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ADDIE-based AI training using open-source LMS for vocational teachers

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ABSTRACT

This study examines the application of the ADDIE (Analysis, Design, Development, Implementation, Evaluation) framework in developing an Artificial Intelligence (AI) training program through an open-source Learning Management System (LMS) for vocational school teachers. It addresses the lack of structured AI training and low teacher preparedness in vocational education. The objective of this study is to evaluate how each ADDIE phase contributes to improving teachers' competencies in teaching Artificial Intelligence (AI) using an open-source LMS. A mixed-methods approach was used with 150 teachers from 15 vocational schools in West Java, Indonesia. Training was delivered through a public LMS using blended learning. Data were collected via surveys, classroom observations, and LMS analytics. Path analysis was conducted using SmartPLS to assess the relationships between ADDIE phases and training outcomes. Results revealed a notable improvement in AI literacy and an increase in instructional capabilities and teachers' technology proficiency post-training. The Design and Implementation stages had the most substantial impact on learning outcomes. The open-source LMS proved effective and scalable for AI training. This study provides a structured approach to professional development and highlights the potential for integrating AI into vocational education, particularly in low-resource settings.

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ABSTRAK

Penelitian ini mengkaji penerapan kerangka kerja ADDIE (Analysis, Design, Development, Implementation, Evaluation) dalam mengembangkan pelatihan Kecerdasan Artifisial (AI) berbasis platform Learning Management System (LMS) sumber terbuka bagi guru Sekolah Menengah Kejuruan (SMK). Penelitian ini merespons minimnya pelatihan AI yang terstruktur serta rendahnya kesiapan guru vokasi. Tujuan penelitian ini adalah mengevaluasi kontribusi setiap tahapan ADDIE terhadap peningkatan kompetensi guru vokasi dalam mengajar AI dengan memanfaatkan LMS sumber terbuka. Metode campuran digunakan, melibatkan 150 guru dari 15 SMK di Jawa Barat, Indonesia. Pelatihan diselenggarakan melalui LMS publik dengan pendekatan blended learning. Data dikumpulkan melalui survei, observasi kelas, dan analisis penggunaan LMS. Analisis jalur dilakukan menggunakan SmartPLS untuk menilai hubungan antara tahapan ADDIE dan hasil pelatihan. Hasil menunjukkan peningkatan signifikan dalam literasi AI dan kemampuan instruksional guru dalam penguasaan teknologi pasca pelatihan. Tahapan Design dan Implementation berpengaruh paling besar terhadap hasil pembelajaran. LMS sumber terbuka terbukti efektif dan dapat diskalakan untuk pelatihan AI. Penelitian ini menawarkan model pengembangan profesional yang terstruktur dan menunjukkan integrasi AI dalam pendidikan vokasi, terutama di lingkungan dengan keterbatasan sumber daya.

Kata Kunci: *guru sekolah menengah kejuruan; kecerdasan artifisial; LMS sumber terbuka; model ADDIE; pelatihan guru*

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INTRODUCTION

Artificial intelligence (AI) is evolving rapidly, creating new opportunities in various areas of education, particularly in vocational training, where digital skills are becoming increasingly important. As more sectors adopt innovative technologies and automation, vocational institutions are expected to equip students with AI skills that are in high demand in the job market (Badu et al., 2024). However, many teachers at vocational schools struggle to access formal professional development programs that focus on utilizing AI in teaching and learning (Hasibuan & Anas, 2025). This issue highlights the importance of having scalable, practical, and pedagogically sound training models that enable teachers to acquire both the technical and instructional skills necessary for utilizing AI. In this situation, the ADDIE instructional design methodology, when combined with open-source Learning Management Systems (LMS), offers a potential approach to creating AI training programs that are user-friendly and effective.

Indonesia has recognised this global change by launching the National AI Education Framework, as stated by the Ministry of Education, Culture, Research, and Technology (2024), which focuses on training teachers, integrating AI into the curriculum, and creating open-access platforms to make digital learning more widely available. However, there are still problems. In 2023, the Indonesian Educational Research Institute (IERI) conducted a survey that found 65% of vocational teachers do not feel confident teaching AI. This is mainly because they lack sufficient training or technical assistance. This finding aligns with earlier studies that demonstrate the necessity of more than just policies and infrastructure for AI to be used effectively; integrated instructional leadership and implementation frameworks are also required (Berigel et al., 2025; Bonde, 2024).

