Łukasz Tomczyk (Ed.)

Communications in Computer and Information Science 2537

New Media Pedagogy: Research Trends, Methodological Challenges, and Successful Implementations

Third International Conference, NMP 2024
Kraków, Poland, November 28–29, 2024
Revised Selected Papers

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Editor

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Preface

It is with great pleasure that we present to you the publication summarising the international conference New Media Pedagogy – NMP 2024, which took place on 28–29 November 2024 at the Jagiellonian University in Krakow (Poland). The event brought together researchers, teachers, education experts and new technology enthusiasts to explore the current challenges and opportunities associated with the transformation of education in the digital age.

The book is divided into two main parts, reflecting the leading topics of the conference. Part I – Innovative ICT Applications in Education – focuses on the practical and theoretical aspects of using information and communication technologies in various educational contexts. The articles in this section address topics such as digital competence, early childhood education, the use of VR, brain-computer interfaces and the role of critical pedagogy in shaping the new digital education.

Part II – Artificial Intelligence in Education – presents a wide range of research and reflections on the impact of AI-based tools on didactic processes, teaching practices and student experiences. The authors analyse both the theoretical framework of education in the age of AI and the practical implications of using generative artificial intelligence in education at various levels – from primary schools to higher education.

The international character of the conference is particularly noteworthy – the authors of the papers include representatives from as many as 16 countries: Belgium, China, Italy, Portugal, Poland, Slovakia, the Czech Republic, Greece, the UK, Morocco, Slovenia, Austria, Indonesia, Chile, Australia and Germany. This global perspective enables a better understanding of common challenges and local contexts of education in a digital world, as well as the exchange of best practices and educational inspiration.

The book contains 23 chapters, carefully selected from 72 submissions sent to the conference in a double-blind review process with three reviews per submission. This means an acceptance rate of 31.94%, which testifies not only to the reliable and responsible work of the Scientific Committee, but above all to their attention to the high substantive quality of the articles presented. The papers were selected with the aim of maintaining high standards of research into the digitalisation of education. In an era of overproduction of analyses of information and communication technologies (ICT) in education, methodological consistency, logical reasoning and adequate anchoring in social science theories take on particular importance. I would like to take this opportunity to thank all the reviewers who helped select the best texts and provided a number of valuable comments for the authors. Without your support, it would not have been possible to finalise the NMP 2024 conference in the form of a book.

The papers presented here show the diverse approaches, methods and cultural perspectives that together form a panoramic picture of contemporary media pedagogy. The NMP 2024 conference and this publication are not only intended to document progress in the field of digital education, but above all to inspire further research, innovation and

activities for the conscious, critical and inclusive use of new media in the educational process.

We would like to thank all authors, reviewers and conference participants for their contribution to the development of this important field and at the same time invite you to participate in the next edition, NMP 2025, which, as every year, will be organised by the Institute of Pedagogy at the Jagiellonian University. More information about the event is available at: www.ict-education.pl

April 2025 Łukasz Tomczyk

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Bridging Scientific Research and AI: How Indonesian Teacher Candidates Perceive Emerging Technologies in Education

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Abstract. The competencies and attitudes towards scientific research are crucial for teacher candidates as one of the basic requirements for professional teachers. Moreover, the power of AI (artificial intelligence) is massively used in many aspects, especially in the academic sector. However, in the Indonesian context, there is still a lack of studies focused on exploring these variables. This paper aims to identify teacher candidates' attitudes towards scientific research and the relationship between their knowledge and familiarity with AI. The current research involved 268 teacher candidates from various Indonesian universities through the use of both closed-ended and open-ended surveys. The results indicate that teacher candidates exhibit consistently positive attitudes across most dimensions of the research inventory, as well as a high level of knowledge regarding AI; however, exhibit a moderate level of familiarity with the application of AI in education. A significant correlation exists between their attitudes towards scientific research and their knowledge and familiarity with using AI in education. Thematic analysis was then conducted on the open-ended responses, revealing dual perceptions and beliefs about the use of AI in education, which were categorized into two emerging themes: AI as (1) a wonderful tool for research, and (2) dangerous and unethical tools for research. This research suggested the importance of emphasizing research knowledge, attitudes, and skills for Indonesian teachers' education curriculum, focusing on theoretical and practical competencies, including the use of AI wisely.

Keywords: attitudes towards scientific research · knowledge of AI · familiarity of AI · teachers candidates · Indonesia

1 Introduction

Scientific research is a systematic process that entails the testing and development of knowledge through a variety of methodologies, activities, and theoretical frameworks [1]. It follows a sequential approach, including problem identification, method selection, data collection and processing, and formulating conclusions [2]. Scientific research

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equips students with theoretical, technical, practical, and methodological knowledge in education, empowering them to address future challenges and drive societal transformations [3]. Students should be encouraged to engage in research experiences [4], as it can positively impact their development [5]. Strategies to enhance students' research skills include participation in academic conferences [6] and improving their understanding of project execution and research methodologies [7].

While the importance of scientific research in education is widely acknowledged, the perception of science education varies across different cultures. For instance, in Bhutan, science is often perceived as abstract and complex [8]; in contrast, students in countries such as Cyprus, Australia, Canada, and South Korea generally hold more favorable views of science [9]. These cultural differences highlight the need for tailored science education and research approaches across different regions. This is related to the importance of research skills in various professional fields. Although, each profession has a different scope and approach to research.

Therefore, teachers are essential in connecting scientific research with education, as they facilitate transformations in the learning process, instructional design, and problem-solving strategies [10]. Their involvement in research can enhance their content understanding, pedagogical expertise, critical thinking skills, and ability to reflect deeply [11]. Teachers who engage in research are better positioned to design effective curricula, serve as knowledge drivers in education, and enhance their self-confidence in the classroom [12].

For teacher candidates, developing a research culture, scientific perspective, and positive attitude toward research is essential [13]. These qualities can influence their future students' attitudes towards science, affecting the science learning process [14]. By fostering a strong research orientation in teacher candidates, educational institutions can create a ripple effect that enhances scientific literacy and research skills among future generations of students.

