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Adaptive Teachers in the Artificial *Intelligence Era*: A Model for Sustainable Professionalism Development in Educational Transformation

Lamberthus. J. Lokollo[1], Salwa Salsabila Latua[2*], Fadhil Alkatiri[3], Preselia Adi[4]

Pattimura University Ambon

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Abstract

The development of Artificial Intelligence (AI) in education is transforming the ways teachers design, implement, and evaluate learning. This transformation requires teachers not only to be able to use technology but also to select, integrate, evaluate, and apply AI appropriately from pedagogical and ethical perspectives. This article aims to analyze the competencies required for teachers to adapt to the development of AI and to formulate a model for the continuous professional development of teachers. This study employed a Systematic Literature Review (SLR) using the PRISMA approach. Literature published between 2021 and 2026 was identified through Google Scholar, GARUDA, and DOAJ, focusing on AI in education, teacher competencies, teacher adaptation, and teacher professional development. The data were analyzed using thematic synthesis to identify patterns, needs, and strategies for developing teacher competencies. The findings indicate that adaptive teachers require AI literacy, pedagogical and digital competencies, critical thinking, ethical awareness, collaboration skills, and a commitment to continuous learning. Professional development cannot rely solely on one-time training but needs to be reinforced through practice, mentoring, collaboration, reflection, evaluation, and continuous improvement. Based on these findings, the Diagnose–Learn–Design–Practice–Collaborate–Reflect–Evaluate–Improve model is proposed as a framework for continuous teacher professional development in the era of AI.

Keywords: Adaptive teachers; Artificial Intelligence; teacher professionalism; educational transformation.

(*) Corresponding Author: **Salsabilasilawanelatua@gmail.com*** , **Fadhilspd44@guru.smp.belajar.id**, **Preseliaadi40@gmail.com**

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INTRODUCTION

The development *of Artificial Intelligence* (AI) in recent years has brought increasingly tangible changes to various aspects of life, including in the implementation of education. The presence of AI-based technology, especially *generative artificial intelligence* (GenAI), such as ChatGPT and various other AI applications, is no longer merely seen as a supporting technological innovation, but has begun to influence how teachers plan lessons, develop teaching materials, provide feedback, conduct assessments, manage administrative tasks, and build more personalized learning experiences for students. These changes show that the transformation of education in the AI era is not merely about how schools provide technological devices, but also how teachers can develop their professional capacities to understand, use, evaluate, and integrate AI pedagogically, critically, ethically, and oriented towards students' needs. A systematic study on AI and

teacher professional development shows that research during the 2015–2024 period still focused more on the use of AI in learning than on the use of AI for teacher professional development; out of 95 articles reviewed, about 65% focused on the application of AI in teaching, while only 35% specifically discussed AI in teacher professional development. This condition shows the existence of space for developing studies on how teacher professionalism can be continuously built amid very rapid technological changes.

This transformation simultaneously places teachers in a different professional situation compared to previous digital eras. If in the early stages of digitalization, teacher education was mainly required to have the ability to use digital devices and platforms, in the AI era teachers face more complex demands because technology not only functions as a medium for delivering information but can also generate texts, images, learning ideas, questions, feedback, and even recommendations that can influence the decision-making process in learning. Therefore, teachers' ability to use AI is not only understood as technical skills to operate applications, but must include the ability to understand AI working principles, assess AI output quality, identify biases and information errors, consider data privacy and security issues, maintain academic integrity, and determine when and how AI is appropriate to be used in the learning process. Delcker, Heil, and Ifenthaler (2025), for example, show that teachers' AI competence is a set of abilities that enable teachers to develop, implement, and evaluate AI ethically and responsibly in the learning and teaching process, while their research on 480 teachers shows that the dimensions of AI competence have not yet developed evenly, so teachers need continuous professional learning opportunities.

