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Development and Evaluation of Massive Open Online Courses to Support Sustainable Learning for Informatics Teachers in Indonesia

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Abstract: Informatics teachers in West Kalimantan face challenges in continuously updating their knowledge and pedagogical skills due to the rapid development of information technology and the implementation of a new curriculum that makes informatics compulsory. However, there is a lack of structured learning facilities to support their professional development. This study aims to develop and evaluate the feasibility of a Massive Open Online Course (MOOC) as a platform for continuous professional development of informatics teachers. This study employed a Research and Development approach using the ADDIE model involving two design experts, two system experts, and thirty informatics teachers. The MOOC was developed using the *Moodle* platform and integrated features aligned with teacher needs, UI/UX design, and expert validation, including diverse learning materials, quizzes, and discussion forums. Validation was carried out by experts, while teacher responses and learning outcomes were evaluated using questionnaires and pre-test/post-test analysis. Expert validations indicated that the MOOC was of very high quality, and teacher responses showed strong enthusiasm and satisfaction. Furthermore, post-implementation evaluation revealed significant improvements in both teachers' knowledge and motivation (p-value less than 0.05). The normalized gain score reached 47.91% for competence, indicating a moderate improvement, and 29.96% for motivation, indicating a low improvement. This demonstrates that the MOOC effectively supports both cognitive and affective growth. The developed MOOC has proven to be both feasible and effective as a professional learning platform for informatics teachers. Beyond improving knowledge and motivation, it offers scalability and accessibility, providing a sustainable solution for professional development in remote or under-resourced regions. Its implementation has the potential to bridge gaps in continuous education, particularly in Indonesia's 3T (frontier, outermost, disadvantaged) areas, while also serving as a pilot model for other subject teachers.

Keywords: MOOC, lifelong learning, teacher competencies, informatics teachers.

▪ INTRODUCTION

The role of lifelong learning is essential for humans, resulting from advancements in science and technology. As discoveries and innovations emerge at an unprecedented pace, individuals must continuously update their skills and knowledge to remain relevant and effectively contribute to society. The basic concept of lifelong learning encompasses learning activities undertaken by humans throughout their lifetime, which extends beyond formal education to include informal and non-formal education (Friedman, 2023). Lifelong learning can occur through various avenues, including education at school, community engagement, family interactions, and even workplace training. The aim is to improve attitudes, knowledge, and life skills in accordance with current developments to achieve sustainable living (Thwe & Kálmán, 2024).

Lifelong learning is crucial for workers and entrepreneurs who want to stay competitive in an ever-evolving job market. By continually acquiring new skills and knowledge, individuals can adapt to changes, innovate, and capitalize on emerging

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opportunities in their respective fields. Various studies have stated that a worker or entrepreneur needs to have the motivation to learn new things that grow from within themselves (Demir-Basaran & Sesli, 2019; Poquet et al., 2021). If someone lacks strong motivation to learn, they will likely feel satisfied with the knowledge and skills they already possess, without seeking to improve or self-actualize. For this reason, individuals need to develop a desire to learn while still attending formal education, so that a learner's habit of continually striving to improve and update their attitudes, knowledge, and skills is formed.

Higher education is responsible for cultivating graduates who recognize the significance of lifelong learning. The development of students' character with enduring aspirations is seen in higher education's objective to cultivate graduates capable of advancing national interests and enhancing the nation's competitiveness (Republic of Indonesia, 2012). Consequently, universities are not only tasked with producing high-quality graduates but also have the capacity to facilitate and collaborate with them in pursuing structured lifelong learning, thereby aiding graduates in acquiring the attitudes, knowledge, and skills essential for advancing national interests and enhancing the nation's competitiveness.

Informatics teachers, as graduates from universities, need to develop the ability for lifelong learning considering the rapid developments in information technology (Kong, Lai, & Li, 2023; Mouza, Mead, Alkhateeb, & Pollock, 2022). This involves not only staying updated with the latest technological advancements but also continually enhancing their pedagogical skills to impart knowledge to their students effectively. Through promoting an attitude of curiosity and flexibility, educators in informatics can better equip their students for the always-changing digital environment. By actively nurturing their own skills, these educators not only stay up-to-date with the latest IT developments but also refine their pedagogical approaches, enabling them to deliver relevant and engaging content to their students.

The chairman of the Information Technology Education Department at IKIP PGRI Pontianak, which prepares graduates to become informatics teachers, revealed during an interview that the department currently lacks a program to enhance the knowledge and skills of its graduates. For this reason, it is necessary for the institution to take a stronger role in graduates' development, not only to address individual limitations but also as part of its broader strategy for community service and graduates' empowerment. In the absence of such institutional support, the burden of professional growth falls on the graduates themselves (Staudt Willet, 2024). Teachers with a strong desire for learning will engage in autodidactic study or participate in training, whereas graduates lacking this zeal will depend solely on their current knowledge. This disparity in motivation highlights the importance of fostering a culture of continuous professional development within the department (Chukwuedo, Mbagwu, & Ogbuanya, 2021). By encouraging graduates to seek further education and providing resources for self-directed learning, the institution can better equip its teachers to meet the evolving demands of the field.

An informatics teacher who graduated from IKIP PGRI Pontianak claims that the most effective way to share knowledge or skills is through social media or messaging apps, such as Facebook, Instagram, Telegram, or WhatsApp. This approach is less effective because teachers often struggle to understand complex subjects such as algorithms and programming, which require structured explanations and guided practice

rather than brief, unverified messages. Such difficulties lead to suboptimal delivery of material in the classroom, limiting students' comprehension. Previous studies have also shown that such misunderstandings can propagate student misconceptions and hinder learning outcomes (C. Chen, Sonnert, Sadler, & Sunbury, 2020). In addition, there are no professionals on hand to answer questions about the information that has been shared or provide clarification when needed. As a result, this method of sharing may lead to misunderstandings or the dissemination of inaccurate information, ultimately hindering the educational process rather than enhancing it. The study's findings indicate that verifying the accuracy of information via social media and instant messaging is challenging and requires expert assistance (Kalogeropoulos, 2021; Luo, Cai, & Cui, 2021).

Furthermore, the chairman of the Graduates Association of the Department of Information Technology Education at IKIP PGRI Pontianak stated that informatics teachers currently need training due to the dynamics of ICT development, especially with the implementation of the new curriculum, which makes informatics a compulsory subject (Ministry of Education, Culture, Research and Technology, 2022). The current information technology subject is more complex than the previous ICT subject, so teachers feel there is a need to update their knowledge and skills. In the future, teachers may experience similar challenges related to the changes that are occurring. The most ideal way to support self-actualization is through lifelong learning, which is carried out in a planned and programmed manner, such as through seminars, training, or workshops. This situation is reinforced by research conducted by Kim (2023), which suggests that lifelong learning should be implemented in a programmed, planned, and systematic manner to achieve the desired competencies. This is intended to provide teachers with lifelong learning experiences from appropriate experts, and these lifelong learning activities can be recorded so that evaluations can be carried out regarding the increase in graduates' knowledge and skills.

