JPPIPA 11(11) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Development of an Artificial Intelligence (AI) Based MOOCs Learning Model to Enhance Digital Literacy

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Received: August 25, 2025
Revised: October 06, 2025
Accepted: November 25, 2025
Published: November 30, 2025

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DOI: 10.29303/jppipa.v11i11.12952

Abstract: This study develops and implements a novel Artificial Intelligence (AI)-based MOOCs learning model specifically designed to enhance students' digital literacy in higher education. Unlike previous studies that focused mainly on content delivery or platform usability, this research integrates adaptive AI algorithms and personalized feedback features into MOOCs to foster more effective and measurable digital literacy development. Using a Research and Development (R&D) approach, the process comprised needs analysis, planning, prototype design, field trials, revisions, and dissemination. The research involved 135 students. Data were collected through observations, questionnaires, interviews, and documentation, and analyzed using both quantitative and qualitative methods. The findings reveal that the AI-based MOOCs model significantly improved students' digital literacy across all testing phases, with consistent gains shown by the 135 participating students. User feedback confirmed that the model is efficient, adaptive, and practical for classroom application. Furthermore, dissemination activities received a positive response from institutions, lecturers, and students, highlighting its potential for wider adoption. The study concludes that the proposed AI-enhanced MOOCs model provides a scalable and sustainable framework for strengthening digital literacy in higher education, offering empirical evidence for its broader institutional adoption.

Keywords: Artificial Intelligent; Digital Literacy; Massive Open Online Course (MOOCs).

Introduction

The advancement of digital technology has significantly influenced various aspects of life, including education (Ploj Virtič, 2022). In Indonesia, universities are expected not only to adopt digital-based learning systems (Watrianthos et al., 2025). but also to ensure that students develop sufficient digital literacy skills (Oktavia et al., 2024). Digital literacy has become a crucial competency for achieving academic success, preparing for professional careers, and participating actively in the digital society (Supriyadi et al., 2024). Nonetheless, research indicates that the digital literacy level of Indonesian students is still categorized as moderate, and in certain areas such as digital security, critical evaluation of online information, and digital ethics, it remains relatively low (Zuhri et al., 2024).

The digital literacy challenges faced by students at Universitas PGRI Argopuro Jember lie in their limited ability to access, evaluate, and effectively utilize digital information in academic activities. Students tend to remain passive and consumptive toward technology, relying mainly on basic functions such as browsing or social media, without adequate critical and collaborative thinking skills in digital contexts (Gita et

How to Cite:
Kustiyowati, K., Gita, R. S. D., Permatasari, A. D. A., & Gunawan, I. Z. B. (2025). Development of an Artificial Intelligence (AI) Based MOOCs Learning Model to Enhance Digital Literacy. *Jurnal Penelitian Pendidikan IPA*, *11*(11), 1207–1220. https://doi.org/10.29303/jppipa.v11i11.12952

al., 2023). This situation presents a serious challenge in preparing a generation capable of competing in the era of the Industrial Revolution 4.0 and Society 5.0 (Panggabean et al., 2021). Massive Open Online Courses (MOOCs) represent one of the open learning innovations that have the potential to expand access to higher education in a broad, flexible, and efficient manner (Isma et al., 2024). Strengthening students' digital literacy through the use of MOOCs can encourage them to actively search for, evaluate, and manage digital information in the learning process.

This platform enables students to learn independently and collaboratively using technology while also fostering advanced digital skills such as content creation and participation in discussions. MOOCs can serve as an effective medium for enhancing students' digital literacy through self-directed, collaborative, and technology based online learning experiences (Edumadze & Govender, 2024). However, in practice, MOOCs in Indonesia have not yet achieved full effectiveness, as they remain largely one directional and lack interactivity (Kuncoro & Yugopuspito, 2022). In addition, MOOCs have not yet been able to accommodate the individual learning needs of students (Le, 2025). It remains limited in accommodating students' personalized learning requirements. (Aprilia, 2024). To address this challenge, a new approach is required in the development of MOOCs, one of which is the integration of Artificial Intelligence (AI) (Delgado et al, 2024). AI technology has the capacity to personalize learning and provide automated feedback (Delfianza et al., 2023). Furthermore, AI can analyze students' learning patterns to deliver more adaptive and effective learning experiences (Pujawan et al., 2022).

The integration of AI into MOOCs not only enhances the quality of learning but also accelerates the comprehensive development of digital literacy (Guntur et al, 2025). Digital literacy is one of the essential twenty-first century competencies that students must possess in order to confront the challenges of the Industrial Revolution 4.0 and Society 5.0 (Eliaumra et al., 2024). The rapid advancement of information and communication technology has positioned Indonesia as the largest digital economy market in Southeast Asia (Gultom et al., 2021). This is evidenced by the internet penetration rate in Indonesia, which has reached 73.3%, indicating that 144,191,413 of the country's 196,714,070 citizens have internet access (Miten et al., 2025). Nevertheless, data from the Ministry of Communication and Information (Kominfo) reveal that Indonesia's digital literacy index remains at a moderate level, with a score of 3.49 on a five point scale (Handri et al., 2023). Furthermore, a study conducted by APJII (2022) highlights that despite the high level of internet penetration, students' critical and ethical abilities in utilizing technology are still limited (Fatah et al., 2025).

