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# Vocational Teachers' Insights on Artificial Intelligence and Computational Thinking Integration

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**Abstract**

This qualitative case study investigates vocational teachers' perceptions of artificial intelligence and computational thinking integration in Indonesian secondary education. Seven vocational high school teachers from West Java Province participated through semi-structured interviews, non-participant observations, and document analysis following artificial intelligence training. The study employed an interactive analysis model to examine teachers' attitudes, concerns, and implementation strategies regarding artificial intelligence in educational contexts. Findings reveal positive teacher perceptions of artificial intelligence as a learning support tool, with applications ranging from creative media production to technical programming assistance. However, significant ethical and pedagogical concerns emerged, including academic integrity challenges, potential student dependency, inadequate prompt engineering skills, and risks of learning dehumanization. Teachers developed sophisticated guidance strategies, positioning artificial intelligence as a verification tool while maintaining human agency in learning processes. Supporting factors included personal initiative and professional learning communities, while barriers encompassed limited infrastructure, absence of formal guidelines, and varied digital competencies. The research contributes to understanding artificial intelligence adoption challenges in Indonesian vocational education and provides insights for implementing artificial intelligence skills curriculum policy. Results of the research are: (1) educators acknowledge significant advantages of AI integration, especially in improving technical learning experiences and promoting innovative educational endeavors, the integration of AI and computational thinking in the learning process must also prioritize the appropriate pattern aspects and requires clear guidance from stakeholders so that it can be implemented in the learning process; (2) ethical and pedagogical issues arise as significant obstacles, encompassing abuses of academic integrity, threats of student dependency, insufficient prompt engineering skills, and the potential dehumanization of learning experiences; (3) educators demonstrate significant adaptability by formulating advanced guiding systems that utilize AI as a verification and support mechanism while maintaining human agency in educational decision-making.

**Keywords:** Artificial Intelligence; Computational Thinking; Vocational Education; Teacher Perceptions; TVET

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## INTRODUCTION

The advancement of technology and the 4th industrial revolution have positioned artificial intelligence as a fundamental pillar across all aspects of global

transformation. The development of AI in education has emerged as a novel innovation, bringing about changes in learning perspectives and patterns, both in schools and classrooms (Hamid et al., 2022; Kavak et al., 2024; Polat, 2025; Sharma et al., 2023). This condition has been welcomed by the Indonesian Government to establish policies for implementing technology-based and AI-enhanced learning at every educational level (Arifah et al., 2025; Deepa et al., 2022; Rusiana et al., 2024). These policies reflect the government's strategic commitment to strengthening digital literacy, computational thinking, and artificial intelligence ethics from an early age (Herlandy et al., 2024; Majid et al., 2023; Roy et al., 2023).

The implementation of technology-based learning, AI support, and optimization of deep learning approaches represents essential steps that must be developed in every school. The government emphasizes the optimization of learning achievement, making appropriate technological assistance a fundamental foundation for optimizing competency acquisition in every learning process(Sharma et al., 2023; L. Zhao et al., 2022; T. Zhao et al., 2024). Teachers are required to systematically and comprehensively adapt to technological developments. However, this condition presents potential challenges due to rapid technological advancement and the need for increased adaptation (Caswita & Kristivan, 2022; Kristianto, 2021). Consequently, teachers must maximize opportunities and competencies in implementing technology-based learning in the classroom.

The concept of technology-based learning applied in vocational education represents a primary step for students to acquire competencies. Through such learning, vocational high school students must adapt to real world working conditions and technological changes, particularly AI optimization (Gabsi, 2024; Polat, 2025). Teachers must also guide students to avoid arbitrary AI usage and develop systematic thinking capabilities (Choon Hui Neo et al., 2021; Herlandy et al., 2019). The implementation of computational thinking constitutes an appropriate approach for teachers to enable students to master the competencies being studied.