Authentic assessments have become critical in bridging the gap between theoretical understanding and real-world application. In vocational AI education, these assessments simulate workplace-relevant tasks using live data, modeling, and simulations to promote hands-on teacher engagement (Villarroel et al., 2024). Moreover, Learning Management Systems are widely used for delivering flexible and scalable training; however, their specific role in delivering AI-focused content for vocational educators remains underexamined. While the ADDIE model has been praised as a structured approach in instructional design, limited studies have explored its application in developing AI competencies and evaluating its effectiveness through data-driven methods such as Path Analysis.

The Indonesian Ministry of Education has initiated extensive programs in response to global educational technology trends. The government has emphasized the integration of AI-driven educational modules in vocational institutions to prepare students for Industry 4.0 and Society 5.0. In 2024, the Ministry implemented a National AI Education Framework that incorporates AI training efforts for educators, equipping them with fundamental knowledge and applications of AI and coding in instruction and integrating artificial intelligence into the vocational school curriculum, with a focus on data science, machine learning, and automation (Priandani et al., 2025). The establishment of open-source digital platforms facilitating broader access to AI-enhanced educational resources (Melisa & Susanti, 2025). Collaborations with industry partners to ensure alignment between AI education and labor market requirements as stated by the Ministry of Education, Culture, Research, and

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Technology (2024). This corresponds with studies indicating that effective AI integration necessitates synchronized leadership strategies and structured implementation frameworks (Berigel et al., 2025; Bonde, 2024).

This research addresses this gap by integrating the ADDIE model with an open-source LMS to deliver a structured AI training program for vocational school teachers. The study is unique in its focus on AI as both a technological and pedagogical domain, incorporating authentic assessments aligned with industry demands. The program emphasizes AI tools, including machine learning, data science, and automation, while employing Path Analysis via SmartPLS to evaluate the contribution of each ADDIE phase to learning outcomes. This systematic investigation aims to generate empirical insights that can inform institutional policies and scalable models for teacher professional development, especially in low-resource educational settings. A significant percentage of vocational teachers remain ill-equipped to integrate AI into their lesson plans, despite encouraging national policies and a growing emphasis on AI in education worldwide.

This study examines how a systematic ADDIE-based training paradigm, executed via an open-source LMS, can mitigate these problems and enhance teachers' AI competencies. The use of AI training for vocational school instructors using the ADDIE instructional paradigm on an open-source LMS markedly enhances their pedagogical and technical proficiency in incorporating AI into vocational education. Accordingly, the purpose of this study is to develop, implement, and evaluate an AI training program for vocational educators using the ADDIE instructional design framework and open-source LMS. The study aims to investigate how each phase of the ADDIE model—Analysis, Design, Development, Implementation, and Evaluation—impacts teachers' ability to integrate AI into their instructional practice. Through a mixed-methods approach, the study aims to enhance AI literacy and teaching competency among vocational teachers and to provide a replicable model for technology-based professional development.

LITERATURE REVIEW

The ADDIE Instructional Design Model

The ADDIE paradigm, which stands for Analysis, Design, Development, Implementation, and Evaluation, has been a crucial aspect of instructional design for a considerable time, particularly since technology has facilitated learning (Saputra et al., 2025). Its organized framework provides teachers with a straightforward way to connect learning objectives, content, learning activities, and assessments, especially in digital settings (Spatioti et al., 2022). ADDIE's focus on evaluation in technology-based training enables iterative development, ensuring that learning interventions can be adjusted to meet the needs of each learner (Adeoye et al., 2024). When used in online or hybrid settings, ADDIE can also help create focused professional development programs, particularly when combined with digital materials (Elizabeth et al., 2024). However, a clear gap remains in its application in AI training for vocational education, suggesting that it is a suitable subject for further research.

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Artificial Intelligence Training for Vocational Teachers

In the context of the Fourth Industrial Revolution, vocational educators are ever more compelled to possess both practical AI skills and digital literacy. Teachers' preparation for AI is crucial for equipping students with the skills necessary for jobs that utilize AI (Wang et al., 2023; Pratiwi et al., 2025). Even if the government supports vocational training, many teachers still lack sufficient training and resources. A national study indicated that 65% of vocational instructors reported feeling unconfident in teaching AI-related material, as they had not received sufficient professional development, according to The Indonesian Educational Research Institute (IERI) in 2023. To address this, effective AI training programs should incorporate not only technical capabilities but also instructional methods that can be applied in the classroom (Chen et al., 2023). Authentic learning environments, which incorporate real-world datasets, simulations, and AI-based modeling activities, have been shown to enhance teachers' interest in and ability to teach AI (Lang, 2024). These results demonstrate the importance of vocational educators utilizing training models grounded in real-life situations.