The need for teachers who can adapt to AI developments is increasingly important because students are also part of a generation living in a technological environment increasingly integrated with AI. In this condition, teachers no longer only act as the primary source of information, as learners can obtain information and generate various forms of content through AI technology in a very short time. As a consequence, the professional position of teachers needs to shift from merely knowledge conveyors to facilitators of learning processes**,** guides of critical thinking processes, developers of learning experiences, mentors of technology use, and guardians of the humanitarian and ethical dimensions in education. Research by Bower et al. (2024) on the use of ChatGPT by teachers shows that the development of GenAI drives the need to rethink learning and assessment strategies, as these technological capabilities have implications for how tasks are assigned, how the learning process is assessed, and how teachers ensure that learning continues to produce authentic thinking processes from students.

In this context, the term adaptive teacher becomes relevant to describe a teacher who is able to respond actively and sustainably to changes in the educational environment. An adaptive teacher is not just a teacher who can use AI applications, but a teacher who has the ability to continuously learn, evaluate their professional practices, develop new competencies, adjust learning strategies to technological developments, and maintain pedagogical orientation and humanitarian values in the use of technology. Thus, teacher adaptivity needs to be understood as a dynamic professional ability, because AI development is

progressing very rapidly and relevant capabilities currently may not be sufficient to face technological developments in the coming years. This is reinforced by a study by Sperling et al. (2024) who found that AI literacy is a rapidly growing field in educational research, but the professional knowledge aspects of teachers, especially practical and ethical knowledge in dealing with AI, have not yet received adequate attention.

These issues show that teacher professional development can no longer be done through training approaches that are temporary, one-time activities, or only oriented towards introducing the use of certain applications. The rapid development of AI requires a continuous professional development approach that allows teachers to learn gradually, practice, receive feedback, reflect, share experiences with fellow teachers, and update their competencies according to evolving educational needs. Research by Ding et al. (2024) shows that case-based teacher professional development can improve AI literacy and encourage teachers to generate more ideas about AI integration in learning, while also demonstrating that professional development design needs to provide space for teachers to face real and contextual AI problems, rather than merely receiving theoretical technical knowledge.

The need for a sustainable professional development model is also supported by empirical research findings showing that work environment support is related to teachers' ability to integrate GenAI. A study of 339 teachers showed that leadership support that provides autonomy and encouragement for professional development is related to increased positive teacher assessments of GenAI, while positive scores towards GenAI are further related to its integration into teacher work and student learning activities. These findings indicate that teachers' adaptability is not only determined by individual characteristics but is also influenced by the professional environment where teachers work, including school leadership, self-development opportunities, organizational support, and space for teachers to experiment and learn from experience.

Thus, the development of teacher professionalism in facing AI needs to be placed as a process involving dimensions of knowledge, skills, attitudes, pedagogy, ethics, reflection, and lifelong learning. This aligns with Mikeladze's (2024) study which affirms that various AI competency frameworks for educators demonstrate the complexity of the competencies teachers need and the importance of frameworks that can provide clearer direction regarding which abilities need to be developed. In fact, research by Chiu, Ahmad, and Çoban (2025) on the development and validation of *the Teacher Artificial Intelligence Competence Self-Efficacy Scale* places teacher AI competence as an important aspect in building a safe, effective, and healthy learning environment in the transition to AI-based education.

From a more comprehensive perspective, teacher competency development in the AI era also needs to consider human and ethical dimensions. AI can provide efficiency and various opportunities in learning, but its use also raises issues regarding information accuracy, algorithmic bias, data privacy, copyright, transparency, dependence on technology, and academic integrity. Therefore, teachers need the ability not only to ask "how to use AI?" **,** but also "why is AI used, when is AI used, is the results trustworthy, and what are the

impacts on learners?" **.** The AI competency framework for teachers developed by UNESCO places five important dimensions: *human-centered mindset*, AI ethics, AI foundations and applications, AI pedagogy, and AI for professional development. The framework affirms that teachers' AI competencies must be developed while still placing human agency, inclusivity, non-discrimination, as well as cultural and linguistic diversity as key principles.

