *"I understand the ethical implications of using AI in academic work"* yielded a median and mode of 5, with 84.6% agreement, and again reflects a very high level of perceived preparedness. This suggests that the majority of participants perceive themselves as aware of the ethical responsibilities associated with AI use, including concerns related to academic honesty, transparency, and the potential misuse of AI-generated content. Such awareness is crucial, especially as AI becomes more embedded in higher education and scholarly communication (Zawacki-Richter et al., 2019). However, the item *"I feel confident about properly citing/acknowledging AI assistance"* received a mixed response. Only 38.5% of students agreed with this statement, while another 38.5% chose a neutral response, and 23.1%

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disagreed. The median and mode for this item were both 3, indicating a lack of strong confidence across the group.

This finding reveals an important ethical gap: although students recognize the ethical importance of using AI responsibly, they are uncertain about how to properly cite AI tools such as ChatGPT or other generative models. This could be due to the evolving nature of citation guidelines and inconsistent messaging from academic institutions. As Zhai (2022) explains, the lack of standardisation in AI citation practices may leave students feeling unsure of what is required, even when they have ethical intentions. The third item, *"My instructors have provided clear guidelines about appropriate AI use,"* shows that only a small proportion of students disagreed (15.4%) that their instructors had provided clear guidelines about appropriate AI use. A larger segment (38.5%) responded neutrally, while the majority of students, with 46.2% agreed, indicating a generally positive perception of instructional support. The mode of 4 (Agree) reinforces this trend. These findings suggest that while some students remain uncertain, many recognise their instructors' efforts in communicating ethical expectations. This reflects progress toward institutional responsibility in preparing students for ethical AI use in academic contexts. As Zhai (2022) and Smutny (2020) emphasise, ethical preparedness is most effective when individual awareness is supported by clear, consistent guidance from educators.

Table 1: Student Perceptions and Attitudes toward AI

Construct	Item Statement	Median	Mode	Frequency Distribution n=13 (%)	Agreement %	Agreement Level
Perceptions of Benefits	AI tools enhanced the quality of my research proposal	4	4	1(7.7%), 0(0.0%), 1(7.7%), 6(46.2%), 5(38.5%)	84.6%	Very High Agreement
	AI tools helped me generate ideas I wouldn't have otherwise	4	4	0(0.0%), 2(15.4%), 1(7.7%), 6(46.2%), 4(30.8%)	76.9%	High Agreement
	AI tools saved me significant time in my research process	4	4	1(7.7%), 2(15.4%), 0(0.0%), 6(46.2%), 4(30.8%)	76.9%	High Agreement
Attitudes toward Trust & Verification	I trust the information provided by AI tools	3	4	0(0.0%), 2(15.4%), 6(46.2%), 5(38.5%), 0(0.0%)	38.5%	Low Agreement
	I verify information provided by AI before using it	5	5	1(7.7%), 0(0.0%), 1(7.7%), 4(30.8%), 7(53.8%)	84.6%	Very High Agreement
	I'm concerned about becoming overly dependent on AI tools	3	3	0(0.0%), 4(30.8%), 7(53.8%),	15.4%	Very Low Agreement

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				2(15.4%), 0(0.0%)		
Perceptions of Ethical Preparedness	I understand the ethical implications of using AI in academic work	5	5	1(7.7%), 0(0.0%), 1(7.7%), 4(30.8%), 7(53.8%)	84.6%	Very High Agreement
	I feel confident about properly citing/acknowledging AI assistance	3	3	0(0.0%), 3(23.1%), 5(38.5%), 5(38.5%), 0(0.0%)	38.5%	Low Agreement
	My instructors have provided clear guidelines about appropriate AI use	3	4	1(7.7%), 1(7.7%), 5(38.5%), 5(38.5%), 1(7.7%)	46.2%	Moderate Agreement

Perceived Benefits and Challenges

Based on Table 5, the highest reported benefit of using AI tools was time efficiency with 38.5% (n=5), followed by improved writing quality with 23.1% (n=4). These results support findings by Kasneci et al. (2023), who noted that AI enhances productivity and writing clarity. A smaller number of students found AI tools helpful for learning new concepts or perspectives (15.4%, n=2), and for literature review, overcoming writer's block and organising ideas (each 7.7%, n=1). None indicated support for the research design. Thus, it shows that students are primarily leveraging AI tools for efficiency and language-related support. It also indicates that AI tools are currently limited in supporting the more complex cognitive and methodological tasks involved in research proposal writing (Zhai, 2022).