However, carrying out programmed, systematic, and structured lifelong learning activities is challenging due to costs, location, and the availability of time for teachers to participate in well-structured activities (Nguyen, Luu, & Ho, 2020). The teachers spread across various districts or cities require a significant amount of money and time to be allocated if they are to participate in the training. Besides that, well-programmed training also requires instructors or experts who can provide material. As a result, many educators may find themselves unable to access valuable professional development opportunities, which can hinder their growth and effectiveness in the classroom.

Reflecting on the situation faced by informatics teachers, facilities are needed that provide opportunities for graduates to improve and actualize their knowledge and competencies. Various studies have been conducted, and they agree that lifelong learning needs to be integrated with ICT to increase its effectiveness and efficiency (Major, Francis, & Tsapali, 2021; Poquet et al., 2021; Şen & Yildiz Durak, 2022). Given the urgent demands faced by informatics teachers in adapting to the new curriculum, a lifelong learning model that is both flexible and accessible becomes essential. In this regard, Massive Open Online Courses (MOOCs) represent not merely an option, but the most strategic ICT-based solution, as they directly address challenges of geographical barriers and high training costs. MOOCs have been proven in various studies to improve general and professional competencies on a broad scale at low cost (Castaño-Muñoz &

Rodrigues, 2021; Pendergast, Main, & McManus, 2024; Sharov, Zemlianskyi, Sharova, & Viktor, 2021). MOOC technology will be suitable for application to informatics teachers in particular and other subjects teachers in general; even the general public can take part in the training provided without having to pay a large amount of money.

A MOOC is an online learning course that can accommodate an unlimited number of participants and is open access via a website (Bettiol, Psereckis, & MacIntyre, 2022). MOOC represents a new step in learning technology, driven by disruptions in development, scale of use, class size, and partnerships involved, despite the technology itself being technically not new. The use of MOOCs is currently widely used in developed countries as a learning tool that is open, inclusive, and affordable for the community (Ayoub, Amin, & Wani, 2020). However, in developing countries, the use of MOOCs is still not widely utilized, even though MOOCs enable equal distribution of education for the wider community (Gamage, Perera, & Fernando, 2020). Further studies indicate that in Indonesia, the implementation of MOOCs remains limited, facing challenges related to facilitators' performance and adoption (Ginting, Woods, Tantri, Rahayu, & Asfihana, 2022).

According to various studies, MOOCs have several benefits, such as a flexible learning environment, reducing education or training costs, eliminating barriers related to distance, and being able to provide up-to-date information sources, thus creating a better learning environment (Huang & Qi, 2025; Mohan, Upadhyaya, & Pillai, 2020; Rubaai & Hashim, 2019). The use of MOOCs is generally free; users only need an internet connection to access the MOOC service provider platform. MOOC provides an entirely virtual learning environment where all activities are carried out online, allowing MOOC users, including participants, instructors, and assistants, can do their work without being tied to time and location.

MOOCs serve as a medium for effective learning by offering extensive resources, enhancing learning outcomes, boosting motivation, making the learning experience enjoyable, and facilitating the acquisition of 21st-century skills (Md Yunus, Umiera Hashim, & Hashim, 2019). The materials offered in MOOCs are highly varied, enhancing the learning experience and allowing adaptation to participants' requirements through both direct (synchronous) and indirect (asynchronous) approaches. MOOCs, which offer numerous features, enable exercises or tasks to be more comprehensive, thereby improving collaboration, communication, creativity, and problem-solving skills. Apart from that, the use of MOOCs will help grow the digital, information, and media literacy of MOOC participants.

While MOOCs have been increasingly recognized as a tool for expanding access to education, their use for teacher professional development in West Kalimantan has received little attention. Most existing research has emphasized the use of MOOCs for higher education or general learning purposes, but there remains a lack of initiatives targeting subject-specific teacher training. This study introduces a MOOC designed for Informatics teachers in West Kalimantan to address this gap and provide structured professional learning opportunities. Furthermore, this research not only develops the MOOC but also evaluates its impact on the competence and motivation of Informatics teachers in enhancing their professional capacities in West Kalimantan. Such integration offers a more holistic perspective on MOOC effectiveness and provides novel insights

into how digital platforms can simultaneously enhance knowledge acquisition and motivational aspects in teacher professional development.

The numerous benefits and advantages that MOOCs offer make them a viable solution for assisting informatics educators in developing and applying their knowledge and skills through well-designed activities. The MOOC that will be developed should enable them to gain a more comprehensive knowledge and skills without incurring significant expenses. The learning resources will be created using both synchronous and asynchronous methods, enabling teachers to engage with the material outside of their working hours while maintaining their responsibilities as educators. Additionally, the MOOC to be built can facilitate collaboration among governments, IKIP PGRI Pontianak, other universities, and qualified instructors, trainers, or educators. Based on these considerations, the research questions are formulated as follows: How can a MOOC be systematically designed and developed to meet the professional learning needs of Informatics teachers in West Kalimantan? and 2) How effective is the developed MOOC in enhancing the competence and motivation of Informatics teachers in West Kalimantan?

▪ METHOD

Participants

The subjects in this study were divided into two groups, namely development subjects and trial subjects. The development subjects consisted of design experts assessing the accuracy of the developing design and system experts assessing the resulting MOOC system. The development team consisted of two design experts and two system experts, all of whom were lecturers in Information Technology Education with expertise in e-learning and software engineering.

For the trial subjects, the study population consisted of graduates of Information Technology Education (PTI) who graduated in 2022 and 2023 and were teaching at the senior high school level in West Kalimantan Province, totaling 52 teachers. From this population, thirty teachers were selected as samples using convenience sampling, based on their availability and willingness to participate in the study. Ethical considerations were applied, where participants provided voluntary consent after being informed of the research objectives and procedures, and their anonymity was guaranteed.

Research Design and Procedures

The method used in this study is the Research and Development (R&D) with the ADDIE development model. The R&D method is a method used to produce and test a product. The ADDIE development model is one of the models that can be used in developing MOOCs (Rafiq, Hashim, Yunus, & Pazilah, 2019; Sulistyo, Nafiáh, & Idris, 2019), which is expected to produce MOOCs that support continuous learning for Informatics teachers in West Kalimantan.

