



Guidelines for Enhancing Artificial Intelligence Literacy and Professional Competencies of Educational Personnel in Non-Formal Education: A Case Study of Phan Thong Non-Formal Education Center, Chonburi Province

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Abstract

Background and Aim: Artificial Intelligence (AI) has emerged as a transformative force in education, creating new opportunities for enhancing teaching, learning, and educational management. In non-formal education settings, where learners exhibit diverse educational needs and backgrounds, educational personnel are increasingly required to possess both AI literacy and the professional competencies necessary to effectively integrate AI technologies into instructional practices. This study aimed to examine the effectiveness of an AI literacy development program and to formulate practical guidelines for strengthening AI literacy and professional competencies among educational personnel at the Phan Thong Non-Formal Education Center, Chonburi Province, Thailand.

Materials and Methods: This study employed a concurrent mixed-methods research design. The quantitative phase involved 26 educational personnel selected through census sampling. Data were collected using a researcher-developed questionnaire measuring AI awareness, AI-related instructional competencies, and training effectiveness. The qualitative phase included semi-structured interviews, classroom observations, implementation records, and document analysis. Quantitative data were analyzed using descriptive statistics and paired-sample t-tests, whereas qualitative data were analyzed through thematic analysis. Findings from both phases were integrated to develop evidence-based guidelines.

Results: The findings revealed significant improvements in participants' AI literacy and professional competencies following the intervention. Mean achievement scores increased substantially from 17.29 before the training to 34.27 after the training ($p < .05$). Improvements were observed across all dimensions of AI awareness, with self-reflection demonstrating the greatest gain. Despite these positive outcomes, technology readiness remained at a moderate level ($M = 3.04$), indicating continuing challenges related to infrastructure and institutional support. Based on the integrated findings, four key guidelines were developed: (1) targeted professional development in AI applications, (2) enhanced institutional support for digital infrastructure, (3) promotion of collaborative and professional learning communities, and (4) continuous monitoring and evaluation supported by clear organizational policies.

Conclusion: The study demonstrates that enhancing AI literacy and professional competencies among educational personnel requires a systematic and sustainable approach that extends beyond short-term training initiatives. Continuous professional development, supportive institutional policies, and adequate technological infrastructure are essential for effective AI integration in non-formal education. The proposed guidelines provide a practical framework for educational institutions seeking to strengthen AI readiness and adapt to ongoing digital transformation.

Keywords: AI literacy; Professional Competencies; Non-formal Education; Educational Personnel; Digital Transformation

Introduction

In the digital era, Artificial Intelligence (AI) has become an important force shaping many sectors, including education. In non-formal education in particular, AI is not only used as a technological tool but also plays a role in improving learning management, supporting administrative work, and creating more personalized learning experiences (Sofiyanti & Marampa, 2025). As learners increasingly expect flexible and accessible learning opportunities, the integration of AI has become a key approach to improving the quality and responsiveness of educational provision.

Growing attention has been given to the role of AI in both formal and non-formal education systems (Purnomo et al., 2024). In non-formal contexts, learners often differ widely in their backgrounds, learning styles, and personal circumstances. Because of this diversity, AI technologies are particularly useful, as they allow educators to design flexible learning environments and adapt content to individual needs (Polomoshnov et al., 2026). Previous research has shown that AI can support





instructional processes by generating personalized learning materials and enabling more learner-centered approaches.

At the same time, AI is increasingly connected to teachers' professional roles. Educators in non-formal settings are expected to develop stronger technological competencies, especially in areas such as data management, curriculum design, communication, and instructional improvement. These skills are becoming essential for maintaining effective teaching practices in rapidly changing digital environments.

From a theoretical perspective, Social Learning Theory highlights the importance of interaction and collaboration in the learning process. AI and other digital technologies can support these processes by facilitating communication between learners and instructors, as well as encouraging shared learning experiences (Worapongpat et al., 2026). In this sense, AI is not only a tool for instruction but also a means of strengthening engagement and collaboration in educational settings.

However, despite these potential benefits, there is still a noticeable gap between what AI can offer and what educators are currently able to implement in practice. Many teachers in non-formal education lack sufficient awareness, understanding, and hands-on experience with AI tools (Molodtsova et al., 2025). As a result, the integration of AI into teaching remains limited. This situation points to the need for more structured professional development and clearer support systems.