Table 5: Benefits of using AI tools

Benefit	Percentage (%)	Frequency
Better organisation of ideas	7.7%	1
Learning new concepts/perspectives	15.4%	2
Overcoming writer's block	7.7%	1
Assistance with research design	0%	0
Help with literature review	7.7%	1
Improved writing quality	23.1%	4
Time efficiency	38.5%	5

The most frequently reported challenge (Table 6) was inaccurate or misleading information, which was reported by 76.9% (n=10) of students. This supports Zhai's (2022) findings that AI tools like ChatGPT may generate plausible-sounding but factually incorrect content, which can undermine academic quality. A smaller proportion of students (15.4%, n=2) noted AI's limited understanding of specialised scientific concepts, which aligns with concerns about the superficial nature of AI-generated explanations in technical subjects (Kasneci et al., 2023). Only one participant (7.7%) reported difficulty integrating AI outputs with their own ideas, and none reported issues with verifying content, plagiarism concerns, or technical access. These outcomes imply that the major barrier to productive AI use is not technical access or ethical

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worry, but rather the questionable accuracy and shallow understanding presented in AI-generated outputs.

Table 6: Challenges of using AI tools

Challenge / Limitation	Percentage (%)	Frequency
Inaccurate or misleading information	76.9%	10
Limited understanding of specialised scientific concepts	15.4%	2
Difficulty in verifying AI-generated content	0%	0
Concerns about academic integrity/plagiarism	0%	0
Technical limitations/accessibility issues	0%	0
Lack of guidance on appropriate use	0%	0
Difficulty integrating AI outputs with the manuscript	7.7%	1

As in Table 7, the majority of students (84.6%, n=11) reported cross-checking AI-generated information with academic sources, indicating a strong awareness of the need to validate content before use. This practice reflects growing student caution about the credibility of AI outputs, as emphasised by scholars who warn that large language models can produce factually incorrect or fabricated information (Flanagin et al., 2023). Only a small number of participants verified content by consulting professors or peers (7.7%, n=1) or checking against course materials (7.7%, n=1). Notably, none reported comparing outputs from multiple AI tools or blindly trusting AI-generated content without verification.

Table 7: Verify information from AI tools

Verification Method	Percentage (%)	Frequency
Cross-check with academic sources	84.6%	11
Consult with professors/peers	0%	0
Compare outputs from multiple AI tools	0%	0
Check against course materials	7.7%	1
I generally trust AI-generated information without verification	7.7%	1

Open-Ended Responses (Themes)

Question 11 mentions describing one example of how an AI tool helped improve a research proposal. The responses from 13 students revealed three prominent themes in how AI tools benefit their research proposal writing, which are language refinement, idea generation, and focus enhancement. As for language enhancement, 6 students used AI tools such as Grammarly and ChatGPT to correct grammar, improve sentence structure, and enhance academic tone. One student explained: *"Grammarly identified grammatical errors, and ChatGPT rephrased complex sections to improve flow."* This corresponds with the quantitative finding where 38.5% reported time efficiency and 23.1% reported improved writing quality as key benefits. The second theme is idea generation and development. 4 students indicated that AI helped them generate new ideas when they felt stuck. One participant shared: *"When I lacked ideas, the AI tool helped me generate them."* Another mentioned using txyz.ai to explore other research papers, aiding the literature review process.