The ADDIE development model comprises five stages: analysis, design, development, implementation, and evaluation. The first stage is analysis, which consists of user analysis, functional needs analysis, and hardware and software needs analysis. In the analysis stage, semi-structured interviews were conducted with the Head of the IT Education Program and the Head of Graduate Affairs. At the same time, user, functional, and hardware/software needs were collected via online questionnaires from graduates across West Kalimantan and analyzed descriptively. The second stage is the design stage, consisting of system design and UI/UX design. The third stage is the development stage,

which involves implementing the design created using the *Moodle* framework. The implementation stage involved a one-month trial of the MOOC with four modules (computer logic, number system conversion, problem solving, computational thinking). Participants worked at their own pace, using PDF and video materials, and completed quizzes/assignments. They received monitoring and support from instructors and moderators. The fifth stage is the evaluation stage, conducted at each step to verify the proper execution of every stage. The steps of this study are illustrated in Figure 1.

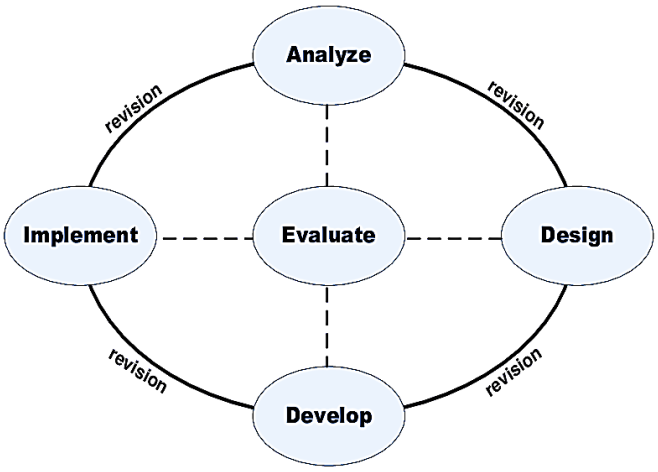

Figure 1. MOOC development model for informatics teachers

Instruments

The instruments used in this study were questionnaires, tests, and documentation. The questionnaire instrument was used to gather data on user characteristics, software and hardware requirements, functional needs, design expert assessments, system expert assessments, and user response evaluations. The documentation instrument was used to gather UI/UX design data, system design information, and details about MOOC development. Additional instruments were employed to measure teacher competence and learning motivation.

Teacher competence was assessed through 20 different multiple-choice items used in pre-tests and post-tests, based on the core Computational Thinking concepts that formed the main focus of the MOOC content. The items were derived from the MOOC learning objectives and mapped to four instructional modules, including computer logic, number system conversion, problem-solving, and computational thinking, based on the senior high school Informatics curriculum. These items were validated by two experts in Information Technology to ensure content validity. Learning motivation was measured using a questionnaire based on six indicators: (1) desire to succeed, (2) learning needs, (3) desire to achieve, (4) appreciation in learning, (5) engaging learning experience, and (6) a conducive learning environment (Aidoo, Chebure, Gyampoh, Tsyawo, & Quansah, 2024; Raufelder & Kulakow, 2021). This instrument was tested with 30 preservice Informatics teachers, and from 25 initial items, 19 were declared valid with a Cronbach's Alpha value of 0.840, indicating that the instrument had good reliability. The responses were collected using a 5-point Likert scale ranging from strongly disagree to strongly agree.

Data Analysis

The data analysis technique employed in this study was descriptive analysis. The descriptive analysis technique was employed to provide an overview of the collected data, encompassing both qualitative and quantitative information. For assessment data from design experts, system experts, and user responses, it will then be interpreted to see the feasibility of the learning media that has been developed. The interpretation of the assessment by experts and users is presented in Table 1 (Sulistiyarini, Sabirin, & Ramadhani, 2021).

Table 1. Interpretation of expert ratings and user rating scores

Score	Criteria
$X > 4.21$	Very Good
$3.40 < X \leq 4.21$	Good
$2.60 < X \leq 3.40$	Fairly Good
$1.79 < X \leq 2.60$	Bad
$X \leq 1.79$	Very Bad

Inferential analysis was used to determine the effectiveness of the MOOC on both teacher competence and learning motivation. A paired sample t-test was conducted to determine whether there was a statistically significant difference between the pre-test and post-test scores of the teachers, after confirming that the assumption of data normality was met. If this assumption was not met, the Wilcoxon signed-rank test was considered as an alternative non-parametric approach. The same test was also used to assess the change in motivation scores before and after using the MOOC. Furthermore, a normalized gain score (N-gain) analysis was used to measure the magnitude of improvement in teacher competence. The N-gain score was calculated by comparing the actual gain to the maximum possible gain, providing an indicator of instructional effectiveness.

▪ RESULT AND DISSCUSSION

The purpose of this research is to develop a MOOC that will serve as a resource for informatics educators for sustainable learning. This product aims to enhance the knowledge and skills of informatics educators by offering affordable access to the newest content, available anytime and anywhere. The R&D research process, utilizing the ADDIE paradigm, which comprises five stages analysis, design, development, implementation, and evaluation is used to produce a high-quality MOOC. This study involved design and product experts to evaluate the viability of the MOOC, together with 30 informatics educators as participants, to gather user feedback on the product.

The first stage of this research involves conducting a MOOC needs analysis. Analysis activities are conducted to identify problems and develop solutions. The analysis aims to understand various aspects of user requirements for the product under development (Tao, Pei, Yunhui, Tingru, & Qu, 2022). To find out the initial needs in developing a MOOC, it is necessary to (1) conduct user analysis, (2) conduct functional needs analysis, and (3) conduct hardware and software needs analysis. This approach ensures that the resulting MOOC aligns effectively with the expectations and requirements of its target audience, creating an engaging and relevant learning experience.

User analysis was conducted to understand the characteristics and experiences of potential users before the development of the MOOC. The results of the user analysis are presented in Table 2.

Table 2. Users analysis

Question	Answer Option	F	%
Where do you get information?	SNS	30	100.00%
	Articles	8	26.67%
	News	2	6.67%
	Others	2	6.67%
Do you ever join online discussions/courses?	Yes	26	86.67%
	No	4	13.33%
What e-learning platform have you ever used?	*Google Classroom*	27	90.00%
	Edmodo	29	96.67%
	Ruang Guru	21	70.00%
	Moodle	20	66.67%
	Others	3	10.00%
Are you enjoying the e-learning platform you use?	Yes	26	86.67%
	No	4	13.33%
Do you know about MOOCs?	Yes	9	30.00%
	No	21	70.00%
Are you interest in using MOOC?	Yes	29	96.67%
	No	1	3.33%

Based on the analysis, social media was identified as the primary source of information for teachers. Most informatics teachers have participated in discussions or online courses and have used e-learning platforms, with Google Classroom being the most frequently used. The majority also reported positive experiences using these platforms and showed a strong interest in developing a MOOC.