Despite the acknowledged significance of research skills, students frequently view research methodology courses as challenging and anxiety-provoking [15]. While recognizing the significance of students' positive attitudes towards research, several challenges persist. Many students shy away from research activities, not identifying themselves as researchers, which leads to a belief in their inability to comprehend and conduct studies effectively [16, 17]. Furthermore, a common misconception among students is the equation of research with statistics. This misunderstanding often leads students to believe that their perceived lack of mathematical proficiency will hinder their research capabilities. Such beliefs can have long-lasting effects on their learning process and future professional development [17, 18]. This anxiety can negatively impact students' self-efficacy and attitudes towards research [19]. A study of teacher candidates in the US and Canada revealed that many consider research difficult and complex [20–22]. These perceptions highlight the necessity for innovative teaching approaches in research methodologies that can mitigate student anxiety and cultivate a more favorable attitude toward research.

In response to the rising demand for research skills, education faculties need to ensure that pre-service teachers are well-equipped with the necessary aptitude and proficiency for success [23]. Further investigation is essential to comprehend the factors

that influence teacher candidates' attitudes toward scientific research, which will provide valuable insights into the interplay between educational factors and perspectives on scientific research. By addressing these challenges and fostering a positive research culture among teacher candidates, educational institutions can enhance their preparation of future educators by integrating research skills into their teaching practices and inspiring scientific curiosity in their students.

Integrating technology and artificial intelligence (AI) in education has rapidly transformed the teaching and learning landscape. As emerging technologies evolve, their impact on educational practices becomes increasingly significant. This paradigm shift necessitates thoroughly examining how teacher candidates perceive and adapt to these technological advancements. Utilizing technology and AI in education has proven effective in improving learning outcomes, personalizing instruction, and boosting educational efficiency [24]. AI-driven tools have the potential to create adaptive learning experiences, streamline administrative tasks, and give students real-time feedback, fundamentally revolutionizing traditional educational approaches [25]. For instance, intelligent tutoring systems have demonstrated the ability to tailor instruction to individual student needs, potentially bridging achievement gaps and promoting equitable learning opportunities [26].

Previous research on technology and AI in education has highlighted the potential advantages and obstacles linked to their implementation. A study by Luckin and Holmes [27] emphasized the importance of developing AI literacy among educators to leverage these tools in the classroom. Similarly, Roll and Wylie [28] explored the role of AI in supporting collaborative learning environments, highlighting the need for careful integration of technology with pedagogical practices.

Nonetheless, there are notable gaps in our understanding of how prepared teacher candidates are to embrace technological advancements. The first gap concerns their readiness to leverage technology for professional development. While research has shown that technology integration can enhance teacher effectiveness [29], there is limited information on how Indonesian teacher candidates perceive and prepare for this technological shift in their future careers. This gap is further highlighted by recent research by Werdiningsih et al. [30], which explored Indonesian EFL students' experiences and strategies when using ChatGPT in their writing. The study revealed both the potential and the limitations of AI tools in education. The study found that ChatGPT often provides overly complex suggestions and lack cultural sensitivity. These findings underscore the importance of comprehensive training programs for both teachers and students on responsible AI integration. The second gap concerns the readiness of teacher candidates to integrate AI and research-based practices in shaping Indonesia's future education. With the ongoing evolution of AI, its ability to transform educational research and practice is rapidly growing. However, there is a lack of insight into how Indonesian pre-service teachers view the convergence of AI and scientific research in their prospective roles as educators.

Another important aspect to consider is the impact of AI on research methods in education. AI-powered tools can significantly enhance data collection, analysis, and interpretation processes, potentially revolutionizing educational research [31]. For instance, machine learning algorithms can identify patterns in large datasets that might not be visible through conventional statistical methods, providing new insights into learning

processes and educational outcomes [32]. Moreover, AI can facilitate more efficient literature reviews, automate data coding in qualitative research, and even generate research hypotheses based on existing knowledge [33]. These advancements can potentially accelerate the pace of educational research and provide more robust evidence for pedagogical decision-making. However, incorporating AI into research methods presents important ethical challenges. Careful attention must be given to data privacy, algorithmic bias, and the interpretability of AI-generated results to safeguard the integrity and validity of educational research [24].

As Indonesian teacher candidates prepare to enter a rapidly evolving educational landscape, it is crucial to understand their perceptions and readiness to engage with these emerging technologies. This understanding will inform the development of teacher education programs that effectively prepare future educators to leverage the power of AI and scientific research in their professional practice. Future research should explore Indonesian teacher candidates' attitudes, knowledge, and skills regarding AI and its applications in education and research. By bridging the gap between scientific research and AI in teacher education, institutional education can better prepare future educators to navigate the complex interplay of technology, pedagogy, and research in the 21st-century classroom. This integration could significantly elevate the quality of education in Indonesia and play a vital role in the global dialogue regarding the future of learning in the age of artificial intelligence.

2 Literature Review

2.1 Definition of Scientific Research

Scientific research is a systematic and methodical process that involves testing and building knowledge through various activities, methods, and theories [1]. It follows a sequential approach, encompassing problem identification, method selection, data collection, data processing, and formulating conclusions [2]. This process is crucial for advancing knowledge and understanding in various fields, including education. Scientific research in education is crucial for equipping students with the necessary theoretical, technical, practical, and methodological knowledge. It enables them to face future challenges and drive societal transformations [3]. Engaging in research experiences enables students to cultivate their critical thinking, communication, and problem-solving skills [34, 35].

2.2 Definition of Attitudes Towards Research

Bolin et al. [21] stated that attitudes toward research are emotional responses or feelings associated with the research process. These responses encompass various attitudes frequently discussed in the literature, such as negativity, anxiety, fear of failure, inadequate preparation or ability to succeed, and a lack of interest. Korkmaz et al. [13] emphasize that developing a research culture, scientific perspective, and positive attitude toward research is essential for teacher candidates. These attitudes can influence their future students' approaches to science and learning [14]. However, research methodology courses are often perceived as challenging and anxiety-inducing by students [15]. This anxiety can negatively impact students' self-efficacy and attitudes towards research [19].

2.3 Definition of Artificial Intelligence (AI) in Education

The AI technique is a developmental tool that creates an innovative learning environment, categorized into several areas. It centered on the development of algorithms, such as classification, matching, recommendation, and deep learning to support and improve the learning and teaching processes. In the extraction dimension, AI techniques, primarily grounded in algorithms, were utilized to deliver feedback, facilitate reasoning, and enable adaptive learning for students. The application aspect included elements such as affective computing, role-playing, immersive learning experiences, and gamification. AI techniques incorporated human factors as essential variables in the integration dimension to assess and examine the unique characteristics of learners. These studies employed human-computer interaction to promote creativity, accountability, and critical thinking, which, in turn, affected learners' performance and their perceptions [36].