Another issue to note is the gap between the rapid development of AI technology and teachers' professional readiness. Research on language teacher readiness in the GenAI era shows a difference in readiness between teachers newly entering the profession and first-year teachers, and shows that direct experience using AI can contribute to teachers' understanding and readiness to utilize it. These findings indicate that AI readiness cannot be formed solely through socialization or information delivery, but requires professional learning experiences that enable teachers to understand the technology while applying it in real-life work contexts. Research by Kitcharoen, Howimanporn, and Chookaew (2024) also shows that specially designed professional development training can enhance teachers' AI knowledge, making systematic competency training and development one of the important elements in preparing teachers to face AI-based educational changes.

Furthermore, recent research on professional development interventions based on *Intelligent-TPACK* provides evidence that systematically designed professional development programs can improve teachers' AI competence. The study implemented a six-month professional development program and found improvements, especially in *the aspects of AI Technological Knowledge* and *AI Technological Pedagogical Knowledge*. These findings are important because they show that AI competency development does not have to be separated from teachers' pedagogical competence but can be developed through the integration of technological knowledge, pedagogy, and learning practice. Thus, teacher professionalism in the AI era is more appropriately viewed as the ability to integrate technology with pedagogical and professional considerations, rather than merely mastery of various popular AI applications.

However, upon closer examination, these studies still show a need to develop a more integrated perspective on how teachers can become adaptive through a sustainable model of professional development**.** Systematic studies on AI in teaching and professional development of teachers show that research on professional development is still less than research on AI use in learning. Meanwhile, studies on AI literacy in teacher education also show that practical knowledge aspects and teachers' ethical considerations still require further development. This condition shows that discussions about teachers in the AI era do not stop at questions about AI literacy levels or frequency of AI use, but need to be directed towards how educational institutions build a professional development ecosystem that enables teachers to learn, adapt, experiment, reflect on practices, collaborate, and continuously update their competencies**.**

Based on this description, adaptive teachers in the Artificial Intelligence era can be understood as teachers who are able to dynamically develop their professionalism by combining AI literacy, pedagogical competence, critical thinking skills, digital skills, ethical awareness, reflective abilities, and the

willingness to keep learning. Meanwhile, the sustainable professional development model is important to ensure that teachers' adaptation to AI is not temporary but part of professional culture and lifelong learning. This model can be directed towards a cycle that includes identifying competency needs, improving AI literacy and competence, integrating AI in learning, collaboration and sharing experiences, reflection on practice, competency evaluation, and continuous development**.** This approach is relevant to the finding that systematic, contextual, and continuous professional development programs enable teachers to develop AI competencies more than approaches oriented solely toward short-term technical training.

Therefore, the study titled "Adaptive Teachers in the Era of Artificial Intelligence: A Model for Sustainable Professionalism Development in Educational Transformation" is relevant to be developed because it places teachers as the main actors in the educational transformation process, not merely as technology users. This focus is important to identify what competencies teachers need to have, what factors support and hinder teachers' adaptability, and how sustainable professional development models can be designed to meet educational demands in the AI era. From this perspective, AI is not positioned as a replacement for the role of teachers, but rather as a technology that demands redefinition and strengthening teacher professionalism so that its utilization remains within a pedagogical, ethical, humanistic framework oriented towards improving learning quality. Thus, the discussion about adaptive teachers not only has relevance to the development of educational technology but also provides a conceptual contribution to the development of teacher professionalism models capable of surviving, developing, and adapting to continuous changes in educational technology**.**