Based on the discussion above, this study is considered both urgent and strategic, as it seeks to develop an AI-based MOOC learning model designed to enhance students' digital literacy in a holistic manner, encompassing cognitive, technical, and ethical dimensions (Aji et al., 2025)). In addition, this research aligns with the digital transformation policy of higher education, consistent with the Independent Learning Independent Campus (MBKM) program and national priorities in strengthening technology-oriented human resources (Amalia et al., 2024). Therefore, a significant contribution in addressing the challenges of digital education in Indonesia, strengthening students' digital literacy capacity, and supporting the achievement of higher education Key Performance Indicators (IKU).

This study sharpens its focus by clearly articulating the novelty it brings to the field: the development of an AI-based MOOCs learning model specifically designed to cultivate digital literacy skills in a scalable, adaptive, and data-driven manner. While existing research has explored either MOOCs or AI-enhanced learning separately, few have integrated both into a cohesive instructional design that systematically targets digital literacy competencies needed in today's technology-driven societies. This research is crucial because the rapid expansion of digital ecosystems demands learners who can navigate information critically, use digital tools effectively, and participate safely in online environments. Without an innovative model that leverages AI's ability to personalize learning pathways and provide continuous feedback at scale, many learners especially those in underserved or remote areas risk being left behind. Therefore, this study not only addresses a significant educational gap but also contributes a forward-looking solution aligned with global digital transformation demands.

Method

This study employed a Research and Development (R&D) approach, adopting the development model proposed by Borg and Gall (1983). The stages of this model consist of Need Assessment, Planning, Early Product Development, First Field Testing, Revision of the Initial Product, Main Field Testing, Product Revision, Operational Field Testing, Final Product Revision, and Dissemination and Implementation. A visual representation of the development model is presented in the corresponding figure (Figure 1).

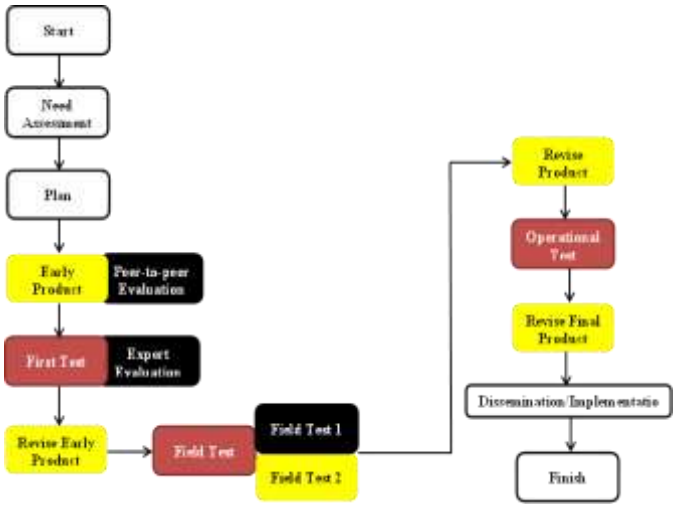

Figure 1. Schematic Representation of the Development Model

Figure 1 presents a detailed outline of the Borg and Gall research and development model, which can be described as follows:

Need Assessment, This stage involved a literature review on digital literacy, MOOCs, and the integration of AI in education. In addition, a preliminary study was conducted through interviews, observations, or questionnaires to explore the needs and characteristics of students at Universitas PGRI Argopuro Jember in relation to digital learning.

Planning, The planning of the learning model development was carried out based on the results of the needs analysis. At this stage, the researchers formulated the development objectives, specified the design of the AI-based MOOC model, and outlined the production stages as well as the evaluation plan.

Early Product Development, At this stage, an initial prototype of the learning model was designed, consisting of specific MOOCs syntax, integrated AI features, and supporting content aimed at enhancing digital literacy.

First Field Testing, A limited trial was conducted with a small group of students to examine the initial effectiveness of the model and to collect feedback. Data were gathered through observations and questionnaires.

Revise Early Product, Based on the results of the initial trial, revisions were made to the design of the model and the AI-based MOOC features in order to improve effectiveness and ensure alignment with students' needs.

Main Field Testing, The product was tested on a larger scale with a greater number of student participants from Universitas PGRI Argopuro Jember. This stage aimed to measure the effectiveness of the model in enhancing digital literacy with greater validity.

Revise Product, Based on the findings of the main field testing, final revisions were made to the product to ensure its readiness for broader implementation. The revisions were guided by the evaluation results concerning effectiveness, efficiency, and user feedback.

Operational Field Testing, The trial was conducted in a real classroom setting to observe how the product functioned under actual learning conditions. The data obtained from this stage were utilized for the final validation of the developed learning model.

Revise Final Product, Based on the results of the operational testing, final improvements were made to the product to ensure its quality, the accuracy of AI functions, and its effectiveness in enhancing digital literacy.