Another description stated by Cardona et al. [37] is that AI is an "automation driven by associations." When computers automate reasoning based on patterns found in data or insights derived from expert knowledge, two key transformations essential to AI take place, pushing computing beyond traditional educational technology. These shifts include (1) moving from simply collecting data to identifying patterns within it and (2) transitioning from merely offering access to instructional resources to automating decisions related to instruction and other educational processes. The ability to detect patterns and make automated decisions represents a significant advancement in the responsibilities entrusted to a computer system.

2.4 The Importance of AI Proficiency for Teacher Candidates

Mastery of AI by teacher candidates is a strategic effort to realize an education system that is relevant and responsive to the dynamics of technological developments. AI can analyze large datasets, identify intricate patterns, and offer recommendations through predictive analysis, which contributes to increasing the efficiency and effectiveness of the learning process. Within the educational context, AI opens up opportunities for implementing more personalized, efficient, and innovative teaching strategies, such as adaptive learning systems that dynamically adjust to the specific needs of students [38].

However, implementing AI also presents challenges that require a deep understanding from both technical and ethical perspectives. AI has potential risks, including data privacy violations, algorithmic bias, and over-reliance on technology that can reduce teachers' pedagogical autonomy [39]. Therefore, teacher candidates need to develop critical competencies in evaluating and utilizing AI technology wisely. These skills involve grasping the principles of AI operation, evaluating the accuracy and relevance of outcomes produced by AI, and recognizing the social and ethical implications linked to the use of this technology.

Within this framework, the education of teacher candidates should be designed to include a curriculum and training oriented towards mastering AI. Teachers are expected to not only be users of technology but also facilitators who are able to optimally integrate AI into learning without sacrificing the interpersonal relationship aspect that is the core of education. Thus, mastery of AI by teacher candidates can support them in becoming competent agents of transformation in facing the challenges of education in the digital era and maximizing students' potential holistically [40].

2.5 The Scope of AI in Education

The integration of artificial intelligence (AI) in education covers various aspects that can be grouped into five main categories: administrative, assistive technology, inclusion and accessibility, educational development and innovation, and policy and ethics [41, 42]. This grouping illustrates the broad scope of AI in supporting holistic educational transformation. AI has a significant role in increasing the efficiency of educational management. Technologies such as learning analytics and prediction systems enable real-time monitoring of student progress and early identification of the risk of learning failure. Automating administrative tasks, such as automatic assessment or report generation, helps teachers save time and focus on learning. In addition, AI supports data-driven curriculum design and evaluation relevant to future needs.

In the educational process, AI enhances personalized and effective teaching and learning by utilizing adaptive learning systems and AI-powered tutors [43]. Virtual assistants and learning chatbots provide students with direct feedback and additional guidance, especially in self-paced learning. So far, learning materials have also been widely developed by integrating AI. Virtual reality (VR) and AI-based gamification create interactive learning environments, increasing student motivation and understanding. In the same context, accessible learning support has also grown significantly along with strengthening the topic of inclusivity in Education. For example, assistive technology that helps students learn, such as layer readers and voice-to-text converters, have been widely used.

2.6 The Use of AI in Inclusive Education

Advances in artificial intelligence (AI) technology are significantly impacting inclusive education, enabling unprecedented personalization of learning. In this context, AI assists in identifying the specific requirements of students, particularly those with learning challenges, through data analysis and the provision of tailored learning pathways. Studies such as that by Kohnke and Zaugg [44] highlight the capability of AI to assist students with disabilities in STEM disciplines, opening up wider access to science and technology education. In addition, AI-based tools have been developed and specifically designed to support the social and emotional growth of children with autism [45, 46]. This shows how AI can help with academic aspects and support the holistic dimension of education. On the other hand, applications such as "GLaM-Sign" allow deaf students to access learning through multimodal lip reading and sign language technology.

However, significant challenges remain. Research by Festus and Emmanuel [47] highlights social and cultural barriers to AI adoption, such as a deficiency in understanding the technology and the digital divide. Additionally, according to a study by Muralidhar et al. [48], ethics in AI implementation is a major concern, including the risk of algorithmic bias that could exacerbate inequalities in education. Infrastructure issues are also a barrier, especially in areas with limited access to technology. While there is a connection between teacher candidates' perceptions of inclusive education and digital competencies [49], however, Almaki et al. [50] found that teachers' resistance to new technologies is often due to a lack of training and support. AI holds significant promise

for transforming inclusive education by offering more equitable and accessible learning opportunities. However, successful implementation requires collaboration across multiple stakeholders to overcome existing social, cultural, and technological barriers.

3 Research Questions

The intersection of scientific research and emerging technologies, such as artificial intelligence (AI), presents a critical area of exploration in contemporary education. This study investigates the attitudes of teacher candidates regarding scientific research and their perceptions of how AI could impact teaching and learning practices.

Three research questions guide the study:

RQ1: What are teacher candidates' attitudes toward scientific research as measured by the Teacher Candidates' Attitudes Toward Scientific Research Inventory?

RQ2: What are Indonesian teacher candidates' knowledge and familiarity with AI?

RQ3: What is the relationship between teacher candidates' attitudes toward scientific research and their perceptions of AI in education? Is there a statistically significant relationship between teacher candidates' attitudes towards scientific research and AI.

The corresponding hypotheses posit that:

H1: Teacher candidates have a generally positive attitude toward scientific research as measured by the Teacher Candidates' Attitudes Toward Scientific Research Inventory.

H2: Teacher candidates have a generally positive knowledge and familiarity with AI in education.

H3: A significant positive relationship exists between teacher candidates' attitudes toward scientific research and their perceptions of AI's impact on education.

By addressing these questions, the study aims to contribute to the academic discourse on the role of scientific research and emerging technologies in shaping the attitudes and preparedness of future educators within a rapidly evolving educational landscape.