This issue is particularly evident at the Phan Thong Non-Formal Education Center in Chonburi Province. The center serves learners with diverse needs and faces increasing pressure to adopt flexible and technology-supported approaches. At the same time, challenges related to infrastructure, readiness, and instructional adaptation remain. These conditions make the center a useful case for examining how AI can be more effectively implemented in non-formal education in Thailand.

Given these challenges, there is a clear need to develop practical guidelines that can support educators in building AI literacy and strengthening their professional competencies. Such guidelines can help teachers apply AI more effectively in their work, improve curriculum design, and enhance overall learning management.

Objectives

1. To evaluate the effectiveness index and compare pre- and post-training outcomes of an AI-awareness development program designed to enhance teachers' instructional management skills at the Phan Thong Non-Formal Education Center, Chonburi Province.
2. To develop and validate standard criteria for the effective use of artificial intelligence in strengthening teachers' instructional management skills in non-formal education contexts.
3. To propose a practical and evidence-based model for utilizing artificial intelligence to enhance teachers' instructional management skills in non-formal education settings.

Literature review

The integration of artificial intelligence (AI) into education has become increasingly important in recent years, particularly in the context of rapid digital transformation (Mandic et al., 2025). Both formal and non-formal education systems have begun to adopt AI technologies to improve teaching and learning processes. (Worapongpat, 2025d). In non-formal education, this shift is especially relevant because learners often come from diverse backgrounds and have different learning needs. As a result, flexibility and adaptability are essential. AI technologies help address these challenges by supporting personalized learning environments and enabling educators to adjust instructional content to suit individual learners.

Previous studies suggest that AI can play a meaningful role in improving instructional practices. For example, AI tools can generate customized learning materials, provide automated feedback, and support learner-centered approaches. (Nazari et al., 2024). These capabilities allow educators to better respond to differences in learners' abilities, interests, and learning pace. In this way, AI is not only a technological innovation but also a practical tool for enhancing teaching effectiveness in diverse educational settings.





AI and Professional Competencies of Educators

In addition to its role in supporting learners, AI is closely linked to the professional competencies of educators. (Worapongpat et al., 2025). noted that teachers in non-formal education need to develop stronger technological skills to effectively use AI in their work. (Worapongpat, 2025a). This includes competencies in managing student data, designing curricula, facilitating communication, and improving instructional strategies.

Developing these skills is not simply an added advantage; it has become a necessary part of teaching in modern educational environments. As technology continues to evolve, educators are expected to adapt and continuously update their knowledge. (Ziyia et al., 2024). Without sufficient competencies in AI, teachers may struggle to fully utilize available tools, which can limit the effectiveness of instruction.

Theoretical Perspective: Social Learning Theory

From a theoretical standpoint, Social Learning Theory provides a useful framework for understanding how AI can support education. This theory emphasizes that learning occurs through interaction, observation, and collaboration. In this context, digital technologies, including AI, can enhance these processes by making communication more accessible and interactive.

For instance, AI-supported platforms can facilitate discussions, enable real-time feedback, and support collaborative learning activities. (Worapongpat, 2025b). These features help create more engaging learning environments where learners can actively participate and learn from one another. (Tomeczyk, 2024, November). Therefore, AI should not be viewed only as a tool for delivering content, but also as a means of strengthening social interaction and shared learning experiences.

Challenges and Gaps in AI Adoption

Despite the clear advantages of AI, many studies highlight ongoing challenges in its implementation. One of the most common issues is the gap between the potential of AI technologies and the actual readiness of educators to use them effectively. (Zhao et al., 2026). Found that many teachers in non-formal education still lack sufficient knowledge, confidence, and practical experience in using AI tools.

This gap can limit the integration of AI into everyday teaching practices. In some cases, educators may be aware of AI but are unsure how to apply it in real classroom situations. In other cases, limited access to resources or infrastructure can further restrict its use. These challenges suggest that simply introducing AI technologies is not enough.