The questionnaire indicates that informatics educators mostly utilize social media as their main source of information. However, this raises concerns because not all information available on these platforms is credible. Research highlights that information shared on social media must be approached with caution, as it may contain inaccuracies or misinformation (Kalogeropoulos, 2021). Additional research indicates that information acquired from the internet requires verification for accuracy, and users must exercise discernment in disseminating the received information (Luo et al., 2021). Consequently, the creation of MOOCs is essential for acquiring reliable information to enhance the skills and expertise of informatics educators.

The same data also revealed that only 30% of informatics teachers had prior knowledge of MOOCs. This low awareness is reflected in findings from developing countries, where MOOCs remain relatively unknown (Lambert, 2020; Lubis, Idrus, & Rashid, 2020). Despite this unfamiliarity, nearly all respondents have utilized various online learning platforms, including Edmodo, Google Classroom, Ruang Guru, *Moodle*, and Zenius. These findings align with recent research indicating that educators have become proficient in utilizing online learning platforms (Rinekso, Muslim, & Lesagia, 2021). This familiarity was largely driven by the shift to remote instruction during the COVID-19 pandemic, which significantly accelerated digital transformation in the

education sector (Gabryelczyk, 2020; Ibrohim, Sudrajat, & Saefi, 2021). Several prior studies indicate a rise in online training utilization post-pandemic, attributed to the convenience and great flexibility afforded by online learning (Rawat, Kumar, Kumar, & Khattri, 2021).

Although MOOCs were previously unfamiliar, our data show that 96.67% of informatics teachers expressed interest in using them once the concept was explained. This high level of interest appears to arise from their increased recognition of MOOCs' potential for professional growth (Kumar, Kumar, Palvia, & Verma, 2019) and the confidence gained from prior e-learning experience (Shea, 2019). In this study, those who felt technologically prepared were the most enthusiastic, a finding consistent with research indicating that digital readiness and prior distance-learning experience are critical for engaging effectively with new online formats (Giovannella, Passarelli, & Persico, 2020; Klapproth, Federkeil, Heinschke, & Jungmann, 2020). Such robust technological readiness can boost teachers' confidence in exploring MOOCs and potentially inspire their peers to experiment with these platforms.

In parallel with the user needs analysis, a functional requirements analysis was conducted to determine which features are required in the MOOC. This analysis examines the aspects most valued by participants and guides the platform's design decisions. Figure 2 presents the results of this functional needs analysis.

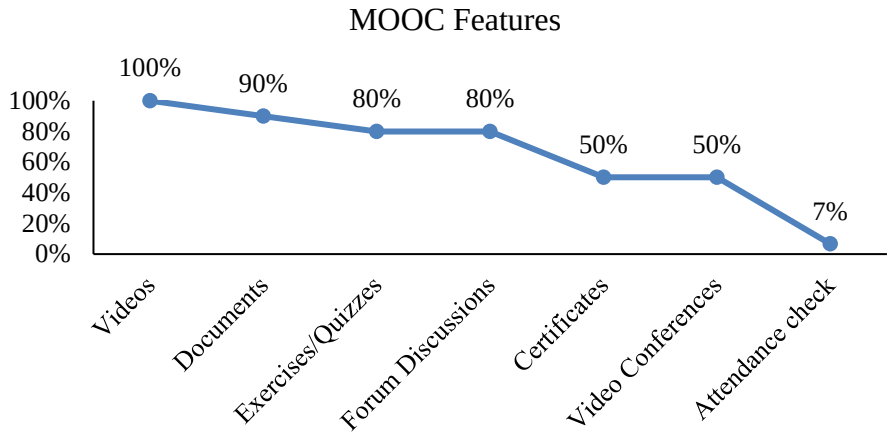

Figure 2. Functional need analysis

Based on the questionnaire responses, participants prioritized the following features for the MOOC: video lessons as their top choice, followed by supporting documents, discussion forums, interactive exercises or assignments, certificates, and video conferencing. Attendance tracking was identified as the least necessary feature. These rankings underscore the importance of incorporating rich multimedia content and providing opportunities for interaction in designing an engaging MOOC experience.

The survey results showed that teachers prefer asynchronous learning modes, such as videos, documents, and forums, while still valuing occasional synchronous sessions such as video conferences. Asynchronous materials allow learners to study at their own pace, and live sessions provide real-time feedback and community interaction that deepen

understanding (Larson, Aroz, & Nordin, 2019; Moorhouse, 2020). The survey also revealed that teachers consider quizzes and assignments essential for supporting the learning process. This finding aligns with previous research, which demonstrates that such formative assessments are effective in monitoring learners' understanding and maintaining their motivation (Febrian, Yennita, & Ma'ruf, 2021). Finally, teachers indicated that earning certificates serves as a key motivator and formal recognition of their learning, consistent with findings that certificates enhance persistence and professional credibility (Bhuana & Apriliyanti, 2021).

An analysis of hardware and software needs is carried out to find out the hardware and software used by graduates, so as to produce a MOOC that suits the hardware and software owned by graduates. The results of the hardware and software requirements questionnaire are presented in Figure 3, which shows the hardware and software requirements analysis graph.

Table 3. Hardware and software needs analysis

Question	Answer Option	F	%
Do you have good internet service?	Yes	30	100.00%
	No	0	0.00%
How long do you use the internet in a day?	More than 4 Hours	19	63.33%
	3 – 4 Hours	8	26.67%
	Less than 3 Hours	3	10.00%
What web browser do you use?	Chrome	30	100.00%
	Firefox	14	46.67%
	Edge	8	26.67%
	Brave	5	16.67%
	Others	3	10.00%
What devices do you have?	Laptop	30	100.00%
	Smartphone	30	100.00%
What operating system do you use?	Windows	28	93.33%
	MacOS	2	6.67%
	Android	24	80.00%
	iOS	6	20.00%

The final stage of the needs analysis involves examining software and hardware readiness, aiming to identify the technological facilities available to informatics teachers for accessing the MOOC platform. Based on the questionnaire results, it is known that all teachers own both smartphones and laptops, indicating a high level of device accessibility. Additionally, teachers have reliable internet access, with most of them using the internet for more than 4 hours daily, and accessing it through popular browsers such as Google Chrome and Mozilla Firefox.

