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Teachers' Lived Experiences and Readiness for Coding and AI Education: A Narrative Case Study from South Kalimantan

Susanti Sufyadi[1], Sulistyo Rini[2], Lazaro Kumala Dewi[3], Adinda Sadilla[4], Muhammad Afriandy[5]
[1] Lambung Mangkurat University, Indonesia
[2] Lambung Mangkurat University, Indonesia
[3] Lambung Mangkurat University, Indonesia
[4] Lambung Mangkurat University, Indonesia
[5] Lambung Mangkurat University, Indonesia

ABSTRACT

Background. The Indonesian government's policy to introduce coding and artificial intelligence (AI) learning from primary to vocational education has raised critical questions about teacher readiness, particularly in regions outside Java where this dimension is still underexplored.

Purpose. This study aims to: (1) map competency standards for teaching coding and AI; (2) analyze teachers competencies readiness; and (3) formulate contextual strategies for teacher capacity building.

Method. Using a mixed method, this study involved six teachers from elementary, junior high, and vocational schools in South Kalimantan that have been appointed to implement coding and AI learning. Data were collected through in-depth interviews and questionnaires, then analyzed using the pattern matching analysis model of Vargas and the interactive model of Miles, Huberman, and Saldana.

Results. Three key findings emerged: first, competency standards validated by experts. Second, teacher readiness was identified at an average of 74.24%, falling into the "ready" category, with the lowest achievement in professional competency at an average of 67.14%. Pattern matching analysis revealed two significant relationships: personal and social competency areas, which showed consistent correlations across all educational levels, drawing on interview data, indicating that teachers' ethical motivation drives collaborative initiatives; and second, pedagogical and professional competency areas, which were identified as moving in tandem, indicating that subject matter mastery directly impacts the ability to design instruction. Based on this analysis, the third findings of this study yielded a three-stage teacher capacity development strategy: initial project-based training, ongoing development through professional learning communities, and ongoing mentoring.

Conclusion. The primary contribution of this study lies in providing an empirically grounded and contextualized strategic framework for enhancing the capacity of coding and AI teachers also to the discourse on teacher readiness for digital transformation in education, particularly in underrepresented regions such as South Kalimantan

KEYWORDS

Coding and AI; Competency Standards; Capacity Building; Pattern Matching Analysis; Teacher Readiness.

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Correspondence:
Susanti Sufyadi
susanti.sufyadi@ulm.ac.id

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INTRODUCTION

The Directorate General of Information Technology Application, Ministry of Communication and Information Technology measures Indonesia's digital literacy index,

which encompasses four pillars: digital skills, digital ethics, digital security, and digital culture. In 2022, the index showed an increase in three pillars: digital skills, digital ethics, and digital security; however, the digital culture pillar was found to have declined (Dirjen Aplikasi Informatika, 2022). This finding indicates that technical progress has not been fully matched by cultural adaptation in the use of technology, including in the field of education. This is consistent with findings by (Basilotta-Gómez-Pablos et al., 2022), who argue that although digital competencies are improving, teachers still face challenges in integrating technology meaningfully into pedagogical practices

Digital transformation in education demands teachers preparedness to address technological advancements, particularly in mastering coding and Artificial Intelligence (AI). Integrating coding and AI into learning not only enhances digital literacy but also develops essential 21st-century competencies such as computational thinking, data analysis, AI ethics, and AI system design (Farchan, 2025; Pallejà et al., 2026) Furthermore, recent research highlights that teachers' competence in AI-integrated pedagogy, particularly within the AI-TPACK framework, plays a crucial role in aligning content, pedagogy, and technology to support effective learning (Hava & Babayiğit, 2025) Therefore The success of implementing coding and AI in learning is largely determined by teachers' readiness and competence.

Previous research indicates that the effectiveness of AI utilization in education depends on strategies designed by teachers that consider aspects of privacy, security, bias, equity, and human evaluation (Utina et al., 2024). n addition, teachers' needs for guidance on utilizing AI pedagogically on a broader scale were also identified, because studies on Artificial Intelligence in Education (AIEd) often ignore ethical aspects and real educational contexts (Zawacki-Richter et al., 2019). Internationally, there are teacher competency frameworks for technology use, such as the UNESCO ICT Competency Framework (UNESCO, 2018) and the ISTE standards (Crompton & Sykora, 2021). However, neither of these standards specifically outlines competencies for coding and AI education. At the national level, to date, no research has been found discussing teacher competency standards for coding and AI learning. Government policies regarding teacher competency standards remain general and have not been specifically linked to the use of technology or coding and AI learning.