Recent studies indicate that AI adoption in education is significantly influenced by teacher perceptions and readiness. Preservice teachers' attitudes toward AI powered educational technology have potential impacts on learning outcomes (Zhang et al., 2023). The integration of AI in education significantly aids educators, illustrated by social robots that can enhance the results of students' educational engagement, motivation, academic achievement, and social skills (Lampropoulos & Papadakis, 2025). Teachers and professors' express discomfort with the potential for academic misconduct through AI driven chatbots such as ChatGPT (Dempere et al., 2023; Yu et al., 2024). In the Indonesian context, data shows that the number of teachers reached 3.033.38 million in the 2023/2024 academic year with extensive geographical distribution (Badan Pusat Statistik Kabupaten Purwakarta, 2025). Furthermore, research on the implementation of ChatGPT in educational environments might improve competencies in practical subjects, such as mathematics and language, and it is recommended to educate teachers and parents appropriately (Uğraş et al., 2024, 2025). Challenges including digital competency gaps, infrastructure limitations, and varying technological literacy remain prominent (Adel, 2024). National surveys indicate that many non-ICT teachers still face barriers in utilizing learning technologies (Majid et al., 2021; OECD, 2025a, 2025b).

Research gaps have been identified in the Indonesian context, where studies on educational AI remain predominantly focused on higher education, while

investigations into secondary education teachers' perceptions remain limited. Yet, teachers constitute key actors in implementing AI policies at the school level. This research contributes to filling this gap by exploring high school and vocational school teachers' perceptions regarding AI utilization in learning, encompassing aspects of usefulness, ease of use, organizational support, competency readiness, as well as ethical and pedagogical concerns.

## METHOD

### Research Design and Participant

This study employs a qualitative research method with a single case study approach to investigate teachers' perceptions of AI and computational thinking implementation in vocational education classrooms. The qualitative method is particularly well-suited to understand and address research objectives related to teacher perceptions in the application of AI and computational thinking in vocational education settings (Cresswell & Poth, 2018).

The single case study design was selected for its capacity to provide indepth examination of a specific phenomenon within its realworld context, allowing for comprehensive exploration of complex social processes and meaningmaking activities (Yin, 2018). This approach enables deep exploration of teachers' subjective experiences with AI and computational thinking integration, capturing the nuanced ways educators interpret, adapt, and implement these technologies within their specific vocational education contexts.

The study involved seven vocational teachers from the Computer Network and Telecommunication Engineering (TJKT/Teknik Jaringan Komputer dan Telekomunikasi) Competence Program in West Java Province, all of them were members of the MGMP TJKT. The participant selection method used purposive sampling, considering various factors, including observations of AI implementation in the classroom, active engagement, comprehension of comprehensive AI utilization in education, and contributions to enhancing student learning outcomes.

### Data Collection

Data collection employed three complementary methods to ensure comprehensive understanding. First, non-participant observation was conducted during AI training sessions to observe teachers' interactions, engagement levels, and spontaneous reactions to AI demonstrations. Second, semistructured indepth interviews lasting 4560 minutes were conducted with each participant to explore their perceptions, experiences, and attitudes toward AI integration. Third, document analysis of policy frameworks, training materials, and institutional guidelines provided contextual background for understanding the broader educational technology environment.

Interview protocols covered key domains including prior technology experiences, perceptions of AI benefits and challenges, ethical concerns, classroom implementation strategies, and institutional factors affecting adoption. All interviews were conducted in Indonesian, audiorecorded with consent, and transcribed verbatim for analysis.

### Data Analysis

Data analysis followed the interactive model by Miles et al., (2014) comprising data collection, data condensation, data display, and conclusion drawing. The analysis

process was conducted continuously with systematic coding of interview data and verification of findings through triangulation across multiple data sources.

Initial coding employed open coding techniques to identify emergent themes, followed by focused coding to develop refined categorical frameworks. Coded data were organized into thematic matrices and concept maps to facilitate pattern recognition and crosscase comparison. Triangulation across observation, interview, and document data enhanced the credibility of interpretations, while member checking procedures ensured accurate representation of participants' perspectives.