MOOCs based AI which was developed was then validated by 2 media expert and 2 material expert. Qualitative data in the form of comments and suggestions will be analyzed descriptively, while quantitative data in the form of scores obtained from the validation sheet will be converted into percent by using the following calculation formula. Data in the form of percentages will be used to determine the validity level MOOCs based AI by interpreting the percentage results based on Table 1.

Table 1. Validity Test Criteria

Interval Score (%)	Category
0-20	Very Less
21-40	Less
41-60	Fair
61-80	Valid
81-100	Very Valid

Source: (Gita et al., 2024)

MOOCs based AI it can be said to be effective if it is able to measure and rank digital literacy skills into three categories namely low, medium and high. The data analysis technique used is in the form of descriptive analysis and calculating the percentage of each category of digital literacy skills.

Table 2. Categories of Digital Literacy Skills

Interval	Category
66,6% < P ≤ 100%	Height
33,3% < P ≤ 66,6%	Middle
0% < P ≤ 33,3%	Low

Source: (Kurniawan et al., 2023)

Result and Discussion

Based on the research conducted, the findings obtained through the Borg and Gall (1983) development model, which consists of the stages of Need

Assessment, Planning, Early Product Development, First Field Testing, Revision of the Initial Product, Main Field Testing, Product Revision, Operational Field Testing, Final Product Revision, and Dissemination and Implementation, are presented. The results and discussion of the study are described as follows.

Need Assessment

Table 3. Findings from the Needs Assessment

Aspect	Data Source	Findings/Student Needs
Students' Digital Literacy Level	Questionnaire and Observation	Most students possess basic digital literacy but are not yet able to manage digital information critically and ethically.
Online Learning Experience	Interview and Questionnaire	Students have participated in online classes but perceived the learning as less interactive and monotonous.
Technological Readiness and Internet Access	Questionnaire and Observation	The majority of students own devices (smartphones/laptops, but internet quality varies.
21st Century Competency Needs	Literature Review and Questionnaire	Students need improvement in critical thinking, collaboration, and digital-based problem solving.

The results of the needs analysis indicate that students at Universitas PGRI Argopuro Jember have access to digital devices and internet connectivity; however, the utilization of these resources for independent and sustainable digital learning remains suboptimal. This finding is consistent with Nugroho et al. (2021), who reported that most students in regional universities are still at the stage of using technology primarily for basic purposes such as information searching, rather than integrating it into critical learning practices. Furthermore, data obtained from interviews and questionnaires revealed that students often experience difficulties in distinguishing valid information, maintaining digital ethics, and understanding cybersecurity, all of which represent essential dimensions of digital literacy (Sucilestari et al., 2025).

On the other hand, the rapid advancement of AI-based learning technologies and MOOCs offers significant opportunities to enhance the quality of digital learning, provided that they are designed in accordance with learners' needs and characteristics (Setyoko et al., 2023). Students' digital literacy can be substantially improved through AI-supported MOOC models that incorporate personalized features, such as content recommendation systems and automated feedback (Yuliana et al., 2023). Aini and Septiani (2020) further emphasize that digital learning personalization using AI not only increases student engagement but also fosters the development of critical, evaluative, and ethical thinking skills. Therefore, the development of such a model is highly relevant to the needs of students in the current era of digital transformation.

Planning

The planning stage of this learning model development was carried out based on the results of the needs analysis regarding students' demand for adaptive and technology-based digital learning (Amalia et al., 2024). At this stage, the researchers formulated development objectives focusing on the enhancement of digital literacy through MOOCs personalized with Artificial Intelligence (AI) technology (Handri et al., 2023). The planning also included defining the model specifications, which integrated AI features such as content recommendation systems, automated assessment, and chatbots as virtual tutors (Karakose et al., 2023). In line with previous findings, the design of MOOCs supported by AI is believed to foster a flexible learning experience that is responsive to individual needs (Siemon, 2022).

Table 4. Findings from the Development Planning Stage

Planning Component	Description
Development Objectives	- To produce an AI-based MOOC learning model capable of improving students' digital literacy - To provide an adaptive and personalized online learning platform that supports independent learning.
Specifications of the AI-Based MOOC Model	- Model Name: AI-MOOCs for Digital Literacy (AIM-DL) -Characteristics: • Modular and open access • Adaptive to students' learning needs through AI technology • Provides self-directed learning through videos, simulations, and interactive exercises • Equipped with chatbot features and AI-driven intelligent recommendations - Approach: Problem-Based Learning (PBL) and Connectivism
Model Components	1. Learning Objectives 2. Digital Literacy Content

Planning Component	Description
	3. Media and AI Technologies (chatbot, adaptive system) 4. Learning Strategies (PBL + MOOCs) 5. AI-based Learning Evaluation
Model Production Plan	- Content Development: Preparation of digital literacy modules tailored to students' needs - Platform Design: Developing MOOCs with a user-friendly and lightweight interface - AI Integration: Incorporating personalization features and automated feedback through AI - Expert Validation: Content, design, and feasibility review by experts in education, technology, and AI
Model Evaluation Plan	- Formative Evaluation: • Expert review (AI, education, and IT specialists) • Limited trials • Revisions based on feedback - Summative Evaluation: • Effectiveness testing of the model in improving digital literacy • Feedback from students and lecturers • Measurement of user satisfaction and acceptance

In addition to establishing the technical specifications, the planning stage also outlined the product development flow, beginning with the creation of an initial prototype, limited trials, revisions based on feedback, and final validation in real learning settings. The evaluation framework at this stage was systematically designed to assess the effectiveness, efficiency, and user acceptance of the developed model (Wang et al., 2024). This step is crucial to ensure that the development of MOOCs does not merely rely on technological aspects but also takes into account the learning context of Indonesian students, particularly considering their varied levels of digital literacy (Algarra et al., 2024). With careful planning, the model is expected to make a tangible contribution to the transformation of digital learning in higher education.