Based on the interview results, it was found that coding and AI learning in schools is still in its early stages and undergoing adjustments, with teachers currently striving to understand the educational concepts and how to apply them in the classroom. Current practices are still heavily influenced by training, so they have not yet fully developed into a structured teaching approach. This is reflected by a teacher's statement that "implementation in the field is still confusing because there are no clear guidelines." On the other hand, at the elementary school level, learning is still limited to the introductory phase, as stated by teachers: "this is just an introduction to the basics," and its implementation is hindered by a lack of facilities, such as "no e-learning or LMS."

As grade levels increase, progress begins to emerge, teachers strive to design more targeted instruction, for example through initial diagnostic tests, although they acknowledge that they are still figuring things out. In more prepared contexts, teachers' understanding is also deeper, going beyond technical aspects and focusing on emphasizing computational thinking and the wise use of AI, these practices are also supported by digital systems. However, challenges regarding teacher capabilities still exist, as stated by the teachers: "the main challenge lies in teachers' capabilities to teach."

Despite these various obstacles, all teachers demonstrated a high level of enthusiasm and commitment to continuing their professional development. Teachers' belief that coding and AI learning is a necessity was reinforced as they participated in training, as evidenced by the statement that "as teachers, we must not give up so that we can guide our students." Not only belief, this statement also indicates motivation. However, relying solely on belief and motivation is insufficient,

support for pedagogical readiness and systemic support is also necessary. Therefore, mapping teachers competencies is crucial so that the needs and challenges they face can be clearly identified, ensuring that the development strategies undertaken are truly appropriate and capable of supporting coding and AI learning in a more optimal and sustainable manner. This is supported by (Darling-Hammond et al., 2017), who emphasize that effective teacher professional development requires not only individual motivation but also structured support systems, including sustained training, collaboration, and alignment with instructional needs.

This gap highlights the urgency of mapping teacher competency standards for coding and Artificial Intelligence (AI) learning that are contextually relevant to Indonesia. Another aspect overlooked by previous research is the motivational dimension and teachers' initiative in responding to policy changes.. Recent studies on the implementation of the Merdeka Curriculum reveal that although the policy grants autonomy, teachers still face various challenges, highlighting a gap between policy design and implementation readiness in the field, in a hierarchical education system, teachers are often placed in a passive role, merely receiving directives from central and local governments (Hilmi et al., 2025; Nurhayati et al., 2025). Beyond the dimensions of motivation and initiative, discussions regarding the interrelationships among competency domains such as how personal competencies drive social competencies, or how mastery of content within the professional competency domain influences the ability to design instruction in the pedagogical competency, have also not been extensively explored, yet competencies do not stand alone; rather, they are arranged hierarchically, where implicit competencies (personality, motivation) serve as the foundation for explicit competencies manifested in behavior (social, pedagogical, and professional skills), this interrelationships condition represented in the Relational Competency Model, which demonstrates that the ability to build positive social relationships (social competency) is highly dependent on emotional maturity and the capacity for self-differentiation (personality competency) (Aspelin & Jonsson, 2019). From this explanation, it becomes clear that mapping these patterns is essential for designing targeted capacity-building interventions.

The significance of this study lies in its contribution to supporting the achievement of the Sustainable Development Goals (SDGs), particularly Goal 4 on quality education, and aligns with the National Asta Cita, which emphasizes the strengthening of innovative and productive human resources (WHO, 2024) The results of the analysis of teachers' readiness will yield recommendations for capacity-building strategies that teachers can use as material for self-evaluation as well as a form of institutional support for continuous professional development (Sufyadi et al., 2025)

This study aims to: (1) map the competency standards that teachers need to master in implementing coding and AI learning; (2) analyze the level of teacher readiness in implementing coding and AI learning; and (3) formulate appropriate strategies for enhancing teacher capacity.