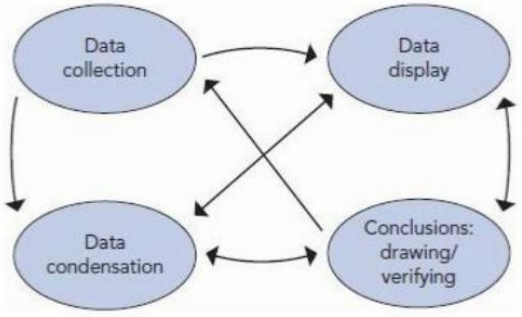


**Figure 1.** Qualitative Data Analysis (Miles et al., 2014)

**Validity and Ethics**

The study employed several strategies to enhance trustworthiness, including prolonged engagement with participants, triangulation of multiple data sources, and maintenance of comprehensive audit trails. Detailed contextual descriptions enable assessment of transferability to similar educational settings.

Ethical considerations included obtaining informed consent from all participants, maintaining confidentiality through pseudonymization, and secure storage of data accessible only to the research team. The research protocol received appropriate institutional ethical approval, ensuring compliance with established standards for educational research involving human subjects.

## RESULTS AND DISCUSSION

**Teachers' Perceptions of AI Benefits**

Indepth interviews revealed positive teacher perceptions regarding the benefits of AI as a learning support tool. Informant A from SMK xyz stated:

*"AI is still relatively new. However, personally, since the emergence of ChatGPT, I have been motivating students... I guide them to engage in discussions specifically with AI"* (Fieldnote 44).

This statement demonstrates an evolution in learning paradigm from oneway information seeking to interactive dialogue with AI, where teachers acknowledge the fundamental difference between Google, which "can only work one way" and AI, which enables two-way discussions. This perspective is consistent with studies on humanAI collaboration that emphasize complementarity (AI that complements, rather than replaces, human functions) (Hemmer et al., 2025; Herath Pathirannehelage et al., 2025).

AI implementation varies according to subject characteristics, reflecting contextual pedagogical adaptation. In creative learning, Informant B explained:

"*We have an extracurricular activity where I teach students to use CapCutAI. Students learn to become speakers or MCs by reading, but their eyes remain focused using AI*" (Fieldnote 48).

This phenomenon aligns with digital literacy and multimodal literacy frameworks (which emphasize the technical and cognitive abilities to think and communicate effectively in digital environments); the use of AI to facilitate media production demonstrates the need for technicalsocial competencies outlined in digital literacy literature.

This implementation demonstrates AI utilization to overcome technical presentation challenges while maintaining the essence of communication learning. Meanwhile, in technical subjects, Informant D presented more complex applications:

"*AI technology has been very helpful, for example, in network engineering subjects... Students also receive guidance from AI or ChatGPT in application development, coding something, interfaces, web development, and even creating database flows*" (Fieldnote 54).

Researchers (Holstein & Aleven, 2022) investigated findings that support the concept of humanAI complementarity in AIEDAI functions as technical augmentation (advisor), while the teacher's role remains central for supervision and final decisionmaking. However, teachers emphasize the importance of verification and evaluation of AI results. Informant C explained:

"*Even in programming learning, it is allowed but must be checked first. Because there are several students who copypaste, and when compiled, many errors occur*" (Fieldnote 50).

This approach the methodology that promotes the development of critical digital literacy skills crucial for the technological age, enabling students to transition from passive information consumers to active evaluators. This highlights the necessity for AI literacya framework of competencies that encompasses the skills to critically evaluate, validate, and refine AIgenerated outputsas articulated in current AI literacy research (Long & Magerko, 2020).

**Ethical and Pedagogical Concerns**

Despite acknowledging the benefits, teachers identified serious concerns regarding the ethical aspects of AI use. The primary concern is AI misuse during academic evaluation. Informant E shared their experience:

"*I have seen it used usually during exams. My student was working on something during the exam, but when asked, they didn't understand. That's when it became obvious they were using AI*" (Fieldnote 60).

This finding reflects academic integrity challenges also found in global studies on ChatGPT in higher education (Adnan et al., 2023). The second concern is potential dependency that could reduce students' intrinsic motivation. Informant E further explained:

"*AI may be promoted, but I don't think it should be like that. Because it makes people lazy when using AI*" (Fieldnote 62).