Early Product

Table 5. Learning Syntax of AI-Integrated MOOCs

Learning Stage	Activity Description
Orientation and Activation	Students access the MOOC platform and participate in an introduction to the digital literacy module. The system identifies students' initial learning profiles
Independent Exploration of Digital Resources	Students study materials (videos, texts, infographics) and explore the provided digital resources.
Online Discussion and Collaboration	Students engage in discussion forums, collaborative tasks, and the exchange of digital experiences.
Reflection and Concept Reinforcement	Students complete interactive exercises, reflective quizzes, and digital literacy case studies.
Mini Project (Project-Based Task)	Students work on a final project such as an educational video, infographic, or blog on digital literacy issues.
Evaluation and Further Learning Recommendations	Students complete a final evaluation and receive their digital literacy achievement results.

Figure 2. MOOCs UNIPAR Homepage

The homepage of MOOCs UNIPAR displays the title Massive Open Online Courses (MOOCs) along with a description that online learning can be accessed flexibly to support students' careers and portfolios. The main menu includes International Class, Live Class, Articles, and Dashboard. The highlighted features are learning from anywhere, learning from others, learning from the best, learning by doing, learning based on needs, and certification.

Figure 3. Selected Courses on MOOCs UNIPAR and AI Chatbot Feature

The platform shows a selection of available courses, such as Basic Concepts of Distance Learning, Development of Distance Education, Functions & Purposes of Distance Learning, and Theories of Distance Learning. Each course is equipped with an illustrative image, the instructor's name, and a short description, supporting students' digital literacy development. An interactive AI Chatbot is available on the right side of the page. The chatbot can answer students' questions about MOOCs, for example, explaining that MOOCs stand for Massive Open Online Courses. The presence of this AI feature represents the implementation of artificial intelligence to assist students in quickly accessing information, improving digital literacy, and supporting self-directed learning.

Figure 4. Student Dashboard-Enrolled Courses

The Dashboard displays the list of courses that students have enrolled in. One active course, Development of Distance Education, is shown with a progress bar (0% completion) and a Start Learning button. This feature demonstrates the system's ability to monitor students' learning progress in real time.

The platform included a structured learning syntax consisting of digital orientation, independent exploration, AI supported interaction, data driven reflection, and adaptive evaluation (Cichocki & Kuleshov, 2021). This structure was intended to cultivate students' critical, evaluative, and collaborative thinking skills within a personalized digital learning environment (Linda et al., 2024). Furthermore, the model applied a competency based learning approach that aligned content and learning tasks with the individual progress of students (Jamebozorg et al., 2022).

In addition to the learning syntax, the prototype integrated key AI features such as a performance based recommendation system, a tutoring chatbot for learning support, and a digital literacy monitoring dashboard (Yelubay et al., 2022). These features were developed using basic algorithms including decision trees and natural language processing to enable interactive communication between students and the system (Смагулова, 2024). With regard to content development, the prototype provided materials that promote digital literacy, including cybersecurity, the application of AI in daily activities, and digital ethics (Fernández-Otoya et al., 2025). Although the product remained at the prototype stage and was not yet fully embedded in the MOOC platform, its core functions were tested through expert validation to ensure alignment between the initial design and the objectives of enhancing students' digital literacy (Moloo et al., 2025).

Validation Test

Table 6. Validation Results *Digital Assessment* based *Moodle*

Assessment Aspects	Validator V1	V2	V3	V4
Development Aspect	5	3	5	5
Display Aspect	5	5	4	4
Content Qualifying Aspects	4	4	4	5
Linguistic Aspect	5	5	4	4
Aspects of Functions and Benefits	4	5	4	4
Result (%)	92%	88%	84%	88%
Validity Category	Very Valid	Very Valid	Very Valid	Very Valid

In addition to expert validation, the trial results with students showed a significant increase in digital literacy scores after using the AI-MOOC learning model. This increase aligns with the findings of Fernández-Otoya et al. (2025), who demonstrated that MOOCs based on the flipped classroom approach consistently improved teachers' information literacy and digital skills. These results indicate that the content validated by media and material experts produced a tangible impact on students' abilities.

Expert validation contributed to the development of a learning product that was relevant, engaging, and aligned with student needs, thereby maximizing the potential of digital learning. These findings also reveal that media design and content accuracy function as catalysts for the success of MOOC-based learning. User-friendly design, consistent visuals, and accurate content tailored to students' levels created a positive and inclusive learning experience.