4 Research Method

We used an exploratory research quantitative approach, utilising both closed and open-ended surveys to comprehensively investigate the Indonesian teachers' candidates' attitudes towards scientific research and their knowledge and familiarity with using AI (Fig. 1). This method enabled effective data aggregation from various participants across Indonesia, yielding important insights into their attitudes and perceptions.

4.1 The Questionnaires

Attitudes Toward Scientific Research Inventory. Attitudes Toward Scientific Research inventory by Mayasari [51] aims to measure teacher candidates' attitudes toward scientific research. The inventory themes include critical thinking, self-efficacy, feelings toward research, practice-based elements, and reinforcement. These themes are categorized into three main factors: cognitive, affective, and behavioral. The cognitive factor includes critical thinking and self-efficacy, the affective factor pertains to attitudes toward

research, and the behavioral factor encompasses practice-based elements and reinforcement. Critical thinking is represented by seven statements; self-efficacy is represented by eight statements; feelings toward research (emotion) are represented by seven statements; seven statements represent practice-based; reinforcement is represented by eight statements. Based on the present study's dataset, a reliability scale test was performed, resulting in an internal consistency coefficient of 0.923.

Familiarity and Experiencing with AI instruments. The Familiarity and Experiencing with AI instruments by Petricini et al. [52] aims to assess the familiarity and experiences of faculty and college students with AI instruments, particularly generative AI tools like ChatGPT. The instruments aimed to gather insights into students' perceptions of AI's usefulness, effectiveness, and ethical considerations within educational contexts. It included questions designed to gauge respondents' awareness of generative AI technologies, their confidence in utilizing these tools for pedagogical purposes, and their overall attitudes towards AI's impact on learning and teaching. The Familiarity and Experiencing with AI instruments are represented by eight statements. Based on the present study's dataset, a reliability scale test was performed, resulting in an internal consistency coefficient of 0.773.

Evaluating Attitudes Toward AI Instruments. The Evaluating Attitudes toward AI instruments by Petricini et al. [52] aims to systematically assess the perceptions of faculty and students regarding the use of generative AI tools, such as ChatGPT, in higher education. This comprehensive survey included scaled items, open-ended responses, and targeted inquiries to capture a variety of attitudes and experiences. The instrument covers the participants' familiarity with AI technologies, confidence in utilizing these tools for educational purposes, and views on the ethical implications of AI integration in academic settings. Additionally, the instrument included specific questions that evaluated respondents' experiences with AI in practical scenarios, such as using AI for research assistance or writing support. The Evaluating Attitudes toward AI instruments are represented by fourteen statements. Based on the present study's dataset, a reliability scale test was performed, resulting in an internal consistency coefficient of 0.726.

Figure 1 represents a research instrument exploring teacher candidates' attitudes, perceptions, and experiences related to research and the use of artificial intelligence (AI). It is divided into two main sections: closed-ended surveys and open-ended surveys. The closed-ended survey section examines two primary areas: the attitudes of teacher candidates toward research and their perceptions of AI usage. Attitudes toward research are further divided into categories such as reinforcement, practice-based approaches, feelings toward research, self-efficacy, and critical thinking. Perceptions of using AI include familiarity and experiences, as well as the benefits and risks of AI. The open-ended survey section focuses on teacher candidates' experiences, encompassing their experiences with research and their experiences using AI specifically for research purposes. The diagram visually connects these themes, demonstrating the relationships between survey type and research focus areas.

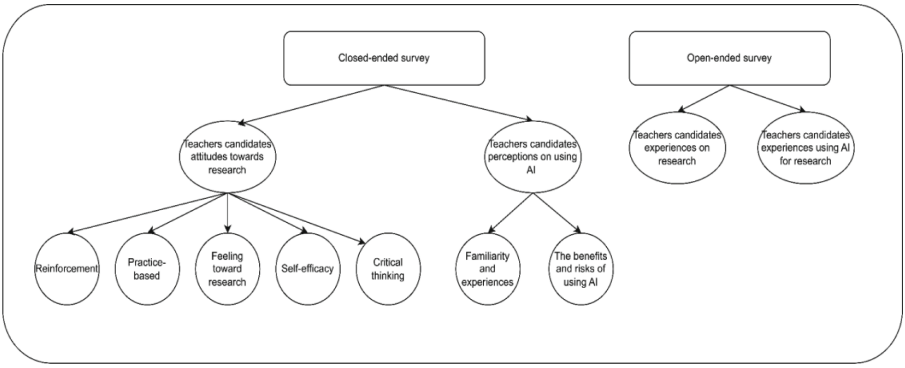

Fig. 1. Research Instrument

4.2 Data Analysis

The analysis of the closed-ended survey data involved utilizing the 27.0 version of IBM SPSS software to detect and understand patterns, trends, and correlations. The open-ended responses underwent thematic analysis [50] to uncover the participants' key themes, subthemes, perspectives, and opinions. This approach provided a thorough understanding of the data. Table 1 below details the demographics of the participants.

Table 1. Participants Characteristics

		N = 268	%
Gender	Male	47	17.5
	Female	222	82.5
Field of expertise	Natural science	12	4.5
	Social science	257	95.5
Study years	1st	101	37.5
	2nd	92	34.2
	3rd	11	4.1
	4th	60	22.3
	>5th	5	1.9

The participants involved in this study are 268 bachelor students joining teacher education programs in Indonesian universities. According to Statistical Power by Cohen [53] regarding sample size, to reach a medium or large effect size requirement with 95% confidence level, the sample in this study was enough and representative with 65% response rate. Most participants were female students, while 17.5% were male. They are 100% in a full-mode study program, which is a four-year study, 95% in social sciences and only 4,5% in natural science. In terms of study year, 37.5% came from the first year,

34.2% in the second year, 4.1% in the third year, 22.3% in their fourth year, and 1.9% more than five years.

5 Results

Non-parametric tests were performed on the dataset (see Table 2), which demonstrates that the distribution adheres to a non-normal distribution.

5.1 RQ 1: What are Teacher Candidates' Attitudes Toward Scientific Research as Measured by the Teacher Candidates' Attitudes Toward Scientific Research Inventory?