Conceptual Framework

The conceptual framework of this study is designed to examine the relationships between artificial intelligence (AI) awareness, AI-related instructional skills, and the development of practical guidelines for enhancing instructional management in non-formal education. The framework consists of two independent variables and one dependent variable, as follows:

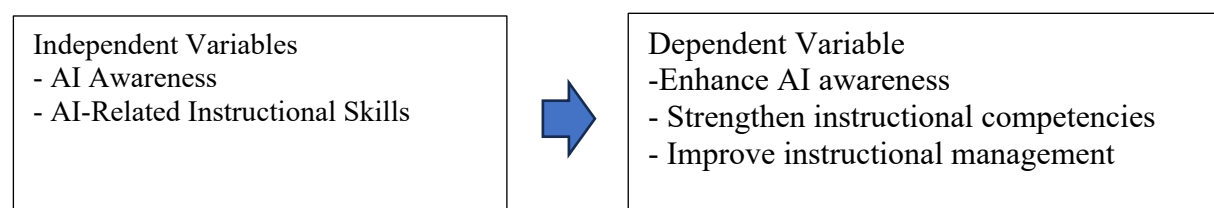


Figure 1 Conceptual Framework

Methodology

Research Design

This study utilized a concurrent mixed-methods research design, combining quantitative and qualitative methodologies in the same phase of data collection and analysis. The quantitative component assessed the efficacy of the AI awareness development program, but the qualitative component offered profound insights into participants' experiences, views, and practical uses of AI in instructional management. The amalgamation of both data sets facilitated a more thorough comprehension of how





AI literacy and professional capabilities could be augmented among educational workers in non-formal education settings.

Scope of the Study

The research was carried out in non-formal education centers situated in Chonburi Province, Thailand. The study encompassed 11 subdistricts: Phan Thong, Nong Tamlueng, Map Pon, Nong Kakha, Nong Hong, Khok Khi Non, Ban Kao, Na Pradu, Bang Nang Ko, Loi Bang Hak, and adjacent regions.

The study encompassed three participant groups: training participants, expert informants, and a pilot implementation group. This framework enabled the researcher to evaluate the training program's outcomes, validate the suggested guidelines, and investigate their practical use in real instructional environments.

Population and Sampling

The population comprised administrators, specialist educators, and instructors employed in non-formal education centers in Chonburi Province.

The quantitative phase included a sample of 26 educational workers who engaged in the AI awareness development program during the first semester of the 2024 academic year. Census sampling was utilized as the study encompassed all members of the target training group.

In the qualitative phase, purposive sampling was employed to pick five experts in special education, instructional design, and artificial intelligence in education for comprehensive interviews. Furthermore, 20 educational staff who employed AI-based instructional approaches in Phan Thong and Nong Tamlueng during the second semester of the 2023 academic year were included to furnish classroom-level evidence and implementation input.

Research Instruments

The research instruments comprised four primary tools.

An AI Awareness and Instructional Skills Assessment Questionnaire, produced by a researcher, was utilized to evaluate participants' awareness of AI, AI-related instructional competencies, and their perceptions of the training program. The questionnaire comprised three sections: AI awareness, encompassing mindfulness, self-reflection, inquiry, and listening/observation; AI-related instructional skills, including learning ability, reasoning, adaptability, and creativity; and training program evaluation, addressing training quality, technology readiness, learning environment, and perceived skill development.

The questionnaire was created through a methodical approach that included literature evaluation, item formulation, expert validation, pilot testing, and reliability assessment. The Item-Objective Congruence (IOC) index was utilized to evaluate content validity, yielding values between 0.67 and 1.00. The reliability analysis demonstrated substantial internal consistency, evidenced by a Cronbach's alpha coefficient of .902.

A semi-structured interview guide was created to investigate participants' perspectives on AI, implementation issues, educational uses, and suggestions for formulating practical guidelines. Third, an observation and implementation log was utilized to document the application of AI technologies in instructional contexts, encompassing teaching methodologies, classroom activities, and student responses during the pilot implementation phase.

A document analysis protocol was employed to examine pertinent documents, including policy materials, training documents, instructional plans, and learning artifacts. The documents were examined to facilitate data triangulation.

Data Collection Procedures

Quantitative data were gathered via pre-test and post-test evaluations conducted prior to and during the AI awareness development program. All 26 participants completed both exams, yielding a 100 percent response rate.

Qualitative data were gathered via comprehensive interviews, classroom observations, implementation logs, and document analysis. Interviews were performed with participants' informed consent, audio-recorded, and transcribed verbatim. Observations and implementation records were gathered during the pilot phase to document the application of AI-based instructional approaches in actual educational settings.