This supports the view of Moloo et al. (2025) that audio-based and adaptive MOOCs can expand access to education for previously underserved groups. Thus, the integration of technical and pedagogical aspects not

only improved learning outcomes but also broadened students' access and engagement in online learning. This success strengthens the position of MOOCs as a flexible and sustainable learning solution, echoing Rulinawaty et al. (2023), who highlighted the flexibility and adaptability of MOOCs during periods of remote learning.

Furthermore, the implications of this research suggest that the validated and tested AI-MOOC learning model has strong potential for wider adoption in higher education. Lin (2025) emphasized the variation in MOOC instructors' digital competencies, underscoring the importance of institutional support and training to ensure effective implementation. Likewise, Yelubay et al. (2022) confirmed that MOOCs contribute to developing future teachers' digital competence through four key components (motivation, technology, cognitive, and ethics).

Based on these findings, higher education institutions can design strategic policies such as providing faculty training, strengthening technological infrastructure, and establishing sufficient technical support systems to optimize the implementation of the AI-MOOC model. With sustained support, this model has the potential to become an innovative, adaptive, and inclusive digital learning solution in the era of higher education transformation.

First Field Testing

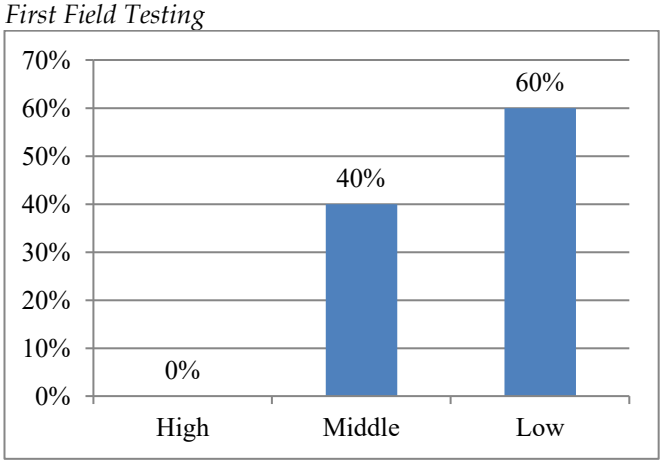

Figure 5. Results Diagram of the Initial Field Testing

The preliminary trial with 15 students at Universitas PGRI Argopuro Jember showed that 60 percent were in the low category of digital literacy and 40 percent were in the middle category, with none achieving a high level. This indicates a considerable gap in digital literacy among students and underscores the need for an AI based MOOCs learning model as an innovative and effective approach to address this issue.

Observations showed that most students followed the learning process effectively, demonstrated enthusiasm for AI features, and actively engaged in discussions and tasks. Questionnaire data indicated that 86.7 percent of students found the model improved their digital literacy, and 80 percent highlighted the chatbot as particularly useful in providing quick and relevant support. Some feedback, however, pointed to the need for a more intuitive interface and faster system performance, which informed revisions before wider implementation.

Data collection through observations and student questionnaires revealed positive responses toward interactive AI features, particularly the tutoring chatbot and adaptive content recommendations (Lin, 2025). Students reported higher interest and motivation when the system adjusted to their abilities and learning pace (Rulinawaty et al., 2023). These findings confirm the potential of AI integration to enhance engagement and learning effectiveness.

Pretest and posttest results showed that the model effectively improved students' understanding of digital literacy, particularly in areas such as personal data security, evaluation of online information, and ethical technology use (Rose & Nakhatra, 2025). Nevertheless, the trial revealed shortcomings, including a less intuitive interface and limited chatbot responses to complex queries (Mehmood & Haroon, 2025). Based on student feedback, revisions were made to the interface, content variety, and AI interactive logic, which provided a strong foundation for broader field testing (Jamebozorg et al., 2022).

Revise Early Product

Table 7. Results of Initial Product Revisions

Component Revised	Feedback from Initial Field Trial	Revision Actions
AI Tutor Chatbot	Chatbot responses were not sufficiently in-depth for answering complex questions	Expanded database and contextual understanding
Distance Learning Materials	Students suggested adding contextual examples from the local environment	Added case studies and infographics based on the local context (East Java)
Reflection and Automated Feedback	Feedback was considered too general	Adjusted AI feedback to be more specific based on the type of student errors

The initial product revisions were carried out based on findings from the preliminary field trial involving 15 students. The revisions primarily focused on refining the instructional design of the MOOCs, simplifying the user interface, and strengthening AI features such as the chatbot and adaptive content recommendation system. Student feedback highlighted

the need for a clearer learning flow, more accurate AI responses, and digital literacy content that was contextually relevant. In response, the developers improved the module structure, integrated interactive guidance, and updated the AI database to be more responsive to user needs.

These revisions were intended to enhance usability, increase learning effectiveness, and prepare the product for broader-scale implementation. The initial product revision was conducted as a follow-up to the findings from the preliminary field trial involving 15 students (Susanti & Maulida, 2021). Student feedback indicated that certain features, such as the user interface and AI chatbot responses, required further refinement to become more intuitive and communicative (Rahayu & Kurniawan, 2022).