The overall analysis indicates that teacher candidates exhibit positively high attitudes across most dimensions of the research inventory (Table 2), including *Reinforcement*, *Practice-based Attitudes*, *Self-efficacy*, and *Critical Thinking*. However, the dimension of *Feelings Toward Research* reflects a moderate attitude, suggesting the need for targeted interventions to enhance teacher candidates' emotional engagement and intrinsic motivation toward scientific research. This study presents essential insights into teacher candidates' attitudes toward research, which can assist in shaping teacher education programs that promote a vibrant research culture.

Table 2. The summary Indonesian teacher candidates' attitudes toward scientific research

	N	Min	Max	Mean	Std. Deviation	Interpretation
Reinforcement	268	18	47	37.84	4.171	Positively high
Practice-based	268	14	42	33.76	4.216	Positively high
Feeling toward research	268	16	42	29.77	4.729	Moderate
Self-efficacy	268	16	48	33.22	5.227	Positively high
Critical thinking	268	14	42	33.59	4.613	Positively high

5.2 RQ2: What are Indonesian Teacher Candidates' Knowledge and Familiarity with AI?

The findings demonstrate that teacher candidates perceive their knowledge of AI positively high (Mean: 35.75), indicating confidence in their conceptual understanding of the subject. However, their familiarity with AI was rated as moderate (Mean: 54.58), indicating less direct interaction or experience with AI technologies in real-world educational contexts (Table 3). These results highlight the need for professional development initiatives and teacher education programs that emphasize experiential learning with AI tools and applications to connect theoretical knowledge with practical experience.

Table 3. The summary Indonesian teacher candidates' knowledge and familiarity with AI

	N	Min	Max	Mean	Std. Deviation	Interpretation
Knowledge of AI	268	16	48	35.75	5.828	Positively high
Familiarity with AI	268	24	78	54.58	6.885	Moderate

Table 4. Differences in Indonesian teacher candidates' knowledge and familiarity between the gender

	Knowledge of AI	Familiarity with AI
Mann-Whitney U	4347.000	4224.000
Z	–1.757	–2.012
Asymp. Sig. (2-tailed)	.079	.044
a. Grouping Variable: GENDER		

Differences in knowledge and familiarity with AI across teacher candidates of different genders (male and female) were analysed using the Mann-Whitney U test (Table 4).

A significant difference was found in teacher candidates' familiarity using AI between male and female (Mann-Whitney, $U = 4224.000$, $Z = -2{-}012$, $p < 0.05$), with a mean rank of 113.87 for males and 138.89 for female teacher candidates, meaning that female participants had significantly higher scores on the familiarity with AI than male counterparts. The possible explanation for this specific result came from Armutat, et al. [54] which concluded in previous research that women perceived knowledge as key to generating more interest in AI. In addition, they want more practical examples, better communication of the advantages and disadvantages of AI, and a more democratic and transparent decision-making process. Furthermore, differences in knowledge and familiarity with AI among teacher candidates across different academic years (1st, 2nd, 3rd, 4th, and 5th year and beyond) were examined using the Kruskal-Wallis test (see Table 5).

Table 5. Differences analysis on Indonesian teacher candidates' knowledge and familiarity based on their study years

	Knowledge of AI	Familiarity with AI
Kruskal-Wallis H	24.393	17.031
df	3	3
Asymp. Sig	.000	.001

a. Kruskal Wallis Test
b. Grouping Variable: YEAR

The findings reveal significant differences in both AI knowledge (Kruskal-Wallis, H = 24.393, p < 0.001) and familiarity with AI for research purposes (Kruskal-Wallis, H = 17.031, p < 0.001) among the various academic year groups. This necessitates further analysis using post hoc tests to pinpoint specific group differences (see Table 6).

Table 6. Multiple comparisons of Indonesian teacher candidates' knowledge and familiarity based on study years

Dependent Variable	(I) YEAR	(J) YEAR	Mean Difference (I-J)	Std. Error	Sig	95%Confidence Interval	
						Lower Bound	Upper Bound
Knowledge of AI	1	2	2.384*	.800	.026	.19	4.58
		3	1.522	1.767	.911	−3.33	6.38
		4	−2.497	.917	.053	−5.02	.02
		> 5	3.158	2.550	.729	−3.85	10.16
	2	1	−2.384*	.800	.026	−4.58	−.19
		3	−.862	1.775	.989	−5.74	4.01
		4	−4.881*	.931	.000	−7.44	−2.32
		> 5	.774	2.555	.998	−6.25	7.79
	3	1	−1.522	1.767	.911	−6.38	3.33
		2	.862	1.775	.989	−4.01	5.74
		4	−4.019	1.831	.185	−9.05	1.01
		> 5	1.636	3.002	.982	−6.61	9.88
	4	1	2.497	.917	.053	−.02	5.02
		2	4.881*	.931	.000	2.32	7.44
		3	4.019	1.831	.185	−1.01	9.05
		> 5	5.655	2.595	.191	−1.47	12.78
	> 5	1	−3.158	2.550	.729	−10.16	3.85
		2	−.774	2.555	.998	−7.79	6.25
		3	−1.636	3.002	.982	−9.88	6.61
		4	−5.655	2.595	.191	−12.78	1.47
Familiarity with AI	1	2	−.811	.952	.914	−3.43	1.80
		3	−.822	2.103	.995	−6.60	4.96
		4	−5.184*	1.091	.000	−8.18	−2.19
		> 5	1.778	3.035	.977	−6.56	10.11

(*continued*)

Table 6. (*continued*)

Dependent Variable	(I) YEAR	(J) YEAR	Mean Difference (I-J)	Std. Error	Sig	95%Confidence Interval	
						Lower Bound	Upper Bound
	2	1	.811	.952	.914	−1.80	3.43
		3	−.011	2.112	1.000	−5.81	5.79
		4	−4.373*	1.108	.001	−7.42	−1.33
		> 5	2.589	3.041	.914	−5.76	10.94
	3	1	.822	2.103	.995	−4.96	6.60
		2	.011	2.112	1.000	−5.79	5.81
		4	−4.362	2.178	.268	−10.35	1.62
		> 5	2.600	3.573	.950	−7.21	12.41
	4	1	5.184*	1.091	.000	2.19	8.18
		2	4.373*	1.108	.001	1.33	7.42
		3	4.362	2.178	.268	−1.62	10.35
		> 5	6.962	3.087	.163	−1.52	15.44
	> 5	1	−1.778	3.035	.977	−10.11	6.56
		2	−2.589	3.041	.914	−10.94	5.76
		3	−2.600	3.573	.950	−12.41	7.21
		4	−6.962	3.087	.163	−15.44	1.52

