

Development of Moodle-Based E-Learning to Improve Students' Mathematical Ability

Dian Rahadian^{1*}, Nugraha Hasan Sadikin², Iman Nasrulloh³, Tina Sri Sumartini⁴

Educational Technology Study Program, Institut Pendidikan Indonesia
Jalan Terusan Pahlawan, Garut, West Java, Indonesia

^{1*}dianrahadianpti@gmail.com

Mathematics Education, Institut Pendidikan Indonesia
Jalan Terusan Pahlawan, Garut, West Java, Indonesia

⁴tina.srisumartini@gmail.com

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Abstrak

Pengembangan pembelajaran elektronik yang merata merupakan isu pendidikan yang krusial dalam menjawab tantangan digitalisasi. Penelitian ini bertujuan mengembangkan sistem e-learning berbasis Moodle di SMK Bina Karya Mandiri untuk meningkatkan kemampuan matematis peserta didik. Metode penelitian yang digunakan adalah penelitian dan pengembangan (Research and Development) dengan pendekatan purposive sampling, melibatkan 35 peserta didik kelas X-Multimedia sebagai sampel. Teknik pengumpulan data dilakukan melalui tes, angket, dan dokumentasi untuk memperoleh informasi komprehensif mengenai kemampuan matematis dan pengalaman belajar peserta didik. Analisis data dilakukan dengan uji t satu pihak (one-tailed t-test) untuk mengukur peningkatan kemampuan matematis peserta didik. Hasil penelitian menunjukkan bahwa pengembangan e-learning berbasis Moodle efektif untuk meningkatkan kemampuan matematis peserta didik. Sistem e-learning ini berfungsi sebagai pelengkap dalam kegiatan belajar mengajar, terutama ketika pembelajaran tidak dapat dilaksanakan sesuai jadwal yang telah ditentukan di sekolah. Namun demikian, pembelajaran yang ideal tetap memerlukan peran aktif guru secara langsung guna mencapai hasil belajar yang optimal.

Kata Kunci: E-learning; Moodle; Pembelajaran Matematika

Abstract

The development of equitable e-learning is a crucial educational issue in responding to the challenges of digitalization. This study aims to develop a Moodle-based e-learning system at SMK Bina Karya Mandiri to improve students' mathematical abilities. The research method used was Research and Development (R&D) with a purposive sampling approach, involving 35 tenth-grade Multimedia students as the sample. Data were collected through tests, questionnaires, and documentation to obtain comprehensive information on students' mathematical abilities and learning experiences. Data analysis was carried out using a one-tailed t-test to measure the improvement in students' mathematical abilities. The results showed that the development of Moodle-based e-learning was effective in enhancing students' mathematical abilities. This e-learning system serves as a complement to teaching and learning activities, especially when learning cannot be conducted according to the predetermined school schedule. Nevertheless, ideal learning still requires the active role of teachers in person to achieve optimal learning outcomes.

Keywords: : E-learning; Moodle; Mathematics Learning

I. INTRODUCTION

The rapid development of science and technology has driven significant changes in almost all sectors of life, including education, which is required to remain dynamic in keeping up with the progress of the times (Fauzi, Yaniawati, & Sari, 2024). The challenges of the Society 5.0 era, characterized by digitalization in all aspects of life, encourage the education sector to make technology the basis of learning and to produce graduates with information technology (IT) literacy competencies as a hallmark of the 21st century (Anita et al., 2021; Nuraeni, Nurjanah, & Siregar, 2024). This aligns with Darmawan's (2017) statement emphasizing that educational institutions should promptly introduce and apply Information and Communication Technology (ICT) as the foundation of modern learning.

One concrete implementation of technology in learning is the use of Moodle (Modular Object-Oriented Dynamic Learning Environment), an open-source Course Management System (CMS) that can be freely used and modified under the GNU General Public License (Retnoningsih, 2017; Dewantara et al., 2023; Saputro et al., 2024). Moodle facilitates interactive digital classroom management, enabling teachers to deliver materials, quizzes, and exams online, as well as to monitor students' learning activities through an automated recording system (Nasution et al., 2020). These advantages have led to Moodle's widespread use in previous research, for example, by Pradana (2019) and by Listiani, Maharani, and Chong (2023), who found that Moodle effectively increases student participation in online

learning, and by Putra and Rachmadi (2021), who showed that Moodle can improve learning outcomes in science subjects.