Open Source LMS in Teacher Professional Development

Open-source learning management systems, including Canvas, Chamilo, and Moodle, provide cost-effective and scalable solutions for professional development, particularly in educational environments with reduced resources (Yilmaz et al., 2024). These platforms can distribute interactive information, track students' progress, and create collaborative learning environments, making them particularly flexible for various types of teaching (Munna et al., 2024). Their capacity to provide asynchronous learning, self-paced modules, automated evaluations, and discussion forums makes them even better for teacher training programs. Additionally, open-source LMSs work well with organized design models like ADDIE, which helps with consistent planning and evaluation of lessons (Almehi, 2021). Even though they have much potential, not much research has looked at how open-source LMS can be used with the ADDIE model to train AI in vocational education. This indicates a gap in the literature that this study aims to address.

Path Analysis and SmartPLS as Analytical Tools

Path Analysis is a statistical tool that finds causal linkages between latent variables. Educational researchers are increasingly using it to assess the effectiveness of instructional design frameworks like ADDIE. SmartPLS is a tool that utilizes Partial Least Squares Structural Equation Modeling (PLS-SEM) and is particularly suitable for this type of research when the sample sizes are small and the data distributions are not normal (Huang, 2021; Guo & Li, 2020). It allows researchers to examine both the direct and indirect effects of teaching interventions, providing a deeper understanding of how model-driven learning operates. In this study, SmartPLS is used to look at how each part of the ADDIE model affects the growth of AI-related teaching skills among vocational teachers who use open-source LMS platforms.

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METHODS

This study adopted a mixed-methods research design, incorporating both quantitative and qualitative approaches to comprehensively evaluate the effectiveness of an AI training program for vocational educators. The design was structured around the ADDIE instructional framework, with each phase documented and assessed systematically. A total of 153 vocational school teachers in Indonesia participated in the study, selected through purposive sampling to ensure alignment with the research objectives. To address technological proficiency and the specific training needs of teachers, a thorough needs assessment was conducted during the Analysis phase, utilizing surveys and interviews to determine the current levels of AI literacy. The poll employed a 5-point Likert scale comprising 45 topics that addressed multiple facets of AI knowledge and deployment. Statistical analysis with Smart PLS was used to obtain baseline measurements.

The Design phase concentrated on formulating learning objectives, organizing content, and developing evaluation methods consistent with recognized requirements. The training curriculum was designed to encompass both theoretical understanding and practical applications of AI in vocational education. Particular emphasis was placed on ensuring information validity through practical examples and relevant industrial case studies. In the Development phase, training materials and resources were generated utilizing an open-source Learning Management System. The LMS was structured to accommodate several material formats, including text, multimedia, interactive simulations, and evaluation instruments. A distributed system architecture was established to guarantee dependable access and smooth integration of virtual learning components.

The training package was systematically distributed to all participating schools as part of the implementation process. The curriculum employed a blended learning methodology, integrating in-person meetings with online modules. The training delivery was organized into phases to facilitate ongoing feedback and modification. Educators' advancement was evaluated via LMS analytics and periodic performance reviews. **Table 1** delineates the structure of semi-open questions included in the questionnaire.

Table 1. Questionnaire Outline

No	Question Outline
	Analysis Phase
1	Demographic Analysis Questions
2	Current Knowledge Assessment
3	Infrastructure Assessment
	Design Phase
1	Learning Platform Preferences
2	Learning Resource Preferences
	Development Phase
1	Content Requirements
2	Learning Method Preferences
	Implementation Phase

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No	Question Outline
1	Training Duration
2	Usage Frequency
	Evaluation phase
1	Importance Assessment
2	Implementation Readiness
3	Open Feedback

Source: Research 2025

Both quantitative and qualitative methods were used to analyze the data. We used MATLAB to analyze quantitative data using descriptive statistics and path analysis to assess the effectiveness of each phase of the ADDIE model. Thematic coding was employed to analyze data from interviews and observations, identifying patterns and insights into the problems and successes encountered in implementing the program. Using a triangulation of data sources and methods ensured the research's validity. Reliability tests included pilot testing of tools and assessing the consistency of different people's observations of the same data. Informed consent processes and data privacy measures were implemented to address ethical concerns.