Data Analysis

Quantitative data were examined using descriptive and inferential statistics. Descriptive statistics, comprising mean, standard deviation, and percentage, were employed to encapsulate participants' responses. A paired-sample t-test was performed to compare pre-test and post-test scores. The threshold for statistical significance was established at the .05 level. Cohen's d was computed to assess the practical significance of the training program.

Qualitative data were examined by thematic analysis. The study encompassed iterative data reading, preliminary coding, classification of associated codes, theme formulation, and cross-case comparison. Data triangulation was performed by contrasting results from interviews, observations, implementation logs, and document analysis. NVivo software was utilized to facilitate the organization and management of qualitative data.

Development and Evaluation of Guidelines

The practical suggestions for improving AI literacy and professional skills were formulated based on the synthesis of quantitative and qualitative findings. Five experts evaluated the initial guidelines to determine their content authenticity, appropriateness, and feasibility. Following expert validation, the recommendations were pilot-tested in designated instructional environments. The feedback from the trial implementation was utilized to enhance the final version of the guidelines.

Ethical Considerations

Ethical considerations were upheld during the study process. All participants were apprised of the study's aims, procedures, and their rights before data collection. All participants provided informed consent. Confidentiality and anonymity were preserved, and participants could withdraw from the study at any point without any repercussions. The research was performed in compliance with recognized ethical criteria for studies involving human subjects.

Results

Table 1. Improvement in AI Awareness Components

Component	Improvement	t-value	Significance
Mindfulness	+4.33	14.033	***
Self-Reflection	+9.47	16.623	***
Self-Questioning	+5.21	26.543	***
Listening & Observation	+3.49	19.412	***
Total Awareness	+21.48	27.758	***

Note: ** $p < .001$

Table 1 presents the improvement in AI awareness among educational personnel following participation in the training program. Significant improvements were observed across all dimensions of AI awareness ($p < .001$). The greatest increase was found in self-reflection (Improvement = 9.47), indicating that participants developed a stronger capacity to critically evaluate and reflect upon the use of AI in educational contexts. Self-questioning also demonstrated substantial improvement (Improvement = 5.21), suggesting enhanced critical inquiry and decision-making skills related to AI applications. Overall, AI awareness increased by 21.48 points, reflecting the effectiveness of the training program in strengthening participants' understanding and awareness of artificial intelligence.

Table 2. Comparison of AI-Related Instructional Skills by Gender

Skill	Male	Female	Mean Difference
Learning Ability	3.63	3.68	0.05
Reasoning Skills	3.75	3.75	0.00
Self-Correction	3.58	3.69	0.11
Creativity	3.68	3.81	0.13





Table 2 compares AI-related instructional skills between male and female participants. The results indicate only minor differences across all skill dimensions. Female participants reported slightly higher mean scores in learning ability, self-correction, and creativity, whereas reasoning skills were identical for both groups. The small mean differences suggest that AI-related instructional competencies were developed relatively equally across genders, indicating that the training program was effective regardless of participants' gender.

Table 3. Interpretation Criteria for Training Effectiveness

Mean Score Range	Interpretation
1.00–1.80	Very Low
1.81–2.60	Low
2.61–3.40	Moderate
3.41–4.20	Good
4.21–5.00	Very Good

Table 3 presents the interpretation criteria used to evaluate the effectiveness of the training program. Mean scores were categorized into five levels ranging from very low to very good. These criteria were used to interpret participants' perceptions of the quality and effectiveness of the training across multiple dimensions.

Table 4. Effectiveness of Training Program

Aspect	Mean	Level
Training	3.75	Good
Trainers	3.31	Moderate
Trainer Personnel	3.61	Good
Technology	3.04	Moderate
Learning Environment	3.49	Good
Classroom Research	3.22	Moderate
Academic Development	3.77	Good
Overall Mean	3.53	Good

Table 4 shows participants' perceptions of the effectiveness of the training program. The overall effectiveness was rated at a good level ($M = 3.53$). Academic development received the highest evaluation ($M = 3.77$), followed by training quality ($M = 3.75$) and trainer personnel ($M = 3.61$). However, technology readiness received only a moderate rating ($M = 3.04$), suggesting that limitations in technological infrastructure and digital resources may still present challenges for the effective implementation of AI in educational settings. These findings indicate that while the training program was positively received, additional institutional support may be necessary to enhance technological readiness.