Poor prompt engineering skills pose another significant challenge. Informant D explained:

"*When I observe students using AI, they ask or give instructions like 'please make this' and that's it. That's insufficient in terms of prompt usage*" (Fieldnote 58).

This indicates the need for more sophisticated AI literacy development, where students not only use but also understand how to communicate effectively with AI systems. A more fundamental concern is the potential dehumanization of learning. Informant F emphasized:

"*AI is humanmade, but it lacks humanity. So for searching information, it's fine, but some people just accept it directly*" (Fieldnote 65).

This perspective reflects teachers' awareness of the importance of maintaining the essence of human interaction in learning, aligning with the human-centred AI approach in education.

**Guidance and Control Strategies**

Facing these challenges, teachers developed various guidance strategies reflecting pedagogical wisdom in the digital era. The primary strategy emphasizes AI's position as a support tool. Informant G firmly stated:

"*Therefore, we need to strengthen students' understanding that AI is only a tool. It's not that the better AI becomes, the more automatic it is, but human control exists. We, as the most perfect beings, must make students aware of this*" (Fieldnote 68).

This approach reflects teachers' efforts to maintain human agency in the learning process while utilizing technological advances. In technical learning, teachers developed strategies for using AI as verification and correction tools. Informant F explained their experience in teaching networking:

"*When they configure and ask AI, there are definitely errors. So sometimes I reverse the prompt, usually asking AI for suggestions whether there are errors in my configuration. Because in Computer Network Engineering, it's better if the configuration results come from us, not AI*" (Fieldnote 63).

This strategy demonstrates a sophisticated approach where AI is positioned as a technical consultant, not the primary executor. Ethical usage aspects became the primary focus of guidance strategies. Informant C emphasized:

"*The point is the ethics of usage. We as teachers might need to be the main party informing students about proper usage. We shouldn't let students know first*" (Fieldnote 75).

This proactive approach aligns with situated learning theory (Holstein & Aleven, 2022) where teachers serve as mentors in communities of practice responsible for shaping technology usage norms. Teachers also developed context differentiation strategies for usage. Informant D provided a concrete example:

"*If students ask something like 'how to make firecrackers,' AI cannot answer that. But if in chemistry, asking about formulas for creating burning effects still appears, that's where the teacher's role comes in. We* (Fieldnote 79).

*tell students that scientific questions are allowed, but in the context of seeking effects, not methods of creation"*

This strategy demonstrates teachers' ability to develop nuanced ethical judgment, distinguishing between legitimate scientific exploration and potential misuse. And consistent with research on the role of professional learning communities/communities of practice in facilitating technology integration and collective teacher learning professional communities (MGMP) serve as sustainability mechanisms for AI adoption (Liu et al., 2024).

**Integration of AI and CT for learning**

The learning undertaken by teachers amidst the challenges of the rise of AI in schools can certainly be utilized by both teachers and students in the learning process. Computational thinking is part of the introduction of logical flow that educators and students can maximize through the learning process. This condition presents a major obstacle because some teachers do not yet understand the flow of the computational thinking process. Training computational thinking is very suitable for informatics learning, which is currently being developed by the government. Informant D provided a concrete example:

*"The introduction of in-depth learning and the implementation of informatics-based learning presents a significant opportunity for students to improve their critical thinking skills. Of course, in practice, critical thinking can also be integrated with computational thinking. Students can perform well on a job if they consistently engage in learning. This allows for optimal implementation of computational thinking."* (Fieldnote 81).

The teachers emphasized that computational thinking is not just about critical thinking, but also about teaching students how to implement the pillars of computational thinking. Students must be able to decompose (break down problems), recognize patterns (find similarities), abstraction (focus on important details), and algorithms (design solutions step by step). These concepts are presented starting with simple, easy-to-understand everyday situations before moving on to more technical or informational realms. Informant E emphasized this in the following conversation:

*" Computational thinking isn't just about critical thinking. There are four main pillars of computational thinking: decomposition, pattern recognition, abstraction, and algorithms. Those who possess these skills are highly adept at designing solutions that can be executed by humans or computers, making them highly relevant in today's era, particularly when integrating with AI. New students can integrate with AI."* (Fieldnote 84).