In this study, the universal ownership of smartphones and laptops, along with the fact that most teachers use the internet for more than four hours daily, demonstrates that the participants are well-equipped to access an online learning platform. This technological readiness is essential for the successful implementation of MOOCs, as internet access serves as the backbone of any distance learning system (Havifah & Khosiyono, 2022). Furthermore, prior studies have emphasized that while ownership of digital devices is important, stable and sufficient internet connectivity is a more critical

factor, as limited data plans and slow speeds can hinder engagement and learning experiences in MOOCs (Joshi, Vinay, & Bhaskar, 2020; Lestiyawati & Widyantoro, 2020). Therefore, to ensure broad accessibility, the MOOC must be optimized for low bandwidth conditions by minimizing the size of OER files and using compressed media formats so that teachers with limited connectivity can enjoy a smooth learning experience.

The design stage produced the core system artifacts Unified Modeling Language (UML) diagrams and user interface/user experience (UI/UX) mockups that serve as a blueprint for the MOOC's structure and functionality. This phase is critical because a well-crafted design ensures alignment between pedagogical goals and technical implementation, reducing costly rework later and improving learner satisfaction (Martin & Bolliger, 2023). All design decisions were directly informed by our earlier needs analyses, guaranteeing that the resulting MOOC features address the priorities identified by informatics teachers.

The system design stage produced a use case diagram that models the core functionalities of the MOOC platform and the interactions available to each user role. Figure 3 presents this diagram, which serves as a blueprint for how administrators, instructors, and participants will engage with the system's features.

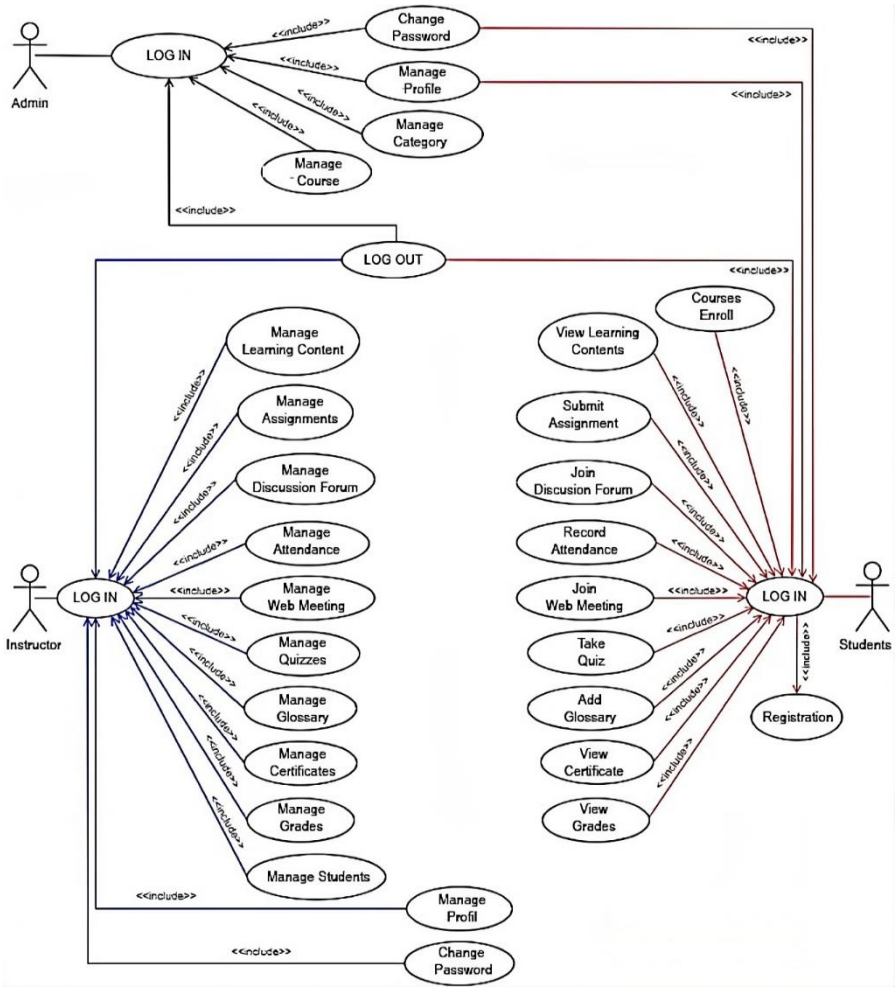

Figure 3. Use case diagram MOOC

The use case diagram identifies three primary actors with distinct responsibilities: students, lecturers or instructors, and administrators. Students are informatics teachers who train or participate in courses; lecturers or instructors are experts who provide training or course materials; and administrators manage users and courses in MOOCs. This is in accordance with MOOCs that have been developed by several previous researchers who stated that MOOCs consist of at least users, learning plans, and assessment systems (Gordon & Wiltrout, 2021). In the MOOC system that will be developed, instructors can carry out various activities, including managing teaching material content, assignments, discussion forums, attendance, quizzes, grades, participants, and certificates. Students in the MOOC system that is developed can carry out various activities, including viewing open materials, working on assignments, participating in discussion forums, taking attendance, completing quizzes, and receiving grades and certificates. Research conducted by several researchers indicates that one of the factors influencing the success of learning in MOOCs is the quality of interaction between instructors and students (Chi, 2023; Yu & Yu, 2023). For this reason, MOOCs need to be designed by considering the relationship between students and instructors so that an effective, meaningful, and interesting learning system is built. Administrators are tasked with managing courses, participants, and instructors. In distance learning, a moderator is needed who can bridge the gap between instructors and participants (Mansour, 2024).

The UI/UX design becomes a bridge for interaction between the user and the system, so that the system developed must be attractive and easy for users to use. On the main page, users can view various information presented in the general website menu without needing to perform further interactions in the system. Several UI/UX designs for MOOCs are shown in Figure 4.