RESEARCH METHOD

This study uses the Systematic Literature Review (SLR) approach to identify, review, analyze, and synthesize various previous research results relevant to the themes of adaptive teachers, artificial *intelligence*, teacher competence, and the development of sustainable professionalism in educational transformation. SLR was chosen because it allows researchers to gain a more comprehensive understanding of knowledge developments in a field through systematic literature search and selection based on predetermined criteria. Unlike conventional literature reviews which tend to be narrative, SLR places the process of source identification, article selection, data extraction, analysis, and synthesis of findings as stages carried out in a structured manner so that the study results have a clearer methodological basis. The use of SLR in educational research has also been applied by several national studies, including Halimah and Dewi (2023) who conducted a systematic study on the implementation of *Understanding by Design*, and Dinata et al. (2024) who used SLR to map the implementation of online learning at various education levels in Indonesia.

RESULTS AND DISCUSSION

Based on the review process of previous studies, it was found that the development of Artificial Intelligence (AI) in education not only provides

opportunities to improve learning efficiency but also changes the demands of teacher competence and professionalism. The literature reviewed shows a tendency for AI to be used in various professional teacher activities, such as preparing teaching materials, lesson planning, developing assessments, providing feedback, developing learning media, and managing administrative tasks. Thus, the changes brought about by AI are not only in the aspect of learning technology but also in how teachers carry out their professional roles. Research findings at SMA Negeri 1 Bodeh, for example, show that training in the use of ChatGPT and Google Gemini can improve teachers' ability to utilize AI to create teaching materials and evaluation questions.

1. Changes in the Role of Teachers in the Era of Artificial Intelligence

Literature review results show that the development *of Artificial Intelligence* (AI) has brought changes to the roles and professional demands of teachers. AI is beginning to be utilized to assist teachers in preparing teaching materials, designing lessons, creating assessments, providing feedback, and developing learning media. However, the use of AI does not mean replacing the teacher's position, but rather transforms the role of the teacher into a more complex one, namely as a learning designer, facilitator, evaluator, technology use guide, and pedagogical decision maker. Previous research shows that the use of AI can improve teachers' ability to complete various professional tasks, especially when technology use is accompanied by appropriate training and mentoring (Pujiono et al., 2024; Tyas et al., 2024).

Based on these findings, adaptive teachers can be understood as teachers who are not only able to use AI technology but also can adapt AI to learning objectives, student characteristics, and professional needs. Teacher adaptivity also includes the ability to review AI-generated information, understand technological limitations, and consider ethical and responsible aspects in its use.

2. **Competencies Needed for Adaptive Teachers**

The synthesis results show that there are several main competencies needed by teachers to face AI developments. These competencies include AI literacy, digital competence, pedagogical competence, critical thinking skills, information evaluation skills, ethical awareness, and continuous learning skills. Thus, AI competence cannot be separated from the existing professional competences of teachers but needs to be integrated into learning practices.

The relationship between teacher collaboration with AI and the improvement of teachers' digital competence. Meanwhile, research on the development of AI-based teaching materials shows that teachers need the ability to prepare *prompts*, evaluate AI outputs, integrate AI results into teaching materials, and consider the ethics of their use. These findings indicate that adaptive teachers are not merely masters of AI applications, but teachers who are capable of using AI critically, pedagogically, and responsibly.

Simply put, adaptive teacher competencies can be formulated as:

AI Literacy + Pedagogical Competence + Critical Thinking + Ethics + Collaboration + Willingness to Continue Learning.

3. **Teacher Professionalism Development Must Be Continuous**

Findings from various studies show that AI training can improve teachers' abilities, but a single training session is not enough to build adaptive teacher professionalism. Some studies show an improvement in teacher skills after attending workshops, training, and AI mentoring. However, AI technology development is progressing very rapidly, so teacher competencies also need to be continuously updated.

Therefore, the development of teacher professionalism in the AI era needs to be directed from **a** "training then completed" pattern to a continuous process. Teachers need to have opportunities to try technology in learning, receive mentoring, discuss with peers, reflect, evaluate the results of AI use, and then improve their practice. Research on AI training for teachers shows that approaches that combine training, practice, mentoring, and learning communities can help teachers develop competencies in a more contextual and sustainable way.