In this study, several terms are defined as follows: Coding is the process of writing, testing, and maintaining computer program instructions; Artificial Intelligence (AI) refers to the simulation of human intelligence in computer systems designed to think and mimic human actions; Teacher Readiness is defined as the level of a teacher's competency across four competency areas: pedagogical, professional, personal, and social which together form the teacher's readiness to plan, implement, and evaluate Coding and AI learning; Teacher Competency Standards are a set of knowledge, skills, and attitudes that teachers must master and demonstrate to effectively conduct coding and AI learning; while Capacity Building Strategies are defined as a series of activities, methods, and materials implemented and used to enhance teachers' competencies in accordance with the results of the competency needs analysis that has been conducted.

RESEARCH METHODOLOGY

This study employs a mixed method (Creswell & Creswell, 2018), involving six teachers across different levels (elementary, junior high, and vocational high schools) who have implemented coding and AI learning in South Kalimantan Province. The study's location and participants represent a regional context outside Java with unique characteristics: teachers who are relatively tech-savvy but face infrastructure and technical challenges.

A mixed method was chosen because it allows for in-depth exploration of the perceptions, experiences, and challenges faced by teachers in implementing Coding and AI instruction.

Teachers' competency levels were assessed using questionnaires and interviews; the questionnaires employed a 5-point Likert scale to measure four competency areas, and the results were calculated as percentages.

Table 1. Highest Score Distribution for Each Competency Area

Competency Area	Number of Indicators	Total Maximum Score
Pedagogical	16	80
Personal	4	20
Social	6	30
Profesional	12	60

Formula for calculating a percentage

$$Percentage\ of\ competency\ achievement \frac{Total\ Score\ for\ Competency\ Area}{Maximum\ Total\ Score} x\ 100\%$$

Table 2. Range of Readiness Criteria:

Percentage	Criteria	Description
0 – 20 %	Not Ready	No observable competency; requires intensive foundational intervention.
21 – 40 %	Low Readiness	Minimal competency with significant gaps; needs structured training.
41 – 60 %	Moderate Readiness	Threshold competency; basic skills present but implementation inconsistent.
61 – 80 %	Ready	Adequate competency; implements instruction independently with minimal support.
81 – 100 %	High Readiness	Excellent competency; demonstrates innovation and is ready to mentor peers.

To explain the implications of the data on teachers' competency levels presented as percentages, pattern matching analysis was used. The significance of pattern matching analysis is emphasized due to its ability to bridge theory and data, allowing for the refinement or qualitative testing of the theory (Vargas-Bianchi, 2025). The analysis process was conducted in three steps. First, establishing the research proposition, namely the Teacher Competency Standards in Coding and KA Education, formulated by referencing the teacher competency frameworks from the (UNESCO, 2018), ISTE Standards (Crompton & Sykora, 2021), and national policy (Direktur Jenderal Guru dan Tenaga Kependidikan, 2023). The second step involved testing the empirical patterns against the predicted patterns, comparing competency scores across grade levels (Table 4), and then comparing the empirical patterns derived from quantitative and qualitative data with the predicted patterns through data presentation in matrix form (Table 5) and triangulation with interview excerpts. The third step

involves interpretation in the form of theoretical explanations and a description of the research findings

The study population consists of all teachers responsible for Coding and AI courses in South Kalimantan Province. Sampling was conducted using purposive sampling with the following criteria: (1) teachers actively teaching courses that integrate Coding and/or AI; (2) assigned to at school that officially implement Coding and AI learning; and (3) willing to participate in the entire research process. Based on these criteria, six teachers were selected from six schools, consisting of three elementary schools (SD), two junior high schools (SMP), and one vocational high school (SMK) in South Kalimantan Province.

Data collection utilized two primary instruments: a questionnaire and an interview guide. Classroom observations could not be conducted because, at the time of the study, the teachers were participating in a training program organized by an institution designated by the Ministry of Basic and Secondary Education. The instruments were used to identify teachers' current competency levels in teaching programming and AI based on teacher competency standards which includes four teacher competency areas: pedagogical, professional, personal, and social, these competency standards were derived from a literature review. In addition to identifying current competency levels, teaching experience, resource support, and initial perceptions regarding readiness to implement programming and AI learning were also identified. Prior to use, the teacher competency standards for teaching programming and AI, as well as both instruments, were qualitatively validated through expert assessment by curriculum and instruction experts, as well as programming and AI content experts, to ensure content alignment with the research objectives.