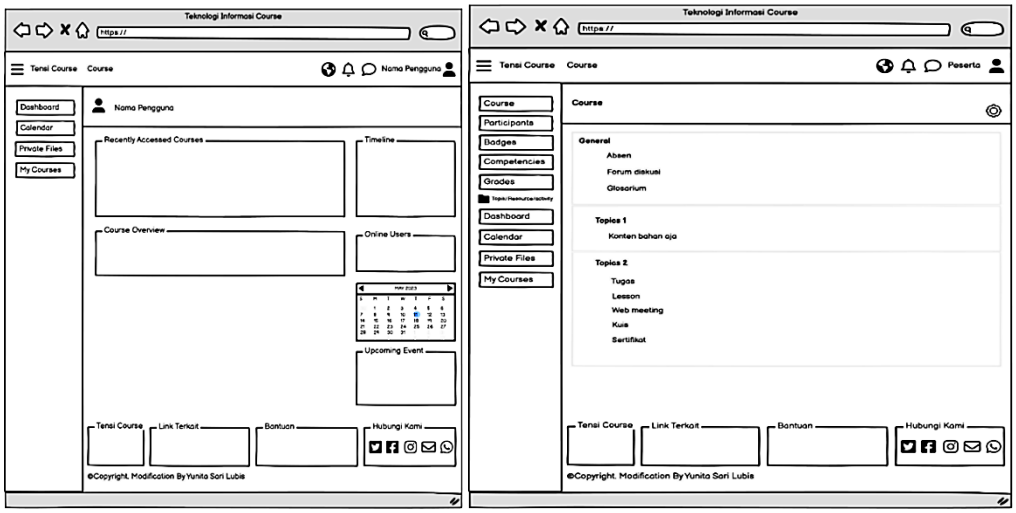

Figure 4. MOOC UI/UX design

UI/UX design is used to provide an overview to system experts about the appearance of the MOOC to be developed. UI/UX plays a crucial role because, in modern interfaces, it is essential to prioritize comfort, satisfaction, and user experience (Li & Zhu, 2022). In designing MOOC interfaces, it is also important to consider usability,

accessibility, and learner engagement to ensure that the system effectively supports the learning process (Deng, Benckendorff, & Gannaway, 2019; Moore & Blackmon, 2022). This ensures that the MOOC platform is not only functional but also capable of maintaining learner motivation and reducing the risk of disengagement. For the design of UI/UX in this study, the *Figma* application was utilized. *Figma* is a web-based application that enables the creation of prototypes with simulation features, allowing for clear and intuitive application designs. The design also takes into account the results of the needs analysis, which highlighted the importance of integrating features such as video materials, documents, quizzes, discussion forums, certificates, and video conferencing. Based on the research conducted, a UI/UX design was developed, which was implemented in three parts: the administrator, lecturer, and student interfaces, according to the system plan that had been created. MOOC is also equipped with a homepage design that displays general information, a registration section for registration, and a login section to access the system.

Evaluation at the design stage is carried out to determine whether the MOOC design is appropriate, so that a planning design is produced that is in accordance with the MOOC structure. The results of the design expert assessment can be seen in Table 4: Design Expert Assessment Results.

Table 4. Design experts assessment results

No	Aspects	Expert 1	Expert 2	Mean	Criteria
1	Use Case Diagram	4.50	4.25	4.38	Very Good
2	Use Case Scenario	4.25	4.00	4.13	Good
3	UI/UX Design	4.56	4.00	4.28	Very Good
Mean		4.44	4.08	4.26	Very Good

The design results were validated by two experts who assessed both the system design, including use case diagrams and scenarios, and the UI/UX designs. The experts agreed that the use case diagram offers a clear overview of system functionality and that the accompanying scenarios effectively detail each user activity. They also rated the UI/UX designs as very good, noting that the interfaces will facilitate seamless MOOC development and user interaction. Overall, the experts declared the MOOC design feasible and ready to proceed to the development stage. A well-planned design plays a crucial role in creating quality learning experiences, and thus is essential in producing an effective and high-quality MOOC (Handoko, Gronseth, McNeil, Bonk, & Robin, 2019).

MOOC development uses the main software *Moodle* and Bootstrap for styling the appearance of the website's main page. Participants and instructors can discuss topics related to the course in the forums. The course page contains all kinds of resources and activities presented by the teacher. Resources contain learning materials presented in various formats. At the same time, activities include tasks that must be completed by course participants, such as filling in absences, taking tests or assignments, attending web meetings, and participating in discussions. After being developed, the system is evaluated by validating system experts. The results of MOOC development are shown in Figure 5. The results of the development were validated by experts to assess the quality of the MOOC produced. The results of the expert assessment are presented in Table 5.

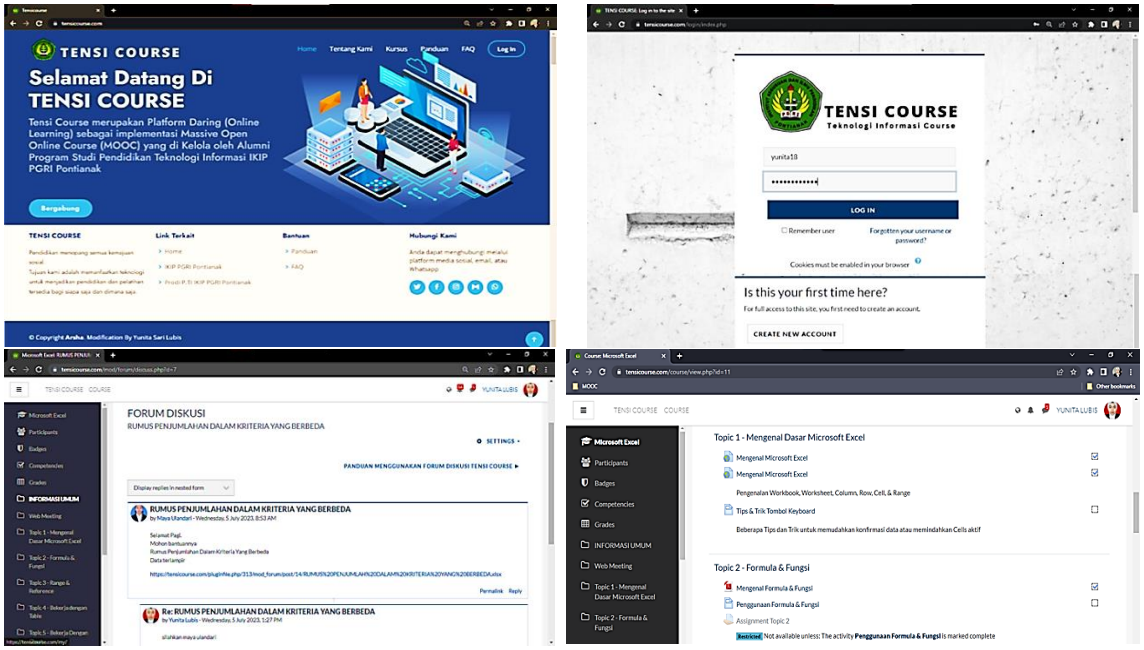

Figure 5. Result of MOOC Development

Table 5. System experts assessment results

No	Aspects	Score		Mean	Criteria
		Expert 1	Expert 2		
1	Correctness	5.00	4.16	4.58	Very Good
2	Reliability	4.67	4.33	4.50	Very Good
3	Efficiency	5.00	4.00	4.50	Very Good
4	Integrity	4.50	4.00	4.25	Very Good
5	Usability	5.00	4.16	4.58	Very Good
	Mean	4.86	4.18	4.52	Very Good

The validation of MOOC development was conducted by two experts, who assessed aspects including correctness, reliability, efficiency, integrity, and usability. The assessment results, according to the two experts, showed that the aspects of correctness, reliability, efficiency, integrity, and usability were classified as very good. In general, the results of MOOC development, according to experts, were classified as very good, allowing for a trial to be conducted to determine user responses.