Consequently, the interface was redesigned to be more responsive and user-friendly, consistent with recommendations by Ramadhani & Syahputra (2020) that a simple yet informative interface enhances user comfort. Additionally, the chatbot interaction logic was strengthened using a more precise natural language processing (NLP) algorithm to effectively address complex questions (Amalia & Fauzan, 2023).

The learning content within the MOOCs was also revised to incorporate interactive elements such as adaptive quizzes, short case-based videos, and scenario-based self-reflections (Putra & Suryani, 2020). According to Handayani & Wibowo (2022), digital learning complemented with immediate feedback and AI-driven quizzes can enhance student engagement and motivation. Furthermore, the content was structured based on a mapping of students' digital literacy needs, which identified weaknesses in areas such as data security and ethical technology use (Nugroho et al., 2021). This revision process ensured that the developed MOOCs model is not only technically more efficient but also pedagogically and contextually more relevant (Latifah & Adi, 2021).

Main Field Testing

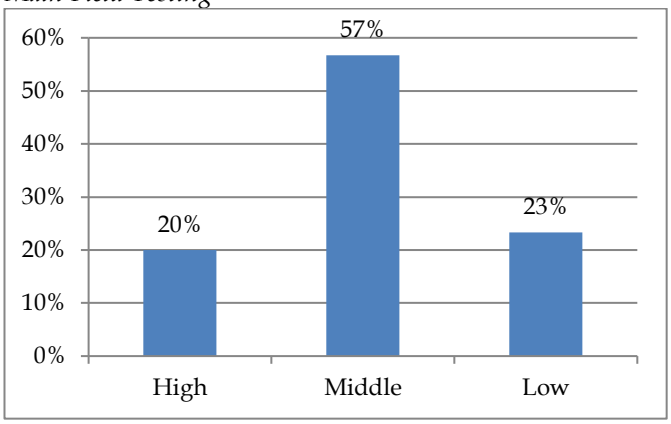

Figure 6. Diagram of Preliminary Field Trial Results

The field trial involving 30 students demonstrated a significant improvement in digital literacy compared to the initial trial. Specifically, 20% of students reached a high literacy level, 57% were classified as middle, and only 23% remained at a low level. The increase in students achieving a high level and the decrease in those at a low level indicate the effectiveness of the AI based MOOCs learning model in enhancing digital literacy among students at Universitas PGRI Argopuro Jember.

The trial results indicated a significant improvement in students' digital literacy scores, particularly in the areas of digital ethics and information security. These findings are consistent with evidence that integrating AI into online learning systems can provide more personalized adaptive support for students (Yuliana & Mahendra, 2023). The use of NLP-based chatbots and interactive modules consistently received positive feedback from users, as they offered a dynamic and engaging learning experience (Kurniawan & Fitriani, 2020).

Furthermore, survey data indicated that over 80% of students felt that the learning model helped them gain a deeper and more practical understanding of digital literacy concepts (Putri & Santoso, 2021). According to Rahmawati and Lestari (2020), the success of a digital learning model is strongly influenced by interface quality, content personalization, and the level of interactivity offered. This was evident in observations during the activities, where students actively participated in forum discussions and completed digital assignments more efficiently (Wulandari & Hidayat, 2022). Accordingly, the main field trial provides preliminary validation that the AI-based MOOCs model holds significant potential in supporting digital learning transformation in higher education (Ardiansyah & Syamsuddin, 2021).

Revise Product

Table 8. Product Revisions

Component Revised	Feedback	Final Revision Actions
Project and Collaboration Activities	Students were enthusiastic about collaborative tasks and digital projects	Added a team-based final project with integrated peer review and AI scoring
User Guide and Tutorials	New users found it difficult to understand the platform usage flow	Developed in-platform textual guidelines within the MOOCs

The product revisions were carried out following the main field trial involving 30 students, with the aim of refining the AI-based MOOCs learning model to be

more effective, efficient, and aligned with user needs. Based on data analysis and student feedback, improvements were made to the platform navigation system, the quality of AI interactions (such as automated feedback and learning progress analysis), and the digital literacy content to ensure greater relevance and applicability. Additionally, the user interface was simplified to enhance accessibility, particularly for students with basic digital skills. These revisions strengthened the integration of technology and pedagogy within the model and prepared the product for operational trials under real learning conditions.

The product revisions were conducted based on the findings from the main field trial to refine the AI-based MOOCs design in order to better align with students' needs and characteristics (Hidayat & Pramudito, 2022). Improvements included enhancing the user interface, adding AI-driven automated feedback features, and refining digital content to be more interactive and contextually relevant (Putra & Andriani, 2023). According to Jamebozorg et al (2022) The effectiveness of MOOCs at the international studies, including the estimated efficiency in learning (Individual learning, learning process, Learning product, Social learning), education (Job skills, Identifying the academic problem, Planning and implementation, Course and educational content), psychological (Self-help skills, Cognitive effectiveness, Functional effectiveness, Life Skills, Motivational effectiveness, positive psychology, emotional effectiveness, Learning Social psychology variables) and pedagogical (Education and higher education processes.