Table 5. Comparison of Training Effectiveness Before and After Participation

Aspect	Before	After	t-value	p-value
Training	8.72	9.67	3.764	.001
Trainers	7.51	10.60	9.807	.000
Trainer Personnel	8.42	9.65	4.788	.000
Technology	8.00	9.74	7.558	.000
Learning Environment	7.28	10.42	10.781	.000
Classroom Research	7.84	10.09	6.461	.000
Academic Development	9.33	10.35	3.800	.000
Total	81.93	100.74	15.661	.000

Note: $p < .001$ indicates statistical significance.





Table 5 compares participants' perceptions of training effectiveness before and after participation in the AI literacy development program. The results revealed statistically significant improvements across all dimensions ($p < .001$). The largest improvement was observed in the learning environment dimension ($t = 10.781$), followed by trainer quality ($t = 9.807$) and technology support ($t = 7.558$). The overall score increased substantially from 81.93 to 100.74, with a highly significant t-value of 15.661. These findings provide strong evidence that the training program positively influenced participants' perceptions of instructional quality, technological support, and professional development opportunities, thereby contributing to enhanced AI literacy and instructional competencies.

Discussion

The findings of this study provide empirical evidence that a structured AI literacy development program can significantly enhance AI awareness, instructional competencies, and instructional management practices among educational personnel in non-formal education settings. The discussion is organized according to the study objectives and interpreted through relevant theoretical and empirical perspectives.

Improvement of AI Awareness among Educational Personnel

The findings revealed that educational personnel demonstrated significant improvements in AI awareness following participation in the training program. The most substantial improvement was observed in self-reflection, suggesting that the program successfully promoted critical awareness and reflective thinking regarding the educational use of artificial intelligence. This outcome may be attributed to the experiential nature of the training, which emphasized hands-on engagement with AI tools in authentic instructional contexts rather than solely focusing on theoretical knowledge.

The result is consistent with recent studies indicating that effective AI literacy development requires active participation, critical engagement, and contextualized learning experiences. Sperling et al. (2024) argued that AI literacy should extend beyond technical understanding and encompass reflective, pedagogical, and ethical dimensions that enable educators to critically evaluate AI applications in educational settings. Similarly, Walter (2024) emphasized that AI literacy development among educators requires opportunities to experiment with AI technologies while simultaneously reflecting on their pedagogical implications. These findings suggest that experiential learning activities can foster deeper conceptual understanding and greater confidence in the educational use of AI technologies.

From a theoretical perspective, the findings support Transformative Learning Theory (Mezirow, 1997), which posits that meaningful learning occurs when individuals critically examine existing assumptions and reconstruct their understanding through reflection and experience. In the present study, participants appeared to move beyond a basic awareness of AI technologies toward a more reflective and informed understanding of their potential role in instructional practice. The substantial increase in self-reflection scores indicates that participants developed a greater capacity to evaluate both the opportunities and limitations of AI integration within their professional contexts.

Enhancement of Instructional Management Competencies

The findings further demonstrated significant improvements in instructional management competencies, particularly in learner engagement, instructional personalization, and adaptive teaching strategies. These improvements may be explained by the capacity of AI technologies to support personalized learning, automated feedback, and data-informed instructional decision-making.

This finding aligns with previous research suggesting that AI technologies can enhance teachers' professional competencies by enabling more adaptive and learner-centered instructional practices. Baashar et al. (2022) reported that AI-supported systems contribute to improved educational effectiveness through intelligent feedback mechanisms and adaptive learning support. Likewise, Mikeladze et al. (2024) emphasized that AI competency frameworks for educators increasingly recognize instructional adaptation, pedagogical decision-making, and learner support as essential competencies for effective AI integration in educational environments.

The findings can also be interpreted through the lens of Differentiated Instruction Theory, which emphasizes adapting instructional approaches to learners' readiness levels, interests, and learning profiles. In non-formal education contexts, where learners often possess diverse educational





backgrounds and learning needs, AI technologies provide practical mechanisms for implementing differentiated instruction at scale. By facilitating content personalization and adaptive learning pathways, AI enables educators to respond more effectively to individual learner characteristics while maintaining instructional quality and efficiency.