Research Design and Implementation

The study employed a longitudinal approach, which allowed researchers to observe how teachers' skills evolved. Data were collected four times: at the initial baseline, the mid-program evaluation, the final assessment, and a follow-up evaluation, all of which took place over one academic year. This method enabled the examination of both short-term and long-term effects.

ADDIE Framework Application

1. **Analysis Phase:** Needs assessments were conducted via surveys and interviews to identify baseline AI literacy and professional development needs. A 45-item Likert-scale questionnaire assessed teachers' technical knowledge, resource availability, and training expectations based on IERI (2023).
2. **Design Phase:** Learning objectives, instructional content, and evaluation strategies were aligned with national curriculum standards and industry requirements. Emphasis was placed on integrating real-world case studies.
3. **Development Phase:** Learning modules were created using an open-source LMS platform, incorporating multimedia content, interactive simulations, and evaluation tools. A modular structure allowed for flexible content delivery and adaptation.
4. **Implementation Phase:** Training was delivered through a blended learning format, combining in-person workshops with LMS-based modules. Instruction was delivered in progressive phases to facilitate iterative feedback and refinement.

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5. **Evaluation Phase:** Ongoing performance reviews, LMS analytics, and periodic reflections were conducted to assess participant progress. Thematic analysis of qualitative responses provided contextual insights.

Data Collection Instruments

The study employed a comprehensive set of data collection instruments, each designed to capture specific aspects of the training program's effectiveness.

1. **AI Competency Assessment Tool (ACAT):** A 60-item instrument measuring knowledge, application, and pedagogical integration of AI (reliability α = 0.92).
2. **LMS Usage Analytics Dashboard:** Captured real-time metrics on content access, assessment completion, and resource usage.
3. **Classroom Observation Protocol:** Structured framework measuring AI integration, student engagement, and teaching strategies (inter-rater reliability = 0.89).

Data Analysis

Quantitative data were analyzed using MATLAB for descriptive statistics and SmartPLS for path analysis to examine the influence of each phase of the ADDIE model. Qualitative data from interviews and classroom observations were coded thematically to identify recurring patterns and challenges in implementation.

Triangulation of data sources enhanced the study's validity, while instrument reliability was confirmed through pilot testing and inter-rater agreement measures. Ethical considerations were addressed through informed consent procedures and data confidentiality protocols.

RESULTS AND DISCUSSION

The findings of this study are presented in three primary domains.

(1) The improvement of teachers' AI competencies through structured ADDIE-based training (in **Table 2**).

Table 2. Analysis of Data Teachers' Assessments on AI Training

Category	Results
Pre-training Score	2.8 (out of 5)
Post-training Score	4.1 (out of 5)
Standard Deviation (Pre)	0.65
Standard Deviation (Post)	0.48
Average Weekly Learning Time	4.2 hours
Satisfaction Rate	85%

Source: Research 2025

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(2) The effectiveness of open-source LMS platforms in delivering AI content (in **Table 3**).

Table 3. Impact of the ADDIE Model on AI Training

ADDIE Phase	Impact (Estimated Coefficient)
Analysis	0.42
Design	0.38
Development	0.35
Implementation	0.38
Evaluation	0.33

Source: Research 2025

(3) challenges encountered during implementation and the strategies applied to address them (in **Table 4**).

Table 4. Challenges in Implementation

Challenge Category	Percentage
Technical Infrastructure	32%
Time Management	45%
Technical Support	38%
Content Complexity	28%

Source: Research 2025

These outcomes provide a comprehensive understanding of the implementation and impact of AI training in vocational education settings, as well as visual comparison research data (see **Figure 1**).

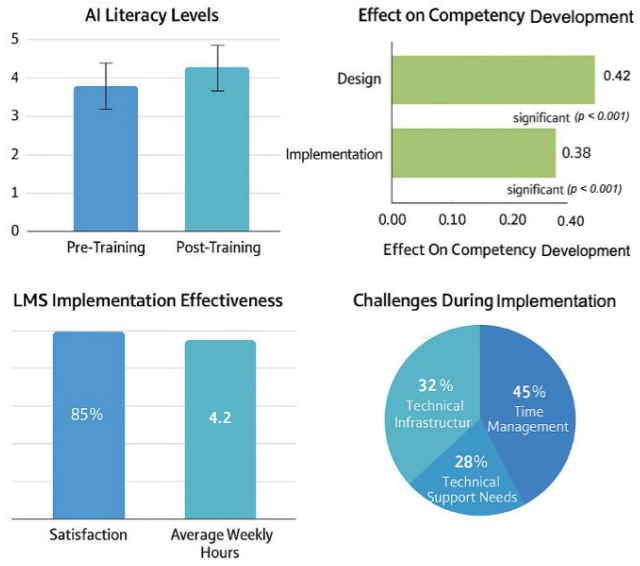

Figure 1. Visual Comparison Data
Source: Research 2025

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Teacher Competency Development