Thus, the development of teacher professionalism can be formulated in the following cycles:

Identification of Needs → Training → Practice → Assistance → Collaboration → Reflection → Evaluation → Improvement.

This cycle keeps repeating itself because AI development and educational needs keep changing.

4. **Adaptive Teacher Model in the Artificial Intelligence Era**

Based on the synthesis of previous research, this article offers a sustainable professional development model consisting of eight stages: *Diagnose, Learn, Design, Practice, Collaborate, Reflect, Evaluate, and Improve.*

Table 1. Model for Developing Adaptive Teacher Professionalism

Stage	Main Focus	Activity Forms
Diagnosis	Need identification	Mapping teachers' AI capabilities and needs
Learn	Knowledge enhancement	AI literacy and competency training
Design	Planning	Designing AI-assisted learning
Practice	Applications	Using AI in learning
Collaborate	Collaboration	Sharing practice through MGMP/KKG/learning communities
Reflect	Reflection	Evaluating AI usage experience
Evaluate	Evaluation	Measuring competency development and learning impact
Improve	Improvements	Updating competencies and learning practices

This model is cyclical, so the *Improve* stage returns to the *Diagnose stage*. This means that after teachers improve their competencies, technological

developments and student needs need to be analyzed again to determine the new competencies that need to be developed.

This model emphasizes that adaptive teachers are not just teachers who can use AI, but teachers who are able to learn, use, evaluate, adjust, and continuously redevelop their competencies.

5. **Meta-Synthesis Summary**

To make it easier for journal readers to understand the SLR results, the synthesis data can be simplified as follows.

Table 2. Meta Synthesis Summary

Aspects Studied	**Tendencies of the Findings**
AI in education	Supporting teachers' learning and professional work
Teacher competencies	Requires AI literacy and digital competencies
Pedagogues	AI needs to be tailored to the goals and characteristics of the learners
Training	Enhancing teachers' initial abilities
Assistance	Helping teachers apply AI in practice
Collaboration	Strengthening professional learning among teachers
Reflection	Helping teachers evaluate AI usage
Ethics	Necessary to maintain responsible AI use
Sustainability	Competencies need to be updated to keep up with AI developments
Models offered	Diagnose–Learn–Design–Practice–Collaborate–Reflect–Evaluate–Improve

Based on the overall study results, it can be concluded that the main challenge in education in the AI era is not merely how to provide technology, but how to ensure teachers have the ability to continuously adapt to technological developments. Previous research has shown many benefits of AI in assisting teacher tasks and learning, but there is still a need to integrate these competencies into a sustainable professional development model. Therefore, the *Diagnose–Learn–Design–Practice–Collaborate–Reflect–Evaluate–Improve* model is offered as a conceptual framework linking AI literacy improvement with pedagogical practice, professional collaboration, reflection, evaluation, and continuous improvement.

CONCLUSION

Based on the results of *the Systematic Literature Review* (SLR), the development *of Artificial Intelligence* (AI) has brought changes to the roles and demands of teacher professionalism. Teachers are not only required to be able to use technology but also need to possess AI literacy, pedagogical and digital competencies, critical thinking skills, ethical awareness, and collaboration skills.

The development of teacher professionalism must be carried out continuously through training, practice, mentoring, collaboration, reflection, and evaluation. Therefore, this article offers the Diagnose–Learn–Design–Practice–Collaborate–Reflect–Evaluate–Improve model as a framework for developing teacher competencies in facing educational transformation.

The success of teachers' adaptation to AI depends not only on their ability to master technology but also on their readiness to continuously learn and adapt to changes. Support from educational institutions, school leadership, and a collaborative environment is also needed to ensure optimal professional development. Thus, AI should become a supporting tool that strengthens teachers' roles in creating effective, innovative, ethical, and student-centered learning.

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