Furthermore, the findings support the conclusions of Dogan et al. (2025), whose systematic review found that AI-focused professional development programs significantly enhance teachers' technological, pedagogical, and content knowledge (TPACK), particularly when training activities emphasize authentic classroom applications and reflective practice.

Influence of AI Integration on Learning Outcomes

The findings also indicated that AI integration positively influenced learner engagement, participation, and overall learning performance. Participants reported that AI-supported instructional environments encouraged more active participation and facilitated responsive learning experiences tailored to individual needs.

These results are consistent with the growing body of literature suggesting that AI-enhanced learning environments can promote more personalized, interactive, and learner-centered educational experiences. Cantú-Ortiz et al. (2020) argued that AI has the potential to transform educational systems by supporting adaptive learning processes and increasing learner engagement through intelligent feedback and personalized learning pathways. Similarly, Martin et al. (2024) concluded that AI applications in education contribute to improved learner participation and engagement when integrated within pedagogically meaningful learning activities.

The findings are also supported by Constructivist Learning Theory, which posits that learners actively construct knowledge through interaction, experience, and social engagement. AI-supported learning environments facilitate these processes by providing opportunities for inquiry, collaboration, problem-solving, and immediate feedback. As a result, learners are able to engage more actively in the learning process and develop greater ownership of their learning experiences.

Recent reviews of AI literacy and educational technology further suggest that the educational value of AI lies not merely in automation but in its ability to augment human learning and support learner-centered pedagogies (Yim & Su, 2025; Gu & Ericson, 2025). Therefore, the positive learning outcomes observed in this study may be attributed to the synergistic interaction between AI-supported instructional tools and learner-centered teaching practices rather than to the technology itself.

Implications for Non-Formal Education

Collectively, the findings suggest that enhancing AI literacy among educational personnel requires a comprehensive and sustainable professional development strategy. Although the training program produced significant improvements in awareness and instructional competencies, technology readiness remained at a moderate level, indicating that individual competency development alone may not be sufficient for sustainable AI adoption.

This finding supports recent international evidence emphasizing that successful AI integration requires the alignment of professional development, institutional leadership, technological infrastructure, and policy support (Walter, 2024; Caspari-Sadeghi, 2026). Educational institutions should therefore adopt a systemic approach to AI capacity building that combines continuous professional learning, organizational support mechanisms, and clear institutional policies governing responsible AI use. Such an approach is particularly important in non-formal education settings, where educators often work with diverse learner populations and face varying levels of technological readiness.

New Knowledge from Research

This study contributes to the fields of educational technology, non-formal education, and AI-enhanced pedagogy by providing both empirical evidence and practical insights into how artificial intelligence (AI) can be integrated into instructional management. Rather than focusing only on theoretical potential, the study highlights how AI can be applied in real non-formal education contexts. The key contributions are outlined below:



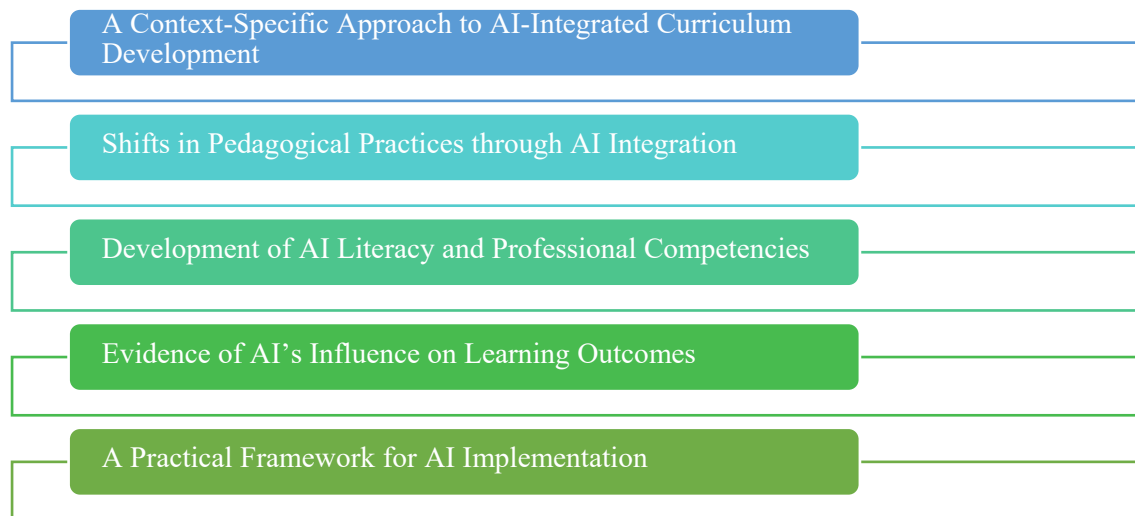


Figure 2 Guidelines for Enhancing Artificial Intelligence Literacy and Professional Competencies of Educational Personnel in Non-Formal Education: A Case Study of Phan Thong Non-Formal Education Center, Chonburi Province

Figure 2 illustrates the approach to developing artificial intelligence (AI) knowledge and professional competence among educational personnel in the non-formal education system: a case study of the Panthong Non-Formal Education Center, Chonburi Province. It comprises: 1. Contextually Appropriate Approaches for Developing AI-Integrated Curricula. This study proposes contextually appropriate approaches for integrating AI into curriculum development within the non-formal education context. The results show that instructors can design more adaptable learning activities, develop AI-supported teaching materials, and use learner data to improve lesson planning. 2. Transforming Teaching Approaches through AI Integration. The study indicates that AI integration involves a gradual shift from teacher-centered teaching to a more interactive and learner-centered approach. In practice, AI tools support strategies such as step-by-step assistance, automated feedback, and flexible content delivery. 3. Developing Understanding of AI and Professional Competencies. This research provides empirical evidence that targeted training can enhance teachers' understanding of AI and professional competencies. Participants demonstrated improved abilities to understand AI concepts, evaluate AI tools, and apply them in teaching contexts. 4. Evidence of the Influence of AI on Learning Outcomes. The research indicates that AI-enhanced learning environments can positively impact learner engagement, participation, and effectiveness. By combining quantitative and qualitative improvements, this research provides a more comprehensive understanding of how AI impacts the learning process. 5. A Practical Framework for AI Implementation. Based on the research findings, this study proposes a practical framework for integrating AI into instructional management. This framework incorporates key elements such as awareness development, hands-on training, reflective practice, and ongoing assessment.

Recommendations

1. Recommendations for Practical Application

1.1 Enhancing AI Awareness and Curriculum Integration

The findings showed that AI integration contributed to improvements in curriculum design and learner engagement. Based on this, educational institutions should focus on developing structured training programs that emphasize the practical use of AI in lesson planning and curriculum development, rather than relying only on theoretical instruction.

1.2 Improving Teaching Methodologies through AI

Since AI-supported approaches were found to enhance instructional effectiveness and promote more learner-centered practices, educators should be encouraged to integrate AI into their teaching.





This can be supported through the provision of appropriate resources, ongoing technical assistance, and instructional coaching.

1.3 Strengthening AI Competencies among Educational Personnel

The study demonstrated clear improvements in AI awareness and skills among participants, suggesting that continued development in this area is both necessary and beneficial. Educational institutions should therefore implement continuous professional development (CPD) programs that focus on AI literacy, hands-on experience, and real classroom application.

2. Recommendations for Future Research

2.1 Investigating Long-Term Impacts

Future research should examine the long-term effects of AI integration on teaching practices, learner outcomes, and the sustainability of educational innovations. Studies conducted over longer periods would provide deeper insight into whether the observed improvements can be maintained over time.

2.2 Exploring Barriers to AI Adoption

Further studies are needed to better understand the challenges associated with AI implementation. These may include technological limitations, ethical concerns, and resistance to change among educators. A clearer understanding of these barriers would help in designing more effective support strategies.

2.3 Comparative Studies of AI Tools

Future research could compare different AI tools and platforms to determine their relative effectiveness across various educational contexts. This would be particularly useful for identifying which tools are most suitable for specific learner groups, including those in non-formal and special education settings.

2.4 Incorporating Learner Perspectives

Finally, future studies should consider learners' perspectives on AI-enhanced education. Understanding how learners experience and respond to AI-supported learning environments would provide a more comprehensive view of its impact and help inform more learner-centered implementation strategies.

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