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These responses align with the 15.4% who cited learning new perspectives as a benefit. Regarding the theme focus and clarity of research components, three students highlighted how AI helped them narrow down broad research questions and clarify their problem statements. For example, one student stated: *"ChatGPT helped me revise my research question to better match my objectives."* Quantitative responses show that AI tools were especially helpful in improving language quality and refining research ideas, though their role in deeper aspects like research design was minimal. However, fewer students reported using AI for deeper tasks such as research design, indicating that while AI is valuable, its application may still be limited to surface-level writing tasks.

For questions 12 and 13, basically on the ethics of using AI. Question 12 mentions "What guidelines or resources would help you use AI tools more effectively and ethically in your academic work?" while question 13 is about "Do you disclose your use of AI tools to your instructors? Why or why not?". The responses to Questions 12 and 13 reveal two main themes, which are i. ethical guidelines and responsible use; ii. transparency and disclosure. For the first theme, 11 students emphasised the importance of following institutional policies, such as institutional rules, APA guidelines, and academic integrity frameworks. Tools like Google Scholar, APA 7th Edition and responsible AI practices (examples like fact-checking, not copying blindly) were frequently mentioned. Many students expressed that AI should be used to support thinking, not replace original work. One student noted, *"Use AI to support my thinking, not to replace my original work."*

This reflects the awareness of the ethical boundaries of AI use, aligning with recommendations in literature that stress human oversight and proper attribution (Floridi & Cowls, 2019). Regarding the second theme on transparency and disclosure, all 13 students reported disclosing their use of AI tools to instructors, citing reasons such as honesty, academic integrity, and building trust. One respondent shared: *"I disclose my use of AI tools because it's honest and shows that I'm using them responsibly."* This strong emphasis on disclosure reflects students' commitment to upholding ethical standards and avoiding plagiarism or misrepresentation. Thus, the data indicate that these pre-service science teachers are not only using AI tools cautiously but are also mindful of the ethical responsibilities involved. They value transparency and seek institutional support to guide ethical AI use in academic work.

Question 14 mentions implications for ethical AI use. The question is on "How do you think AI tools will affect science education research in the future?". Question 14 reveals three themes, which are i. Increased Efficiency and Speed in Research, ii. Enhance Data Analysis and Pattern Recognition and iii. Support for Innovation in Teaching and Learning. For the first theme (i. Increased Efficiency and Speed in Research), 11 students emphasised AI's ability to enhance the efficiency of the research process. They highlighted support for literature reviews, data analysis, and writing assistance, making research tasks faster and more manageable. For instance, one student shared, *"AI tools will make science education research faster and easier by helping with data analysis, finding patterns, and improving writing."* This aligns with existing research showing that AI enhances research productivity and reduces cognitive workload (Zawacki-Richter et al., 2019).

For the second theme (ii. Enhance Data Analysis and Pattern Recognition), 9 students mentioned that AI can help analyse large datasets, identify patterns in student learning, and spot gaps in existing research (in terms of evaluating teaching effectiveness and improving

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curriculum). This suggests a belief in AI's ability to support evidence-based educational decisions. For example, a student wrote: *"AI can help identify patterns in large datasets, generate insights for curriculum development, and assist in adaptive learning."* The third theme (iii. Support for Innovation in Teaching and Learning), 6 students believed AI could transform science education through personalised learning, adaptive platforms, and improved teaching methods. These tools were seen as a way to make science learning more engaging, accessible, and creative for students. These responses suggest that AI is not only viewed as a research aid but also as a catalyst for pedagogical innovation, enabling more student-centred and responsive teaching approaches (Luckin et al., 2016). Students foresee AI as a valuable asset in science education research by recognising AI's potential to improve the efficiency of science education research, enable data-driven findings and support innovation in pedagogy. These findings align with current literature emphasising AI's role in shaping the future of education through automation, personalisation, and intelligent analysis (Holmes et al., 2019).

Discussion

RQ1: What AI Tools Do Pre-Service Science Teachers Use In Developing Their Research Proposals?