The research was conducted over a four-month period (June–September 2025) in three phases. The first phase (July 2025) involved a literature review to map teacher competency standards for Coding and AI learning, and also development and validation of teacher competency standards and research instruments. The second phase (August–September 2025) consisted of field data collection through the distribution of questionnaires, the conduct of in-depth interviews. Each interview lasted 60–90 minutes, was recorded with the participants' permission, and was transcribed verbatim for further analysis. The third phase (September 2025) involved data processing, analysis, and the formulation of a teacher capacity-building strategy

Data were analyzed using an interactive model (Miles et al., 2014) comprising three phases: (1) data condensation, which involves selecting, simplifying, and transforming data derived from interview transcripts and questionnaires; (2) data display, in the form of matrices, charts, or narratives to facilitate drawing conclusions; and (3) conclusion drawing/verification. To strengthen the validity of the findings, source triangulation was conducted by comparing data from questionnaires and interviews, as well as researcher triangulation through peer debriefing in interpreting the data

To ensure the credibility of the research, several strategies were implemented: (1) member checking, which involves reconfirming the summary of interview results with participants to ensure the accuracy of the interpretation; (2) prolonged engagement, by establishing a solid rapport prior to the main data collection; and (3) an audit trail, which involves systematically documenting the entire research process from data collection to drawing conclusions. A limitation of this study is the small sample size of only 6 participants, meaning the findings cannot be statistically generalized. However, the depth of the data obtained still provides valuable and in-depth insights into teachers' readiness within the specific context of South Kalimantan. Recommendations for future research include expanding the scope of participants or respondents and using a quantitative approach to test the generalizability of the findings

RESULT AND DISCUSSION

This study yielded three interrelated main findings: (1) a mapping of teacher competency standards for coding and AI instruction that has been validated by experts; (2) a profile of teacher readiness based on four competency areas; and (3) the identification of priority areas for capacity building along with recommended strategies.

Based on a literature review, referring to the Teacher Competency Model (Direktur Jenderal Guru dan Tenaga Kependidikan, 2023), the UNESCO ICT Competency Framework for Teachers (UNESCO, 2018), and the ISTE standards (Crompton & Sykora, 2021), the Teacher Competency Standards for Coding and AI learning were developed following validation by experts in curriculum and instruction as well as experts in coding and artificial intelligence. The teacher competency standards, which cover four areas presented in Table 3:

Table 3. Teacher Competency Standards for Coding and AI learning

COMPETENCY AREAS	COMPETENCY INDICATORS
Pedagogical Competencies (A safe and comfortable learning environment for students; Effective student-centered learning; Student-centered assessment, feedback, and reporting)	Designs lesson plans using various relevant instructional models (tailored to student characteristics).
	Identifying students who are already "self-aware" in their learning, capable of making sense of the learning process, and enjoying it with enthusiasm.
	Designing strategies to inspire and facilitate students in understanding learning objectives, tracking their learning progress, engaging in reflection, and evaluating their own learning.
	Mastering competencies in learning assessment and reflection on the quality of learning.
	Understand ICT policies and their role in education
	Integrating ICT into the curriculum and learning assessment
	Applying technology-based teaching strategies and problem-solving
	Understand the fundamental roles of coding and AI in education and policy
	Applying coding and AI learning policies in instructional planning
	Innovating in the implementation of coding and digital literacy policies for educational reform
	Understanding the basics of digital content and ICT assessment