MOOC development was executed using the *Moodle* platform, based on a design validated by experts. *Moodle* is a comprehensive e-learning development platform (Suparjan, Ismiyani, Mariyadi, Shintasari, & Kresnadi, 2023), and numerous research studies indicate that *Moodle*-based MOOCs can enhance student motivation to enroll in available courses (Sabah, 2019; Teo, Zhou, Fan, & Huang, 2019). The MOOC's features align with the design outcomes, including features for providing materials in various forms, assignments, exercises, attendance, discussion forums, and certificates. The MOOC was validated by experts, who stated that the product developed is excellent. According to experts, the features in MOOCs are well-functioning and can help users effectively utilize MOOCs. Instructors on this MOOC can add learning materials in various forms, including images, text, video, and sound. In addition, MOOC also provides

video conference facilities, allowing learning to occur not only synchronously but also asynchronously. Instructors can also add quizzes easily and provide assessment rubrics. Both teachers and students can create discussion forums on MOOCs to discuss the provided material or assignments. MOOC also provides certificate facilities as proof that students have completed the course. The findings of this study align with numerous prior investigations indicating that *Moodle* possesses diverse functionalities and can facilitate a conducive learning environment, including web conferences, videos, presentations, documents, questionnaires, discussion forums, and quizzes or exercises (Sari & Dahnial, 2022). *Moodle* can be enhanced with different add-ons to optimize learning activities (Yelubay, Dzhussubaliyeva, Moldagali, Suleimenova, & Akimbekova, 2022), including interactive movies, quizzes, attendance tracking, and certificate generation. Furthermore, MOOCs can run on various platforms and browsers, and do not require large bandwidth, so they do not require a large internet quota (Purwanto, Dwiyanto, & Uriu, 2024).

The implementation stage was conducted to assess the response of informatics teachers to the MOOC that was developed. At this stage, 30 informatics teachers were involved in trying to use the MOOC application. After users tried the MOOC, participants were asked to complete a questionnaire to assess their responses to the usefulness, ease of use, ease of learning, and overall satisfaction with the MOOC.

Table 6. Users responses results

No	Aspect	Total Score	Questionnaires	Means	Criteria
1	Usefulness	777	900	4.32	Very Good
2	Ease of Use	753	900	4.18	Good
3	Ease of Learning	759	900	4.22	Very Good
4	Satisfaction	780	900	4.34	Very Good
Total		**3.069**	**3600**	**4.26**	Very Good

In general, based on the results presented in Table 6, the developed MOOC is classified as very good. According to teachers, the MOOC developed is useful, easy to learn, and satisfying, with a very good category, while the ease of use aspect is classified as good.

Implementation was carried out after the MOOC was declared feasible by experts. The implementation of MOOC involved 30 informatics teachers trying the application that had been developed. The trial results indicate that MOOCs garnered a positive reception from users and will contribute to the enhancement of teachers' knowledge and skills. Additionally, this platform is easy to learn and provides comfort when used, although teachers may need to become accustomed to it, especially for those new to smartphone technology. This is because, based on user needs analysis, many teachers had never used the *Moodle* platform before, so navigating the features and managing activities requires more time for adaptation, particularly when accessed via smartphones. Prior research has also shown that MOOCs are well-liked by users because they make it easy to learn new things at a low cost (Rosyida & Lumbanbatu, 2024). Other studies suggest that the ease of use and learning features available in MOOCs will impact long-term application use (Liliana, Santosa, & Kusumawardani, 2022). Based on the results of this study, the MOOC developed can be utilized as a platform to share knowledge and skills

among informatics teachers in West Kalimantan. This MOOC can also serve as a means to connect IKIP PGRI Pontianak colleges with Informatics teachers.

To evaluate the impact of the MOOC on participants' motivation and competence in Computational Thinking, a paired sample t-test was conducted. This analysis measured whether there was a statistically significant difference between pre-test and post-test scores. The results are summarized in Table 7.

Table 7. Paired sample T-Test results

No	Variable	Mean (Pre)	Mean (Post)	Mean Diff.	Sig	Intepreation
1	Teacher Competence	61.33	78.83	17.50	0.00	Significant difference
2	Motivation	68.00	76.57	8.57	0.00	Significant difference

The results in Table 7 indicate that both motivation and teacher competence showed statistically significant improvement after using the MOOC, with a p-value < 0,05 for both variables. This suggests that the MOOC had a positive and measurable impact on improving teachers' motivation to learn and their understanding of Computational Thinking. According to Self-Determination Theory, the sense of competence is a key factor that fosters intrinsic motivation (Ryan & Deci, 2020). In this study, the improvement of teachers' competence in Computational Thinking through the MOOC catalyzed their increased motivation, indicating that competence building plays a central role in sustaining teachers' learning motivation. This finding is consistent with previous studies, which emphasize that MOOCs can enhance learners' competence, thereby fostering their motivation to engage in learning activities (Lan & Hew, 2020).

In addition to statistical significance, a normalized gain (N-Gain) analysis was conducted to assess the magnitude of improvement. The N-Gain score compares the actual gain to the maximum possible gain, providing a percentage that indicates the effectiveness of the intervention. The results are presented in Table 8.

Table 8. General N-Gain results

No	Variable	N-Gain (%)	Criteria
1	Teacher Competence	47.91	Moderate
2	Motivation	29.96	Moderate

Based on Table 8, N-Gain results show moderate improvement in both motivation and competence. Although not categorized as high, these gains demonstrate that the MOOC contributed substantially to improving both the motivational and cognitive aspects of teacher learning, indicating that the platform was effective in supporting professional development. To provide a more detailed view, Tables 9 and 10 present the N-Gain results for competence in computational thinking and each motivation indicator.