*. **The mean difference is significant at the 0.05 level.**

Tukey's HSD post-hoc analysis showed that Indonesian teacher candidates in their fourth year of education had significantly higher knowledge of AI than those who are in the second year of study (Tukey's HSD, $\Delta = 4..881$, $p < 0.001$), while first-year study teachers candidates revealed significantly higher knowledge of AI than second-year students (Tukey's HSD, $\Delta = 2.384$, $p < 0.05$). Similar to their familiarity with AI, Tukey's HSD post-hoc analysis revealed that fourth-year teachers candidates had significantly higher scores on familiarity with AI than those who are first-year (Tukey's HSD, $\Delta = 5.184$, $p < 0.001$) as well as those in second-year (Tukey's HSD, $\Delta = 4.373$, $p = 0.001$).

5.3 RQ3: What is the Relationship Between Teacher Candidates' Attitudes Toward Scientific Research and Their Knowledge and Familiarity with AI in Education?

The research examined the connection between teacher candidates' attitudes toward scientific research and their perceptions of AI in education. A Spearman correlation analysis was conducted to determine the strength and significance of the relationships between the

five dimensions of attitudes toward scientific research (*Reinforcement, Practice-based, Feelings Toward Research, Self-efficacy*, and *Critical Thinking*) and the two dimensions of AI perceptions (*AI Knowledge* and *AI Familiarity*).

The analysis reveals several statistically significant relationships between teacher candidates' attitudes toward scientific research and their perceptions of AI in education. In particular:

AI Knowledge. The dimensions of *Reinforcement, Practice-based Attitudes, Self-efficacy,* and *Critical thinking* were significantly correlated with AI knowledge, indicating that teacher candidates who hold more positive attitudes toward scientific research are likely to perceive themselves as having a greater understanding of AI.

AI Familiarity. While weaker, significant correlations were observed for *Reinforcement* and *Practice-based Attitudes*, suggesting some link between these research attitudes and familiarity with AI technologies. However, dimensions such as *Feelings Toward Research* and *Self-efficacy* demonstrated minimal or no significant correlations with AI familiarity, suggesting that emotional and confidence-related aspects of research attitudes may not directly influence engagement with AI tools.

Table 7. Correlation of candidate teachers' attitudes towards research and their knowledge and familiarity with artificial intelligence.

		A	B	C	D	E	F	G
Reinforcement (A)	Correlation Coefficient	1	0.644**	0.468**	0.484**	0.521**	0.272**	0.167**
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000	0.006
Practice-based (B)	Correlation Coefficient	0.644**	1	0.584**	0.593**	0.713**	0.312**	0.165**
	Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.000	0.007
Feeling toward research (C)	Correlation Coefficient	0.468**	0.584**	1	0.725**	0.524**	0.087	-0.015
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.157	0.801
Self-efficacy (D)	Correlation Coefficient	0.484**	0.593**	0.725**	1	0.524**	0.135*	0.031
	Sig. (2-tailed)	0.000	0.000	0.000		0.000	0.027	0.615
Critical thinking (E)	Correlation Coefficient	0.521**	0.713**	0.524**	0.524**	1	0.282**	0.1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000	0.102
Knowledge of AI (F)	Correlation Coefficient	0.272**	0.312**	0.087	0.135*	0.282**	1	0.351**

(*continued*)

Table 7. (*continued*)

		A	B	C	D	E	F	G
	Sig. (2-tailed)	0.000	0.000	0.157	0.027	0.000		0.000
Familiar with AI (G)	Correlation Coefficient	0.167**	0.165**	-0.015	0.031	0.1	0.351**	1
	Sig. (2-tailed)	0.006	0.007	0.801	0.615	0.102	0.000	

** $p < 0.001$; * $p < 0.05$.

The correlation analysis (Table 7) showed a significant correlation between several variables. Reinforcement had the strongest correlation with practice-based learning (Spearman rho, $\rho = 0.644$, $p < 0.001$) and critical thinking (Spearman rho, $\rho = 0.521$, $p < 0.001$). Practice-based learning also had a significantly strong relationship with critical thinking (Spearman rho, $\rho = 0.713$, $p < 0.001$). Feelings towards research are the most strongly correlated to self-efficacy (Spearman rho, $\rho = 0.725$, $p < 0.001$). Critical thinking demonstrated significant strong relationships with practice-based learning and self-efficacy (Spearman rho, $\rho = 0.524$, $p < 0.001$ for both). Additionally, Indonesian teachers' candidates' knowledge of AI had a significant correlation with familiarity with AI (Spearman rho, $\rho = 0.351$, $p < 0.001$). However, it had no significant or weaker correlations with other variables. The results indicated that practice-based learning and critical thinking are essential for enhancing self-efficacy and attitudes toward research.

5.4 The Analysis of Open-Ended Questions

Additionally, the open-ended questions were analysed using thematic analysis by [55] to understand more comprehensively. The final thematic map illustrates the primary themes and subthemes related to teacher candidates' perceptions and experiences of using AI for research (see Fig. 2).

The thematic map (Fig. 2) highlights the essential elements based on the experiences of Indonesian teacher candidates in utilizing AI for research. The primary themes identified were (1) The wonderful tools for research and (2) Dangerous and unethical tools for research.

Theme 1: The Wonderful Tools for Research. The first theme that emerged was 'the wonderful tools for research', with two subthemes: (1) gather ideas and (2) enhance productivity. This theme reflects the positive aspects of teacher candidates' perceptions regarding the use of AI in conducting research.

Gather ideas. The first subtheme in the first main theme is 'gather ideas'. Interestingly, many Indonesian teacher candidates think of AI as a tool to gather ideas related to their academic path, including research. The statement below (made by Indonesian teachers' candidates) illustrates their perceptions.

AI is very good at using research [context] for students.