Integrating learning with an emphasis on AI requires students to first understand the concept of computational thinking. This facilitates the process of understanding logical flows and algorithms, thus facilitating competency acquisition. Computational thinking-based learning can be applied to various subjects, such as mathematics, and has been proven to impact student learning in the K-12 context (Ye et al., 2023). Teachers can also develop effective learning processes by integrating computational thinking into their learning processes (Listiaji & Molnár, 2025). Therefore, in integrating AI in education through the concept of computational thinking, it is necessary to have a clear framework, comprehensiveness and regulations from stakeholders to be more appropriate in the learning process, so that

later practical guidelines can be issued in the learning process (Aydoğdu, 2024; Chick, 2025; Weng et al., 2024).

**Supporting and Inhibiting Factors**

The primary supporting factor is teachers' personal initiative and professional communication support through MGMP (Subject Teachers' Council) groups. Information about training and AI developments is disseminated through these professional networks, demonstrating the role of communities of practice in supporting technology adoption as explained in situated learning theory. The established teaching community is highly helpful of the educational process and facilitates the exchange of competencies among educators, assuring equal compliance to learning standards. This community engagement is reinforced by the participation of stakeholders from government, industry, and universities, each of them contribute to the improvement of knowledge and educational materials for students. The established teacher community can significantly impact the trajectory of learning, as well as the school's vision and mission; therefore, the community's existence is essential for solving the various challenges experienced by educators. The community exercises a substantial impact including: the formulation of a collective vision and transparency, the presence and lack of themes within the shared vision, the relationship of tradition and creativity, the enduring character of educational development, and the vision's participation in regular school activities (Karlsson et al., 2025; Toikka & Tarnanen, 2024). The MGMP has an essential role, involving active participation, as it facilitates collaboration among teachers in enhancing pedagogical practices. This encompasses the development and implementation of teaching programs, the creation and application of instructional materials, the adoption of teaching methodologies, the evaluation of student learning processes and outcomes, the optimization of the learning environment, classroom management, and other educational activities (Bachtiar & Nirmala, 2023; Sumiyani, 2023).

The Indonesian Ministry of Primary and Secondary Education (Kemdikdasmen of Indonesia) recently implemented a policy mandating the implementation of Informatics and Coding & Artificial Intelligence courses (KKA) in schools. However, AI implementation faces obstacles including limited digital infrastructure in some schools, lack of formal AI usage guidelines, and variations in teachers' digital competence. Several teachers still rely on personal initiative without adequate institutional support. This aligns with previous research findings on technology adoption barriers in Indonesian schools (Ng et al., 2023).

**Prospects and obstacles of informatics learning and KKA to improve competency for students**

Research findings provide important insights for KKA (*Kurikulum Keterampilan* AI/ AI Skills Curriculum) policy implementation. Teachers' positive perceptions of AI indicate potential implementation success, but ethical and pedagogical concerns suggest the need for comprehensive guidance strategies. Teachers require not only technical training but also practical and contextual ethical guidelines. Developing AI-based communities of practice in schools becomes key to implementation sustainability. Teachers with positive experiences can mentor colleagues, creating a multiplier effect in technology adoption. This aligns with bottom-up approaches emphasizing the role of teacher agency in educational transformation. This approach is effective for improving and cooperating in the collaborative definition of

competencies, enabling educators to more easily acquire new knowledge. In this bottom-up approach to practice renewal, outcomes are not preordained but generated by the participants as they formulate comprehensive solutions to the tensions (Hyrkkö & Kajamaa, 2025). Despite the presence of robust hierarchical systems in school administration, a trusting management community and collaborative efforts that facilitate bottom-up feedback and opportunities for individual learning can foster good change and sustain professional agency (Lau et al., 2025).