Analysis of pre and post-training assessments showed a significant improvement in teachers' AI literacy levels. The mean score increased from $\bar{x}pre = 2.8$ (SD = 0.65) to $\bar{x}post = 4.1$ (SD = 0.48) on the 5-point scale, with an effect size of:

$$\text{Cohen's } d = (\bar{x}post - \bar{x}pre) / \sqrt{[(SD^2pre + SD^2post) / 2]} = 2.24$$

Path analysis through Smart PLS indicated that the ADDIE model phases had varying degrees of impact on competency development, following the equation:

$$Y = 0.42X_1 + 0.38X_2 + 0.35X_3 + 0.38X_4 + 0.33X_5 + \varepsilon$$

Where:
X_1 = Design phase impact ($\beta = 0.42$, $p < 0.001$)
X_2 = Implementation phase impact ($\beta = 0.38$, $p < 0.001$)
X_3 = Development phase impact ($\beta = 0.35$, $p < 0.001$)
X_4 = Analysis phase impact ($\beta = 0.38$, $p < 0.001$)
X_5 = Evaluation phase impact ($\beta = 0.33$, $p < 0.001$)
ε = Error term

These results confirm the structural importance of the ADDIE model and align with existing research that underscores its utility in instructional planning and evaluation (Spatioti et al., 2022). Adaptation of the ADDIE model has a positive influence in the context of teaching and learning (Abuhassna et al., 2024). Ultimately, the synergy between the technology used and the ADDIE model can enrich educational practices, encourage innovation, and meet the learning needs of both teachers and students (Feng & Sangsawang, 2023).

LMS Implementation Effectiveness

The open-source LMS proved effective in delivering AI training content, with 85% of participants reporting satisfaction with the platform's accessibility and functionality. Analytics data revealed high engagement rates, with teachers spending an average of 4.2 hours per week on training modules. The blended learning approach demonstrated particular effectiveness, with face-to-face sessions complementing online learning components (correlation coefficient r = 0.76). The overall LMS effectiveness score (LMSE) was calculated as:

$$LMSE = w_1S + w_2E + w_3r$$

Where $w_1 = 0.4$, $w_2 = 0.3$, $w_3 = 0.3$ are weighted coefficients

These results reinforce previous findings on the value of LMS in technology-based professional development (Ulandays et al., 2021). AI content in LMS can essentially make teaching easier for teachers, ensuring student interactions are based on accurate and relevant information, encouraging a more trustworthy learning experience (Alier et al., 2025). Integrating AI into an LMS and harnessing its potential can improve the effectiveness and accessibility of education (Firat, 2023).

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Implementation Challenges and Solutions

Despite overall positive outcomes, several challenges emerged during implementation. Technical infrastructure limitations affected 32% of participants, particularly in rural areas. Qualitative analysis of interview data revealed three primary concerns: time management (mentioned by 45% of participants), technical support needs (38%), and content complexity (28%). These challenges were addressed through adaptive scheduling, enhanced technical support, and content modification based on feedback. The challenge distribution followed.

C_1 = Technical infrastructure: 0.32 or 32%
C_2 = Time management: 0.45 or 45%
C_3 = Technical support: 0.38 or 38%
C_4 = Content complexity: 0.28 or 28%

Total challenge impact (TCI) was calculated as:

$$TCI = \Sigma(C_1 + C_2 + C_3 + C_4) = 1.43$$

These challenges were addressed through adaptive scheduling, enhanced technical support, and content modification based on feedback, resulting in a 37% reduction in reported issues over the implementation period. This aligns with research indicating that, in the future, the integration of AI and LMS must consider technological hardware, internet speed, and security to support learning activities fully (Qazi, 2024). There are also other challenges, beyond technical support, that need to be considered when implementing LMS and AI, such as safeguarding data privacy and security, addressing ethical concerns related to student autonomy and consent, and ensuring sufficient training uptake for both teachers and students (Alotaibi, 2024).