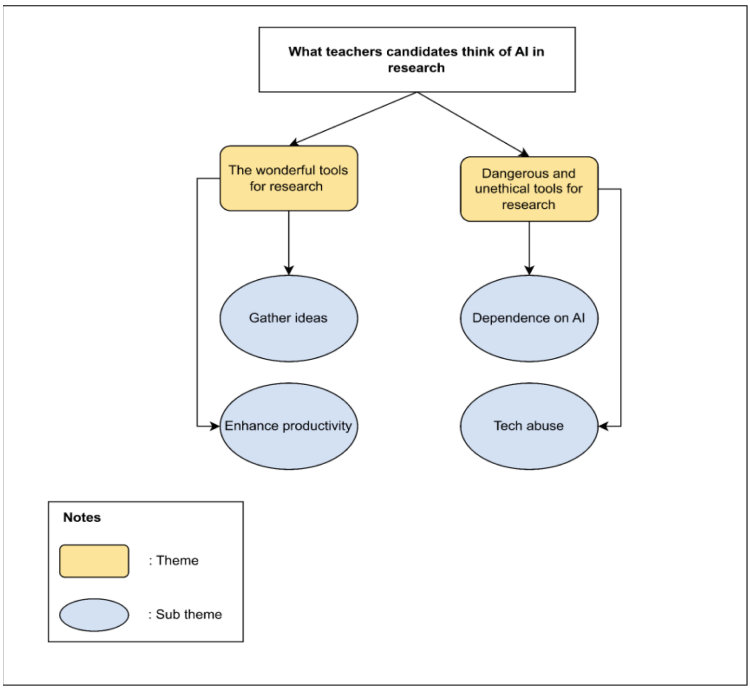

Fig. 2. Thematic map of teachers candidates toward research and AI

Basically, AI is made to make it easier for humans, and as students, we should also use AI as it should be, just to help, not to complete the entire task [research].

The use of AI in the context of education is very helpful for lecturers and students; more precisely, it adds a very broad insight and makes it easier for students to dig up information [related to study].

The use of AI in the context of education is very helpful for lecturers and students; more precisely, it adds a very broad insight and makes it easier for students to dig up information [related to study].

Enhance Productivity. The second subtheme in the first main theme is 'enhance productivity'. The participants shared their experiences of utilizing AI in education to improve their research and study productivity, highlighting their positive encounters with the technology. Nonetheless, they expressed concerns about the need for responsible usage.

The existence of AI is certainly very helpful in doing all tasks and work, but keep in mind that we also need to sharpen our writing skills even without AI's help.

AI is considered good and helpful for students and lecturers as long as AI is used positively and does not violate the rules that apply in higher education.

AI is a tool that can improve efficiency, make work easier, and provide innovative solutions to other complex problems.

I always use AI to improve my sentences. Then I read the sentence words according to the research so that I can understand the reading of composing sentences.

Theme 2: Dangerous and Unethical Tools for Research. The second theme that emerged was 'dangerous and unethical tools for research', with two subthemes: (1) dependence on AI and (2) tech abuse. While the first theme emphasized the positive aspects, this theme, on the other hand, focuses on the negative perceptions and apprehensions of teacher candidates related to the use of AI in research.

Dependence on AI. The first subtheme in the second main theme is 'dependence on AI'. It explores the perception among teacher candidates regarding their reliance on AI when it is not utilized appropriately. Participants voiced their concerns regarding their dependence on AI usage.

Using AI can actually add broad insights, but students can also be dependent on using AI.

If students depend on AI, then the integrity of a university's academic graduates is questionable.

The use of AI is a form of technological adaptation that cannot be abandoned therefore our attitude towards technology needs to be considered so as not to lead to the negative side, for example in the use of AI ChatGPT, students can use AI to develop sentences that have been compiled independently before so that AI is only a tool that does not replace the obligations as a student in completing assignments.

Tech Abuse. The second subtheme in the second main theme is 'tech abuse'. This sub-theme centers on participants' perceptions of the misuse of AI technology and unethical practices in research. The statements reflected participants' beliefs about the implications of tech abuse when using AI in research.

Many students are now misusing AI for assignments and even for their research. In this case, of course, there is a need for further action.

The use of AI for students to complete coursework can lead to a decline in academic integrity at universities.

AI helps students to find some references so many children feel helped by the AI policy. In research, AI also helps with the procedures for compiling research. However, the unwise use of AI can create problems for children, especially if it is misused.

6 Discussion

6.1 The Link Between Scientific Research Attitudes and AI Perceptions in Teacher Education

This study offers important insights into the connection between teacher candidates' attitudes toward scientific research and their perceptions of AI's role in education. Several dimensions of research attitudes, including Reinforcement, Practice-based Attitudes, Self-efficacy, and Critical Thinking, are significantly correlated with AI knowledge. This

indicates that teacher candidates with positive research-oriented attitudes are more likely to perceive themselves as knowledgeable about AI. These results align with prior research suggesting that engagement with scientific inquiry fosters a deeper understanding of technological advancements, including AI [56, 57].

However, the relationship between research attitudes and familiarity with AI reveals a more complex scenario, with weaker correlations noted between Reinforcement and Practice-based Attitudes and AI familiarity. At the same time, dimensions such as Feelings Toward Research and Self-efficacy demonstrated limited or no significant relationships with AI familiarity. This finding suggests that although confidence and emotional disposition toward research may enhance perceptions of AI knowledge, they do not necessarily translate into practical familiarity with AI tools [58].

The distinction between AI knowledge and familiarity underscores the importance of adopting a dual approach. Teacher education programs should cultivate positive attitudes toward scientific research and integrate practical, hands-on experiences with AI technologies. Research emphasizes that authentic learning experiences, such as workshops or simulations that incorporate AI in real classroom settings, effectively connect theoretical knowledge with practical application [24]. These strategies can enhance familiarity with AI tools and the confidence to use them effectively in professional settings [59].

6.2 Insights and Implications Research Attitudes in Teacher Education

The findings of this study reveal that most teacher candidates exhibit positive attitudes toward research in the dimensions of Reinforcement, Practice-based Attitudes, Self-efficacy, and Critical Thinking. The result suggests their cognitive readiness to understand and apply research methods. However, moderate attitudes in the dimension of Feelings Toward Research reflect emotional barriers, which may stem from fear or scepticism toward technology, including AI, perceived as a threat or unethical tool.