Table 9. N-Gain results for teacher competences on computational thinking

No	Indicator	Pre	Post	N-Gain (%)	Criteria
1	Computer Logic	14.67	19.17	43.56	Moderate
2	Number System Conversion	13.83	18.83	44.76	Moderate

3	Problem Solving	16.67	20.33	43.94	Moderate
4	Computational Thinking	16.17	20.50	49.04	Moderate

Table 10. N-Gain results for motivation by indicators

No	Indicator	Pre	Post	N-Gain (%)	Criteria
1	Desire to Succeed	10.67	11.83	26.79	Moderate
2	Learning Needs	14.57	16.67	38.67	Moderate
3	Desire to Achieve	11.47	12.27	22.66	Low
4	Appreciation in Learning	11.36	11.83	12.91	Low
5	Engaging Learning Experience	10.93	12.07	28.01	Moderate
6	A Conducive Learning Environment	9.00	11.90	48.33	Moderate

The moderate results appear related to limited MOOC interactivity and support. Instructors mainly evaluated assignments without providing active mentoring, which was constrained by participants' work schedules and the limited time available for synchronous sessions. Discussion forums were primarily used for addressing technical issues rather than facilitating collaborative problem-solving, and learning resources were largely asynchronous, consisting of videos, documents, and quizzes, which limited adaptive and interactive learning.

Furthermore, the evaluation results from this study show a measurable improvement in teachers' cognitive competence. Based on pre-test and post-test scores, there was a significant increase in knowledge and skills regarding informatics education. Overall, the N-Gain results in Table 9 demonstrate a moderate but consistent improvement across all modules, with scores exceeding 40%, confirming the MOOC's effectiveness in enhancing cognitive aspects of teacher competence. This finding supports previous research demonstrating that MOOCs can significantly enhance teacher competence, especially when designed with local relevance, structured modules, and interactive learning components (Cabero-Almenara, Barragán-Sánchez, Palacios-Rodríguez, & Martín-Párraga, 2021; K.-Z. Chen & Oakley, 2020). In this study, the observed improvement in competence is directly linked to the structured learning process, where teachers must complete multimedia-based lessons (videos and documents) and associated quizzes or exercises successfully before proceeding to the next module. The increase in competence is attributed to the combination of multimedia learning materials, self-paced modules, and interactive tasks that enable teachers to learn at their own pace and revisit complex concepts as needed. Instructors provided active feedback and required participants to revise their assignments if tasks were incomplete or incorrect, ensuring mastery before proceeding.

Furthermore, well-designed MOOCs incorporating formative assessments and learner-centered approaches have been shown to improve not only subject mastery but also critical digital literacies among educators (Fernández-Otoya, Bravo, Pérez-Postigo, Alcázar-Holguin, & Loaiza Chumacero, 2024). These MOOC design features align closely with adult learning principles autonomy through flexible access, relevance via practical content, and active participation through interactive modules elements that research shows are essential for sustainable professional growth among teachers (Hertz et al., 2022; Lan & Hew, 2020). In practice, teachers experienced autonomy through self-

paced access to modules, relevance via content tailored to the current curriculum and local teaching context, and active participation through tasks and feedback from instructors. Such manifestations of adult learning principles were observed to drive both competence and motivation among teachers in West Kalimantan, highlighting the effectiveness of these design choices in supporting sustainable professional development.

In addition to cognitive improvements, participants also reported increased motivation to engage in self-paced online learning. Based on Table 10, the N-Gain analysis indicates that several motivational indicators, including the desire to succeed, learning needs, and the perception of a conducive learning environment, reached moderate levels. This affective gain is consistent with studies showing that well-designed MOOCs can foster digital self-efficacy and intrinsic motivation, particularly when they incorporate social interaction and personalized feedback (B. Chen, Fan, Zhang, Liu, & Wang, 2020). Features such as asynchronous access, downloadable materials, discussion forums, and progress-tracking tools likely contributed to teachers' perception of autonomy and control over their own learning process. This sense of ownership and perceived competence strengthens their confidence in using digital platforms for professional development. However, several motivation indicators showed relatively low improvement. Specifically, the desire to achieve and appreciation in learning remained in the low category, indicating the need for further enhancement in fostering intrinsic motivation and recognition within the MOOC design. The limited increase in these areas is attributed to minimal synchronous interaction, and the forums are primarily used for technical support rather than collaborative engagement. As highlighted in networked learning studies, the combination of peer interaction and structured self-learning in MOOCs not only facilitates knowledge acquisition but also enhances teachers' willingness to pursue further learning independently (Loh, Martins van Jaarsveld, Mesutoglu, & Baars, 2024).

Although this study demonstrates positive outcomes in enhancing the competence of Informatics teachers in West Kalimantan and provides insights for improving graduates of IKIP PGRI Pontianak, it has several limitations. The relatively small sample size and the use of convenience sampling limit the generalizability of the findings to a broader population of Informatics teachers. Additionally, motivation and satisfaction data were self-reported, making them susceptible to social desirability bias. The observed increase in motivation requires further analysis to ensure it stems from the MOOC design rather than the novelty effect of the technology. Therefore, future research should involve a larger and more representative sample and explore the development of MOOCs for teachers in remote or internet-limited areas.

▪ CONCLUSION

The MOOC for informatics educators in West Kalimantan was created utilizing the ADDIE development approach. During the analysis stage, it was generally acknowledged that teachers had previously used e-learning but were unfamiliar with MOOCs. However, teachers were interested in the MOOC that would be developed because it could serve as a means of gaining knowledge and skills, as they currently rely on social media to obtain information that is not always accurate or reliable. Informatics teachers also have internet access and adequate devices to access MOOCs later. Meanwhile, the main feature of MOOCs that is most important, according to teachers, is the diverse range of learning

materials accompanied by quizzes, exercises, and discussion forums. Based on the results of this analysis, a system and UI/UX design were developed prior to implementation. The results of the expert examination of the design showed that the resulting design obtained a very good category. The design results were then implemented to produce a MOOC using the Moodle framework. The resulting MOOC features various elements required by instructors, participants, and administrators. The results of this MOOC development were validated by experts who showed that the resulting MOOC was classified as very good. The implementation of the MOOC was carried out through trials involving informatics teachers, who responded very positively to the experience. Post-implementation evaluation further demonstrated a clear improvement in both teacher competence and motivation, indicating that the MOOC effectively supported professional growth and digital learning engagement. However, given the relatively small sample size, convenience sampling, and the short duration of the trial, further testing is needed in real-world conditions to confirm the sustained effectiveness of the MOOC, especially for teachers in 3T and other under-resourced areas. For this reason, Future research can expand on these findings by involving larger and more diverse samples to explore additional aspects of teacher competence and motivation in MOOC-based learning, particularly in remote regions where access to digital resources is limited.

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