Additionally, enhancing the effectiveness and efficiency of the learning process was a key focus of this revision, particularly in improving material access times and system responsiveness (Nuraini & Saputra, 2023). According to Yulianti and Fikri (2021), the speed and accuracy of AI-based learning services are critical determinants of user satisfaction and learning outcomes. The revision also integrated AI into discussion features to promote asynchronous interaction between students and instructors (Ramadhan & Susanto, 2020). Thus, the product revisions addressed not only technical aspects but also pedagogical dimensions, significantly improving the quality of students' learning experiences (Larasati & Nugroho, 2022).

Operational Field Testing

The operational trial with 45 students revealed that 53 percent achieved a middle level of digital literacy, 42 percent reached a high level, and only 5 percent remained at a low level.

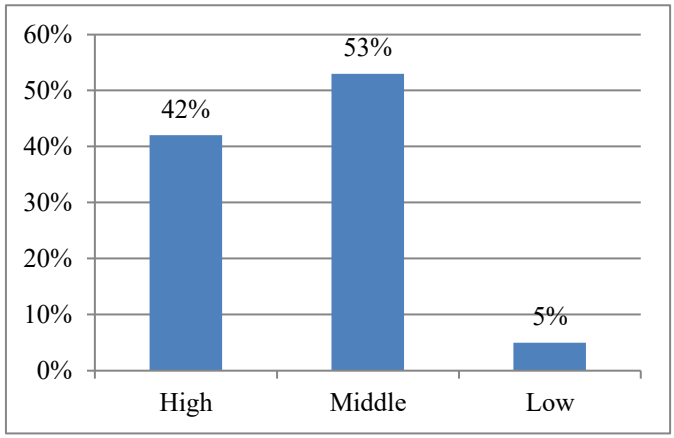

Figure 7. Experimental Class Operational Trial Results

These results demonstrate the potential of the AI based MOOCs learning model to enhance students' digital literacy. While most students effectively utilized digital technology in learning, further refinement is needed to support those still in the low category.

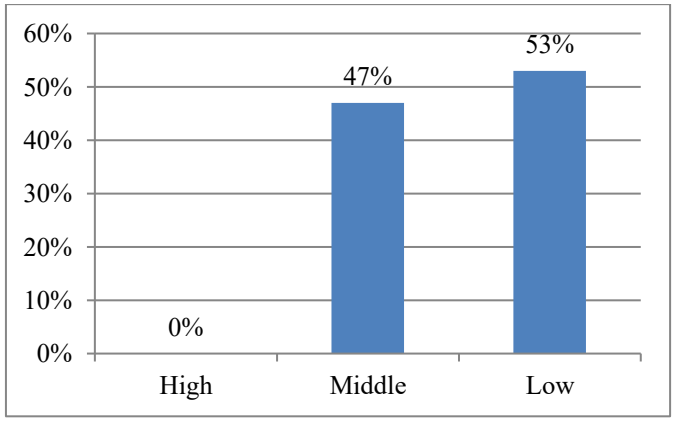

Figure 8. Diagram of Operational Trial Results in the Control Class

The operational trial in the control class, consisting of 45 students, revealed that none of the students reached the high digital literacy category. A total of 47% were classified as middle, while the majority (53%) remained in the low category. These findings suggest that without the implementation of the AI-based MOOCs learning model, students' digital literacy tends to remain stagnant or underdeveloped. The low proportion of students in the high category underscores the importance of innovative digital learning strategies to promote improvements in students' digital literacy competencies.

The operational trial was conducted to examine how the AI-based MOOCs learning model functions under real learning conditions (Santosa & Wahyuni, 2021). A total of 45 students participated in this trial to evaluate the effectiveness, efficiency, and engagement of the product in authentic settings (Lestari & Huda,

2022). The results indicated that the majority of students demonstrated significant improvements in digital literacy after using the developed model (Yuliana & Maulana, 2023). After the MOOC application, it was found that the competency of navigation, search and filtering of information, data and digital content obtained the highest score (Fernández-Otoya et al., 2025).

Furthermore, student interaction with the platform increased due to AI features that were responsive and adaptive to individual learning needs (Rahmat & Dewi, 2020). The audio-MOOC should incorporate a learner-centric approach to provide effective learning capabilities to the oral and low-literate population (Moloo et al., 2025). Active student engagement in the learning process was also enhanced through interactive modules and AI-based discussion forums (Wibowo & Ningsih, 2021).

During the operational implementation, students expressed satisfaction with ease of access, an engaging user interface, and the system's fast response times (Handayani & Permana, 2022). Observations indicated that the learning process was more independent and efficient compared to conventional learning models (Rose & Nakhatra, 2025).

MOOCs can be considered the most up-to-date and appropriate opportunity distance education offers for lifelong learning (Yılmaz, 2025). Evaluations also revealed that the model could accommodate various student learning styles through personalization features enabled by artificial intelligence (Utami & Raharjo, 2023). Thus, this operational trial validated that the AI-based MOOCs learning model is suitable for broader implementation in higher education contexts (Arifin & Munir, 2021).