Currently, technological advancement is fast and automation has been extensively implemented across all sectors, including industry and education. The situation demands government action to enhance the educational system, particularly through the integration of informatics, coding, and artificial intelligence (AI) coursework (Iswara Sanantagraha et al., 2025; Kholifah et al., 2024; Mutohhari et al., 2025). However, the current issue is the lack of informatics educators and courses related to artificial intelligence subjects (Rasimin et al., 2024). Consequently, the solution involves teachers either retraining or transitioning from other disciplines (Rahmi et al., 2025). This situation necessitates assessment by stakeholders and demands a thorough engagement of educators possessing informatics proficiency capable of implementing AI and coding in education.

The MGMP TJKT provides an essential forum for educators, providing training for teachers from that specific field of study. Nonetheless, the problem encountered is the deficiency of educational resources required for teacher training, prompting administrators to engage with the ICT sector and academic institutions. The MGMP TJKT collaboration with the Axioo Class Program (ACP), a corporate social responsibility program by Axioo in conjunction with the Information Systems and Technology Education Study Program at Universitas Pendidikan Indonesia, aims to enhance informatics competence. Collaboration among stakeholders (schools, industry, and universities) is essential for implementing the link and match approach and establishing sustainable competencies (Wahjusaputri et al., 2024). The link and match idea is highly suitable for ensuring the sustainability of competencies and eliminating disparities between educational institutions and industry (Lalanne, 2025). Hence, graduates will possess real-time competencies aligned with market and industry demands.

## CONCLUSION

This research provides in-depth insights into vocational educators' thoughts and experiences regarding the integration of artificial intelligence in Indonesian secondary education contexts. The findings suggest a complicated situation in which teachers demonstrate optimistic attitudes towards AI as an instructional tool, while concurrently articulate significant apprehensions over its ethical ramifications and its misapplications. The research highlights three key dimensions of educators' perspectives. At first, educators acknowledge significant advantages of AI integration, especially in improving technical learning experiences and promoting innovative educational endeavors. AI applications range from fundamental information retrieval to intricate programming support, showcasing versatility across several domains. The integration of AI and computational thinking in the learning process must also prioritize the appropriate pattern aspects and requires clear guidance from stakeholders so that it can be implemented in the learning process. Secondly, ethical and pedagogical issues arise as significant obstacles, encompassing

abuses of academic integrity, threats of student dependency, insufficient prompt engineering skills, and the potential dehumanization of learning experiences. Third, educators demonstrate significant adaptability by formulating advanced guiding systems that utilize AI as a verification and support mechanism while maintaining human agency in educational decision-making. The study indicates that effective AI integration necessitates more than the enhancement of technical skills. Educators require extensive training that includes ethical principles, teaching methodologies, and practical application directives. Professional learning communities, especially via MGMP networks, function as essential support systems for knowledge exchange and collaborative problem-solving in AI implementation procedures.

The implications for the implementation of the AI Skills Curriculum (KKA) policy include the need for comprehensive strategies that tackle infrastructure deficiencies, establish official usage protocols, and accommodate diverse levels of instructor digital proficiency. The bottom-up method utilizing teacher agency and peer mentoring is a viable model for educational reform.

## RECOMMENDATION

Future research should explore the long-term effects of AI integration on student learning outcomes and assess scalable professional development frameworks for enhancing teacher AI literacy. Moreover, comparison analyses across various regional contexts could yield profound insights into the contextual factors affecting AI uptake in Indonesian vocational education environments. This study improves the existing literature on AI in education by presenting culturally contextualized viewpoints from Indonesian vocational educators, thereby offering pragmatic insights for policymakers, educators, and researchers aiming for effective technology integration in developing educational environments.

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**Author Contributions Statement**

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| Mark Jhon R P | | | | ✓ | ✓ | | | | | ✓ | | ✓ | | |

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

**Conflict of Interest Statement**
The authors declare no conflict of interest and The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

**Informed Consent**
We have obtained informed consent from all individuals included in this study.

**Data Availability**
The data that support the findings of this study are available from the corresponding author upon reasonable request.

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