The concerns surrounding AI identified in this study underscore stereotypes that depict it as "dangerous" and "unethical." According to qualitative data, some teacher candidates believe that using AI in academic tasks may diminish the originality of their work. These concerns align with findings by Lo [60], who noted that generative AI could impact students' motivation and creativity while posing misconduct risks, such as the unsupervised use of AI-generated content. The phenomenon of technological dependence can also explain moderate attitudes toward the dimension of Feelings Toward Research. As highlighted by Wiederhold [61], reliance on AI technology can negatively impact mental health, leading to emotional stress, sleep disturbances, and weakened interpersonal relationships. For instance, teacher candidates may struggle to balance the use of technology with the development of traditional research skills.

Although AI offers various benefits, such as rapid and accurate data analysis, concerns about ethical issues and potential dependency can hinder the development of positive attitudes toward research. This paradox is evident in generative AI, where teacher candidates find it helpful in expediting research processes but are also concerned about its long-term effects on creativity and critical thinking skills. Ajani et al. [62] suggest that teacher education programs should integrate AI literacy training that emphasizes ethics and responsible usage to bridge the gap between research attitudes and perceptions of AI. For example, workshops on the ethical application of AI in research can provide

teacher candidates with guidelines on how to utilize AI to enhance productivity without compromising academic integrity.

According to Butson and Spronken-Smith [63], it falls upon educators to navigate this technological transformation while upholding academic values. Through support, skepticism, or alternative strategies, their decisions today will define the educational framework for future generations. Therefore, maintaining an adaptive and ongoing dialogue is essential to continually reassess and redefine humanity's relationship with AI as it evolves. This is not merely a technological imperative but also an ethical, epistemological, and existential one. However, this effort is certainly not only the responsibility of individuals. Teacher trainers have a crucial role in taking an approach to introduce and guide students about the ethics of using AI.

6.3 Teacher Candidates' AI Knowledge and Familiarity Through Experiential Learning

Attitudes toward research and perceptions of AI use in education are closely related, although both can align or show tension depending on the approach used. Based on the research findings, teacher candidates' positive perceptions of their knowledge about AI (average: 35.75) reflect their confidence in understanding the theoretical concepts of AI. However, their familiarity with AI (average: 54.58) indicates their direct experience with this technology in real educational contexts remains limited. This points to a gap that needs to be addressed through professional development initiatives and educational programs that emphasize the practical integration of AI into educational practices.

AI has the potential to improve teaching and learning outcomes, as highlighted by Luckin and Holmes [27], its analytical capabilities enable the development of adaptive learning systems designed to address the unique needs of each student. In the context of educational research, AI allows for more efficient analysis, such as simulating learning interventions and assessing teaching effectiveness. Therefore, a positive attitude toward research that is open to new technologies often aligns with the acceptance of AI as a tool that can expand educational understanding and enhance efficiency.

Nevertheless, incorporating AI into education introduces notable ethical challenges. Selwyn [64] warns that excessive reliance on technology, including AI, may undermine more humanistic educational goals, such as developing critical thinking and social interaction. AI can reduce human interaction in the learning process and may exacerbate biases embedded in algorithms, which can lead to injustice, particularly concerning race, gender, and socio-economic status. This could potentially conflict with the inclusivity values of educational research, particularly in areas concerning equality and social justice.

Furthermore, challenges related to oversight, privacy, and autonomy in AI use in education add to the complexity of integrating this technology. According to Pedro et al. [38], reliance on biased AI data can hinder inclusive educational research goals. Therefore, it is essential to ensure that AI is used with ethical considerations that involve fairness and equality. In this regard, the TPACK framework [65] provides guidance on using AI to complement pedagogy, emphasizing human interaction and humanistic principles.

Social and cultural aspects are also important in technology use, where gender gaps in access to technology highlight the need for more inclusive policies [66]. A UNESCO [67] reveals that women are less involved in technology, including data and AI. Thus, policies that encourage women's access to technology and ensure their participation in AI development are needed. This is also supported by findings from UNICEF [68], which emphasize the importance of education in bridging the gender digital gap, thereby reinforcing equality in the technology sector.

Recent research by Nikoula and Caroni [69] underscores the importance of education in equipping teacher candidates with the skills and knowledge necessary to navigate the evolving landscape of AI technology. They found that first-year students showed greater familiarity with AI-based devices. This familiarity stemmed from introducing this technology during secondary education. Nikoula and Caroni [69] findings further reveal that senior students showed greater familiarity with and use of AI for complex tasks across various subjects. This indicates that early exposure to AI can increase the use and understanding of this technology among students in higher education and their future careers as educators. Therefore, teacher candidates should gain direct experience with AI tools early on to prepare them for the challenges and opportunities presented by this technology in education.

The findings from this study suggest that teacher preparation programs should balance theoretical and practical learning approaches. By fostering positive attitudes toward scientific research and providing opportunities for practical engagement with AI technologies, these programs can ensure that teacher candidates are knowledgeable about AI and skilled in its application within their professional practice. Addressing this dual need is critical for equipping future educators to meet the demands of 21st-century education [59].

7 Conclusion

The results indicate that teacher candidates exhibit positively high attitudes across most dimensions of the research inventory and possess knowledge and familiarity with AI in educational settings. A significant correlation exists between their perceptions of scientific research and their knowledge and familiarity with using AI in education. In complementing the survey result, the open-ended questions were conducted which concluded that there is still dual perception and belief on how AI is used in education. There are two emerging themes based on thematic analysis: AI as (1) a wonderful tool and (2) a dangerous and unethical tool for research.

8 Limitation

However, a limitation of this study is its reliance on self-reported data and its focus on a specific Indonesian context, which may limit its generalizability. Future research should consider comparing teacher candidates (preservice) and in-service in including AI in research and teaching strategies to find the best practices using AI. In addition, the efforts and approaches of teacher trainers in adapting AI are also important to study. Furthermore, the comprehensive research should also focus on the dual perceptions of using AI in research.

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Declaration of Interest. The authors report no potential conflict of interest.

Informed Consent Statement. Respondents provided informed consent for participation in accordance with the approval of the review board.

Data Availability Statement. The datasets generated and/or analysed during the current study are available from the corresponding author upon reasonable request. Due to privacy concerns, some data cannot be publicly shared.

Declaration of Ethics. This project was carefully reviewed and received positive feedback from the Institutional Review Board Universitas Negeri Malang, Indonesia, No. Reff: 5.12.9/UN32.14/PB/2024.

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