COMPETENCY AREAS	COMPETENCY INDICATORS
	Understanding the basics of Coding and AI learning
	Integrating 21st-century competencies, digital literacy, artificial intelligence, and coding into the curriculum
	Encouraging students to learn independently, creatively, and innovatively using technology
	Guiding students in the safe, lawful, and ethical use of digital tools and content
	Serving as a role model and promoting the management of personal data, digital identity, and student data protection.
Personal Competencies ethics; Self-development through the habit of reflection; Student-centered orientation)	Serving as a role model, reinforced by a strong work ethic, a sense of responsibility, pride in being a teacher, and self-confidence.
	Demonstrating a love of learning and reflective behavior in the learning process.
	Serving as a role model for colleagues in identifying, experimenting with, evaluating, curating, and adopting new digital resources and tools for learning.
Social Competencies (Collaboration for learning improvement; Involvement of parents/guardians and the community in learning; Engagement in professional organizations and broader networks for learning improvement)	Partnering and collaborating with students in designing, learning and evaluating the learning process.
	Partner with fellow teachers, demonstrating collaborative inquiry within learning communities or working groups, both within the school and in clusters, districts, or cities.
	Creating learning experiences that enable students to make positive contributions, act responsibly, and build an inclusive online community.
	Collaborating and learning alongside students to discover and utilize new digital resources, as well as diagnose and resolve technology issues.
	Using collaborative tools to expand students' real-world learning experiences by virtually engaging experts, teams, and students at the local, national, and global levels.
	Demonstrating cultural competence when communicating with students, parents, and colleagues, and interacting with them as

COMPETENCY AREAS	COMPETENCY INDICATORS
	collaborative partners in the student learning process.
Professional Competencies (Knowledge of learning content and how to teach it; Characteristics and ways students learn)	Ability to use digital tools
	Practicing technology-based classroom and school management
	Teacher professional development (*digital literacy* → innovator)
	Using digital tools, coding, and AR functionally
	Transformatively changing how students learn using advanced technology (AI, simulations, etc.)
	Building collaboration between students and teachers using coding and AI
	Creating an adaptive and sustainable digital learning ecosystem
	Actively engaging in the digital teacher community and sharing best practices
	Becoming an innovator, a change leader, and a facilitator of AI teacher development
	Fostering a culture of innovation, driving change, and advocating for equitable and ethical access to and use of technology in schools
	Pursuing professional interests by creating and actively participating in local and global learning networks
	Staying abreast of research developments that support improved student learning outcomes, including findings from the *learning sciences*.

These competency standards have distinct characteristics compared to the international frameworks they reference. While the UNESCO ICT Framework (UNESCO, 2018) focuses more on the general use of technology, the standards developed in this study specifically outline the competencies needed to teach coding and AI. For example, in the pedagogical competency, indicators have been added regarding an understanding of the fundamental role of coding and AI in educational policy, as well as the ability to integrate 21st-century competencies with digital literacy and AI. This aligns with findings (Utina et al., 2024) that emphasize the importance of considering cultural, ethical, and social factors in the integration of AI in education. This perspective is further supported by (Zawacki-Richter et al., 2019), who emphasize that the integration of AI in education must consider pedagogical, ethical, and contextual dimensions, not merely technical implementation These standards also accommodate the Indonesian context, unlike a direct adoption of international standards without adaptation.

Data analysis from questionnaires and interviews with six participants indicates the level of teachers readiness to implement Coding and AI learning, as summarized in Table 3.

Table 4. Teachers' Readiness Levels for Coding and AI learning

Level	Pedagogical Competency Area	Professional Competency Area	Personal Competency Area	Social Competency Area	Average
Elementary School (n=3)	54,20%	48,33%	60,00%	61,33%	**55,97%**
Junior High School (n=2)	78,50%	73,00%	82,50%	83,00%	**79,25%**
Vocational High School (n=1)	72,00%	68,00%	71,00%	71,00%	**70,50%**
Average	**72,35%**	**67,14%**	**76,11%**	**76,19%**	**74,24%**

In general, teachers' readiness levels fall into the "ready" category, with an average of 74.24%, this indicates that teachers have adequate competency, they implement instruction independently with minimal support, however, variations across educational levels and competency areas reveal patterns that need closer attention. The implications of this data were analyzed using pattern matching analysis as shown in Table 6

Table 5. Trends in Relationships Among Competency Areas

Construct (Competency Area)	Proposisi Pattern	Empirical Pattern	Interpretation
Pedagogi, professional, personal dan social	ESQ (Emotional-Spiritual Quotient) has a significant impact on the four competencies (Putri, 2025). As predicted pattern, there are other factors or aspects that influence these four competency areas, namely the teachers spiritual state, specifically, their belief in the importance of their role and the urgency of teaching coding and AI	Professional vs. Social Professional competencies are consistently lower than social competencies at all levels	There is **a consistent gap** which indicates social competencies are more developed than professional ones.