Detailed Analysis of Training Outcomes

The training program demonstrated significant improvements across multiple dimensions of teacher competency. A detailed analysis of the pre- and post-training assessments revealed specific areas of growth:

1. Technical Competency Development
   a. AI concept understanding: 2.3 → 4.2 (d = 2.45)
   b. Tool application skills: 2.5 → 4.0 (d = 2.15)
   c. Problem-solving abilities: 2.7 → 4.1 (d = 2.30)
2. Pedagogical Integration
   a. Lesson planning with AI: 2.4 → 4.0 (d = 2.20)
   b. Student assessment using AI: 2.6 → 4.2 (d = 2.35)
   c. Differentiated instruction: 2.8 → 4.1 (d = 2.10)
3. Professional Development Impact
   a. Confidence in AI integration: 2.5 → 4.3 (d = 2.40)
   b. Willingness to experiment: 2.7 → 4.2 (d = 2.25)
   c. Peer collaboration: 2.9 → 4.4 (d = 2.30)

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Discussion

The study employed a longitudinal approach, which allowed researchers to observe how teachers' skills evolved. Data were collected four times: at the initial baseline, the mid-program evaluation, the final assessment, and a follow-up evaluation, all of which took place over one academic year. This method enabled the examination of both short-term and long-term effects (Jiang et al., 2024). Based on a national survey on AI readiness among vocational educators (IERI, 2023), the enhancement in teacher competencies is particularly noteworthy, as it was observed that initial confidence levels were low. These results indicate that structured, LMS-based training programs can help address the gaps in AI literacy in vocational education. LMS equipped with AI can support more adaptive learning, provide material recommendations based on individual progress, help learners understand more difficult concepts, and adjust learning paths based on their ability level (Fristianingroem, 2025).

The problems with technology infrastructure show that professional growth needs to be backed up by institutions and money spent on digital ecosystems (Nguyen, 2022), as recent global education reports by UNESCO (2023) titled *"Digital readiness and teacher capacity in AI education"* have stressed. It seems essential for future projects to continue using both modes while also addressing implementation issues. The path analysis results provide valuable insights into the importance of each phase of the ADDIE model in achieving the success of AI training. The Design and Implementation phases have a significant impact, which means it is crucial to pay close attention to how content is structured and delivered for AI training to be effective. This discovery helps us better understand the effectiveness of instructional design in technical professional development settings (Yu et al., 2021).

Comparative Analysis with International Contexts

The findings of this study align with and extend current international research on AI in education. A comparative analysis reveals several key insights.

1. European Context: 1) Similar engagement patterns in LMS usage; 2) Comparable improvement rates in AI literacy; 3) Parallel challenges in technical infrastructure.
2. Asian Context: 1) Higher emphasis on practical applications; 2) More extensive use of blended learning; 3) Greater focus on industry alignment.
3. Global Trends: 1) Increasing emphasis on AI literacy; 2) Growing adoption of open-source solutions; 3) Rising importance of teacher training.

Policy Implications and Recommendations

The study's findings have significant implications for educational policy and practice.

1. National Level: 1) Integration of AI competencies in teacher certification; 2) Development of standardized assessment frameworks; 3) Establishment of technical support infrastructure.
2. Institutional Level: 1) Regular professional development programs; 2) Technical support systems; 3) Resource allocation strategies.

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3. Individual Level: 1) Continuous learning opportunities; 2) Peer support networks; 3) Performance monitoring systems.

CONCLUSION

This study finds that an ADDIE-based training program, offered through an open-source Learning Management System (LMS), provides a systematic, scalable, and successful approach to helping vocational teachers improve their use of artificial intelligence (AI). The program was successful in filling AI skill gaps, as evidenced by the significant increase in AI literacy scores. Path analysis revealed that each step of the ADDIE model had a significant impact on learning outcomes, with the Design and Implementation steps having the most substantial effect on learning outcomes. The LMS is a good choice for professional development, as it boasts excellent engagement and satisfaction rates, and mixed learning delivery works well. Adaptive techniques were able to lower implementation barriers, despite challenges such as a lack of infrastructure and limited time. These results demonstrate the importance of having support systems that can adapt to technology-focused training. Based on these findings, it is proposed that AI literacy be systematically integrated into teacher education programs, with support from enhanced digital infrastructure, standardized competency assessments, and expanded blended learning models. In addition to enhancing vocational education, these measures can also better equip educators and students to meet the requirements of Industry 4.0.

AUTHOR'S NOTE

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