Revise Final Product

Table 9. Final Product Revisions

Product Component	Recommended Improvement	Revision Action
Interactive Media	Unequal distribution of media across modules	Added interactive media to all learning modules

The final product revisions were carried out based on findings from the operational trial, which highlighted the need for adjustments to both the features and content of the AI based MOOCs learning model (Lestari & Huda, 2022). Improvements focused on enhancing the accuracy of AI features in providing more personalized learning recommendations (Utami & Raharjo, 2023). Additionally, the navigation system and user interface were refined to be more user-friendly and adaptive across various devices (Wibowo & Ningsih, 2021).

The revisions also incorporated student feedback regarding the need for more concise and interactive instructional videos (Handayani & Permana, 2022). Furthermore, digital literacy-based enrichment materials were added to ensure greater relevance to 21st-century learning needs (Yuliana & Maulana, 2023). All revisions were aimed at ensuring the final product's quality from pedagogical, technological, and user experience perspectives (Rahmat & Dewi, 2020).

Yelubay et al., (2022) findings of this study confirm that MOOCs as a distance learning technology have positively affected all participants and effectively improved future teachers' digital competence depending on four components (motivational, technological, cognitive, and ethical) and the indicators of future teachers' digital competence presented. Post-revision validation demonstrated significant improvements in students' learning motivation and engagement. With AI-based adaptive features, students reported greater support in understanding materials tailored to their individual proficiency levels (Arifin & Munir, 2021). These revisions represent a crucial step to ensure that the product is fully prepared for broader implementation in higher education settings (Santosa & Wahyuni, 2021). The final product outcomes indicate that the integration of AI within MOOCs substantially enhances both digital literacy and overall learning quality among students (Lestari & Huda, 2022).

Dissemination and Implementation

Table 7. Results of Dissemination and Implementation of the AI-Based MOOCs Learning Model

Dissemination & Implementation Activities	Participants	Description
Faculty Workshop	Course instructors	Training on AI-based MOOCs model and dashboard use
Student Training	Students across programs	Training on platform use, AI interaction, and digital literacy

The dissemination and implementation phase represents a strategic step in ensuring the sustainability of the AI based MOOCs learning model in higher education settings (Sutrisno & Pratiwi, 2020). The revised and validated product was introduced to instructors, program administrators, and students through workshops and training sessions (Fadillah & Suryani, 2022). These activities aimed to help users understand how to access, utilize, and adapt content according to their individual needs (Rizki & Marlina, 2023). Information dissemination was also conducted through institutional digital media, such as university websites and social media channels, to expand the

reach of the product (Handayani & Putra, 2021). Through this approach, the implementation of the digital learning model can be conducted systematically and comprehensively within the higher education ecosystem (Yusuf & Anjani, 2021).

The initial implementation demonstrated positive responses from various stakeholders regarding the benefits of AI-based MOOCs in enhancing students' digital literacy and independent learning (Nugroho & Kurniawan, 2022). Study Mehmood & Haroon (2025) shown Coursera user in Pakistan reported that MOOCs increase access to flexible learning and improve theirs basic digital skills. Our findings reveal significant variations across disciplines, with high-tech departments like Computer Information Engineering showing consistently higher scores across all assessment levels compared to humanities departments such as Fine Arts (Lin, 2025).

Instructors reported that AI personalization features assisted in designing more adaptive and targeted learning strategies (Cichocki & Kuleshov, 2021). Students also expressed increased engagement, as the system offered flexibility and catered to their actual learning needs. Initial evaluation results indicated a rise in active participation and interaction within the online learning process (Dökme et al., 2022). Consequently, this model is considered suitable for broader implementation and holds potential as an inclusive and sustainable digital learning alternative for the future (Fung, 2024).

Conclusion

The findings of this study conclude that the AI-based MOOCs learning model developed through the R&D process has proven effective in significantly improving students' digital literacy across all implementation stages. Evidence from observations, questionnaires, interviews, and documentation consistently shows that the 135 participants experienced measurable gains in accessing, evaluating, and using digital information responsibly. These results demonstrate that integrating adaptive AI algorithms and personalized feedback within MOOCs offers a more responsive and data-driven learning environment compared to conventional online learning approaches. Overall, the study provides a validated framework that can be generalized to broader higher-education settings, particularly those seeking scalable solutions to strengthen digital competence.

Practically, this research highlights that the AI-based MOOCs model is not only feasible but also advantageous for institutional adoption. The positive feedback from students, lecturers, and institutions indicates that the model is efficient, adaptive to learners' needs, and practical for classroom or blended-learning integration. Its scalability makes it suitable for large student populations, while its AI-driven personalization supports differentiated learning without increasing instructors' workload. These implications suggest that higher-education institutions can utilize this model as a sustainable strategy to elevate digital literacy, support digital transformation agendas, and bridge competency gaps among diverse learners.

Acknowledgments

We extend our deepest gratitude to the Directorate General of Higher Education, Research, and Technology, specifically through the 2025 Research and Community Service Program (DRTPM). The research grant with contract number 07/SP2H/PT.106/LPPM/2025 has made this work possible. We also wish to thank Universitas PGRI Argopuro Jember for their support and for providing the necessary facilities and resources.

Author Contributions

K. conceptualized the study, R. S. D. G. Methodology and reviewed the article, while A. D. A. P. collected the data and conducted the data analysis. I. Z. B. G. approval of the manuscript. All authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

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