	Professional and pedagogical competencies simultaneously influence teacher performance (Delafini et al., 2025). The predicted patterns indicate that professional and pedagogical competencies strongly influence one another.	Pedagogical vs. Professional Both rise and fall together: Elementary School (54.20% & 48.33%), Middle School (78.50% & 73.00%), Vocational High School (72.00% & 68.00%)	There is **a tendency** that teachers with high pedagogical competence tend to have better professional competence, and vice versa
	SEC (Social-Emotional Competence) and multicultural effectiveness, which represent the social and professional dimensions of teaching were interrelated constructs (Ura et al., 2025). The patterns predicted by social and professional competencies cannot be completely separated in the learning process	Personal vs. Social Nearly identical: Elementary School (60.00% & 61.33%), Middle School (82.50% & 83.00%), Vocational High School (71.00% & 71.00%)	**A very close pattern** these two competencies appear to develop in tandem which means if we intervene in one of the competencies areas, it will affect one another.

The pattern matching analysis presented in Table 3 reveals both alignment and divergence between theoretical propositions and empirical findings across the four competency areas. At the general level, the integration of pedagogical, professional, personal, and social competencies is not solely influenced by technical factors but also by internal dimensions such as teachers' emotional and spiritual conditions. The finding that personal competence has a significant influence on social competence is consistent with the research by (Putri, 2025), who reported that the Emotional-Spiritual Quotient (ESQ) has a significant influence on the four dimensions of teacher competence, including personal and social competence, as empirical findings in this research suggest the presence of underlying personal beliefs and values that shape teachers overall competence development.

However, a contrasting pattern emerges in the relationship between professional and social competencies. While prior studies (Susanto, 2025) predict professional competence as the dominant factor influencing other competencies, the empirical data show the opposite trend, where social competence consistently exceeds professional competence across all levels. This indicates a gap between theoretical expectations and field conditions, suggesting that teachers are more socially adaptive and collaborative than they are technically prepared in coding and AI. This finding is

consistent with (OECD, 2019), which reports that teachers tend to demonstrate stronger collaboration and social engagement skills compared to their digital and technical competencies, particularly in contexts where technology integration is still developing.

The relationship between pedagogical and professional competencies demonstrates a strong alignment between theory and empirical data. Both competencies show parallel trends (rising and falling together across educational levels) indicating a reciprocal relationship. This finding supports the proposition that professional and pedagogical competencies jointly influence teacher performance (Delafini et al., 2025), and confirms that limitations in professional competence directly affect the quality of pedagogical implementation.

Meanwhile, the relationship between personal and social competencies exhibits the strongest empirical consistency. The nearly identical scores across all levels indicate that both competencies develop simultaneously. This pattern suggests that personal competence, particularly internal motivation and values, serves as the foundation for social competence, enabling teachers to engage in collaboration and collective practices. This pattern aligns with the findings of (Ura et al., 2025), who found that social-emotional competence (SEC) and multicultural efficacy, which represent the social and professional dimensions of teacher competence, are closely related constructs. Although these two constructs are distinct entities, it remains significantly correlated and cannot be separated in teaching practice. This is further supported by (Aldrup et al., 2020), who found that teachers' social-emotional competence significantly influences the quality of teacher–student relationships and collaborative interactions in the classroom.

Overall, these findings indicate that while some patterns align with theoretical expectations (particularly in the pedagogical-professional and personal-social relationships) there are also notable deviations, especially in the dominance of professional competence. This reinforces the need for a more contextualized approach to teacher capacity building, where strengthening professional competence becomes a priority, while personal and social competencies function as supporting capital in collaborative learning environments.