Findings revealed a dominant reliance on ChatGPT, with all students (100%) reporting its use, while few explored supplementary tools like Grammarly and Deepseek. This suggests ChatGPT's prominence due to its accessibility and broad functionality (Dwivedi et al., 2023; Kasneci et al., 2023). The limited adoption of alternatives indicates a narrow awareness of AI tools among pre-service teachers (Zawacki-Richter et al., 2019).

RQ2: How Frequently And For What Purposes Are These Tools Used?

AI tools were integrated into students' academic routines, with 53.8% using them daily. They were primarily employed for drafting, topic selection, and grammar improvement, particularly at the early stages of writing. However, AI was less used for tasks requiring methodological rigor, such as research design and data analysis, suggesting a boundary between support and academic integrity (Smutný & Schreiberová, 2020; Zawacki-Richter et al., 2019). Most students (84.6%) used AI-generated content for less than half of their proposal, reflecting cautious, controlled use (Kasneci et al., 2023).

RQ3: What Are Students' Perceptions Of The Benefits And Challenges Associated With AI Usage?

Students viewed AI tools as largely beneficial for research proposal development. Most students agreed that AI improved the quality of their writing, saved time, and helped generate new ideas, particularly in language refinement, idea generation and overcoming writer's block (Kasneci et al., 2023; Zawacki-Richter et al., 2019). However, trust in AI-generated content was moderate; while only 38.5% trusted the information, 84.6% consistently verified it, indicating critical awareness (Bender et al., 2021). The main challenges included AI's tendency to produce inaccurate or misleading information, with 76.9% (n = 10) of students reporting this concern. While 15.4% (n=2) noted a limited understanding of specialised scientific concepts. In contrast, only one student (7.7%) reported difficulty integrating AI outputs with their own ideas, which suggests that accuracy is the dominant concern. Lee and Palmer (2025) mention that necessary prompt engineering skills is needed to elicit accurate and contextually appropriate outputs from AI tools, particularly in scientific contexts. Poorly constructed prompts can lead to vague, superficial, or even incorrect responses, thereby limiting the

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effectiveness of AI support. Additionally, the cognitive limitations of current large language models in processing discipline-specific content, such as complex scientific concepts, may further contribute to this challenge (Kasneci et al., 2023). Thus, these findings suggest there is a need for enhanced AI literacy, structured training in prompt design, and a deeper understanding of the constraints of generative AI technologies within academic and scientific writing tasks.

RQ4: What Are The Implications For Ethical AI Use In Science Teacher Education?
Despite frequent AI use, 93.3% (n = 14), the students reported high ethical awareness, with 84.6% stating they understood the implications of AI use. Yet, only 38.5% felt confident about citing AI tools correctly, revealing a need for clearer academic guidelines (Cotton, 2023). 100% students acknowledged and disclosed their AI use to instructors, emphasising honesty and academic integrity. Students called for institutional resources such as APA guidelines, academic policies, and training to support ethical AI use (Floridi & Cowls, 2019). Looking ahead, they believed AI could improve research efficiency, support data analysis, and foster innovative teaching methods in science education (Holmes et al., 2019; Luckin et al., 2016). These responses highlight the potential of AI to enhance educational practice, provided ethical use is guided by clear institutional support.

Conclusion

The findings reveal that pre-service science teachers are actively and thoughtfully engaging with AI tools, particularly ChatGPT, in their research proposal development. AI is primarily used for drafting content, refining language, and generating ideas, with students perceiving it as a beneficial support for improving writing quality and academic efficiency. Despite these advantages, students remain cautious, demonstrating verification practices, moderate trust in AI-generated content, and strong ethical awareness. Importantly, the study indicates that these students approach AI with a balanced mindset, using it as a supplementary tool rather than a replacement for their own academic thinking. Their practices of disclosure, critical verification, and emphasis on academic honesty suggest a developing culture of ethical AI engagement. This reflects broader implications for science teacher education, where responsible and reflective AI use can enhance research literacy, support academic integrity, and encourage innovative yet principled academic practices in the age of generative technologies.

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