The finding that professional competence is at the lowest level (67.14%) indicates that teachers face the greatest challenges in mastering coding and AI content as well as the required technical skills. This aligns with (Sufyadi et al., 2025), who noted that teachers tend to be more prepared in personal and social aspects than in pedagogical and professional domains when facing new curriculum implementation. This pattern is consistent with the empirical finding in Table 3, which shows that professional competence is consistently lower than social competence across all levels, indicating a gap between collaborative readiness and technical mastery. In the context of coding and AI learning, this gap is understandable due to the rapid development of technology and limited access to technical training. This is further supported by (Falloon, 2020) who found that teachers digital competence (particularly in integrating emerging technologies into pedagogy) remains uneven and often limited by insufficient training and support.

Another data and information that supported the interpretation of this pattern analysis is qualitative findings from interviews, particularly in the relationship between personal and social competencies. Both competencies show nearly identical trends across all levels: elementary (60.00% and 61.33%), junior high (82.50% and 83.00%), and vocational high school (71.00% and 71.00%), indicating that they develop simultaneously. This empirical pattern supports the interpretation that internal factors, such as motivation and values, influence social engagement. Interview findings reinforce this, where a teacher's concern for students' moral development motivated initiatives such as organizing learning communities and collaborative sessions. This suggests that personal competence serves as the foundation for social competence, which is also

supported by studies emphasizing the role of personal stability in building social relationships in 21st-century educational contexts (Ananda et al., 2025).

The disparity in readiness across educational levels further strengthens this interpretation. Lower readiness at the elementary level (55.97%) appears to be influenced by the abstract nature of coding and AI concepts, while higher readiness at the junior high level reflects a more suitable alignment between student cognitive development and content complexity. These findings indicate that variations in readiness are shaped not only by teacher competence but also by contextual factors. Overall, this provides a clear rationale that, in the era of coding and AI, all four competencies must develop in an integrated manner to effectively respond to ongoing curriculum changes (Syamsuar & Reflianto, 2019).

Overall, the list of competencies identified with the lowest achievement rates serves as a reference for the competencies that teachers need to improve in coding and AI instruction. This list is presented in Table 6

Table 6. List of Teacher Competency Improvement Needs in Coding and AI learning

Pedagogical Competency Area	a. Understanding the relationship between coding, AI and educational policy objectives. b. Implementation of coding and AI learning policies in my lesson planning. c. Designing a curriculum that develops digital literacy, coding skills, and an understanding of AI among students. d. Integrating digital literacy or AI skills into learning materials. a. Facilitating students to learn independently and creatively with the support of technology.
Personal Competency Area	a. Participating in professional development activities or training to enhance teaching skills. a. Serving as a role model in the adoption of digital innovations in my workplace.
Social Competency Area	a. Encouraging students to learn together as they collaboratively explore and overcome digital challenges. a. Utilizing collaborative technologies to connect students with external parties such as teams, experts, or students from other schools.
Professional Competency Area	a. Operating coding and AI tools or applications for learning purposes. b. Operating coding and AI tools or applications for learning. a. Regularly evaluating technology-based teaching practices.

Referring to the list table 6 and the finding that professional competencies received the lowest score (67.14%), competencies in this area are the top priority for teacher capacity building among the listed competency requirements. To address this challenge, the researcher conducted a literature review and identified several models and approaches for teacher capacity building suitable for implementation, First, Project-Based and Collaborative Professional Development (Pallejà et al., 2026) This strategy focuses on training where teachers not only receive materials but also actively participate in designing and implementing coding and artificial intelligence projects. Collaboration among teachers is a key element for sharing knowledge and overcoming practical challenges. Second,

the Professional Learning Communities (PLC) strategy provides a collaborative platform for teachers to engage in sustained professional development (Jin et al., 2025), PLCs facilitate knowledge co-construction among novice and experienced teachers using generative AI and particularly effective for deepening understanding of student' characteristics and learning styles in emerging fields such as AI and coding education. Third, the Continuous Mentoring and Coaching strategy (Masoumi & Noroozi, 2025), providing direct support and focused feedback for teachers beginning to teach coding and AI. This approach, identifying 'mentoring as a way of development' as one of the four key themes for building early-career teachers' professional digital competence. Mentoring is crucial for teachers who are just beginning to teach coding and artificial intelligence, as it provides direct support and focused feedback. Referring to the results of the aforementioned studies and considering the indicators in the four competency areas that still require intervention, the capacity-building strategy recommended in this study is the integration of the Project-Based and Collaborative Professional Development Model, the Professional Practice Community Utilization Strategy, and the Continuous Mentoring and Coaching Strategy. The design of the teacher capacity- building strategy for coding and AI instruction is illustrated as follows:

Table 7. Design of the Teacher Capacity Building Strategy in Coding and AI Learning

Initial Training		
Objectives	:	Strengthen teachers' technical foundations, including mastery of coding and AI learning content and teaching methods, as well as an understanding of students' learning characteristics and styles.
Activities	:	• Teachers receive coding and AI materials • Teachers collaborate in groups to design and implement learning projects. • The outcomes of this collaboration may include interactive teaching modules or simple applications that can be used in the classroom.
Sustained Phase		
Objectives	:	Building a collaborative ecosystem
Activities	:	• Teachers form PLCs. • Teachers hold regular meetings to discuss various topics, including: classroom challenges, sharing best practices, and analyzing students' learning processes in the context of coding and AI.
Mentoring Phase		
Objectives	:	To provide technical support tailored to the individual needs of teachers
Activites	:	• Selection and appointment of skilled teachers as mentors. • Provide scheduled one-on-one mentoring. • Providing periodic feedback to assess teachers' progress in coding and AI instruction

The integration of the model into the three training phases is summarized as follows: Initial Training Phase: Teachers are introduced to the basics of coding and digital literacy through intensive, project-based workshops. This approach aligns with recommendations (Pallejà et al., 2026) that emphasize the importance of hands-on learning in developing teachers' ICT competencies. Continuous Phase: Teachers participate in communities of practice, both online and offline, to share experiences and learning resources. This model has proven effective in research (Jin et al., 2025) which found that continuous professional development has a greater impact than one-time training. Mentoring Phase: Teachers receive guidance from more experienced mentors, including industry

practitioners and faculty members. This mentoring approach accommodates teachers' individual needs and enables contextual problem-solving that cannot be addressed in mass training

CONCLUSION

This study yields three main findings corresponding to its research objectives. First, a contextual competency framework for coding and AI learning has been successfully developed and validated by experts, encompassing four competency areas: pedagogical, professional, personal, and social. This framework addresses a critical gap in the Indonesian educational landscape, where no nationally standardized competency standards specifically tailored for coding and AI learning currently exist. Unlike generic international frameworks such as UNESCO ICT CFT or ISTE standards, this contextual framework incorporates local cultural, ethical, and social considerations relevant to Indonesian classrooms. Second, the study identified teachers' current competency achievement with an average readiness of 74.24% falls in the "ready" category. However, significant variation exists across school levels and competency areas. Professional competency emerged as the lowest area (67.14%), particularly at the elementary level (55.97%), while personal and social competencies showed relatively higher achievement (76.11% and 76.19%). Pattern analysis revealed two significant relationships: personal and social competencies consistently correlated across all school levels, indicating that teachers' ethical motivation drives collaborative initiatives; pedagogical and professional competencies moved in tandem, suggesting that content mastery directly influences instructional design ability. Third, based on these analysis this study formulates a capacity-building strategy that integrates three approaches: project-based and collaborative professional development, the utilization of professional learning communities, and ongoing mentoring and coaching. These three approaches are implemented in three phases: initial training, a continuous phase, and mentoring, designed to accommodate adult learning needs and ensure long-term impact. The primary contribution of this study lies in providing an empirically grounded and contextualized strategic framework for enhancing the capacity of coding and AI teachers also to the discourse on teacher readiness for digital transformation in education, particularly in underrepresented regions such as South Kalimantan.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the author(s) used Deepseek and DeepL to assist in improving grammar, language quality, and overall readability of the text. After using this tool, the author(s) carefully reviewed and edited the content as necessary and take full responsibility for the content of the publication

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AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Formal analysis; Writing - review and editing.

Author 2: Conceptualization; Data curation; Methodology; Writing - original draft.

Author 3: Formal analysis; Data curation; Investigation, Supervision; Validation
Author 4: Other contribution; Investigation; Resources; Visuali-zation; Writing - original draft.
Author 5: Other contribution; Investigation; Resources; Visuali-zation; Writing - original draft.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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