At SMK Bina Karya Mandiri, the implementation of Moodle-based e-learning was motivated by the challenges faced by teachers in delivering material directly during the COVID-19 pandemic, compounded by the limited number of classrooms, which can only accommodate four study groups. Based on data from interviews with the Vice Principal for Curriculum Affairs (2024), learning had to be divided into two systems: Grades XI and XII studied at school, while Grade X studied from home using Moodle-based e-learning. This situation was further complicated by the Industrial Work Practice (Prakerin) program lasting three months, during which students still had to take their final semester exams.

Unlike previous studies, which generally examined Moodle only in terms of its effectiveness on learning outcomes, this research presents novelty by focusing on developing Moodle-based e-learning tailored to the specific conditions of SMK Bina Karya Mandiri, including limitations in physical facilities and the split learning system due to the pandemic and Prakerin. This study not only measures the improvement of students' mathematical abilities but also examines the development procedures of an e-learning system relevant to the school's needs.

Therefore, the objectives of this study are: to describe the development procedures of Moodle-based e-learning media at SMK Bina Karya Mandiri; and to determine the improvement in learning

effectiveness through the use of the Moodle-based e-learning system for teachers and students as an innovative solution to overcome the limitations of face-to-face learning at the school.

II. METHOD

This study employs a Research and Development (R&D) approach, which is a systematic process consisting of steps to develop new products or refine existing products to optimize their functions and ensure their scientific accountability.

The research approach used is qualitative, with the development procedure based on the Borg & Gall model, which aims to produce Moodle-based e-learning media that can be utilized in the learning process. The research and development model according to Borg & Gall consists of ten steps: (1) Research and initial information gathering; (2) Planning; (3) Development of initial product; (4) Limited field testing; (5) Revision of limited field testing results; (6) Wider field testing; (7) Revision of wide field testing results; (8) Product feasibility testing; (9) Feasibility revision; and (10) Dissemination and socialization of the final product (Munandar et al., 2022). These steps are procedural and systematic, allowing the researcher to carry out the development process in a continuous manner from the initial to the final stages.

The main subjects of this study are 35 students from class X at SMK Bina Karya Mandiri in Leles District, Garut Regency. This group was chosen based on several considerations, including: (1) The students in class X have heterogeneous academic

abilities, ranging from high to moderate and low performance; and (2) Out of the 13 learning groups (rombel) at SMK Bina Karya Mandiri, the X Multimedia class is the only one where all students own smartphones, which supports the implementation of Moodle-based e-learning.

III. RESULT AND DISCUSSION

A. Development of Moodle-based E-learning System

In this stage, the researcher designs the product using an online Learning Management System (LMS) Moodle. The development of the Moodle-based e-learning system is carried out through several stages as follows.

1. Identifying Potential and Problems

Based on the identification process, it was found that a major issue arises in learning activities when teachers and students are unable to meet face-to-face. The learning becomes ineffective, even if assignments have been given (Pohan, 2020). These potential issues can be considered by the researcher in the development of the Moodle-based e-learning system.

2. Literature Review

In this stage, the researcher collects and studies several literatures related to the research and development, based on previous studies, to determine what product should be developed in order to address the problem, particularly the development of Moodle-based e-learning as an effort to improve learning effectiveness at SMK Bina Karya Mandiri.

3. Information Gathering

At this stage, the researcher collects various information from the administrative section related to student data, teachers, subjects according to the curriculum structure, class schedules, materials, articles, school news, and other information that supports the completeness of data in the Moodle-based e-learning system.

4. Product Design

The product design offered is a Moodle-based e-learning system that provides two types of personalization, namely real-time and non-real-time. The researcher develops the LMS online, taking into account time and cost considerations, by applying the following stages.

a. Pre-production Stage

This stage explains the design of features and content provided in the Moodle-based e-learning system, presented in the form of a flowchart divided into three sections of user access, namely administrator, teacher, and student.

b. Production Stage

The production stage is when the researcher implements the design of the Moodle-based e-learning system that was carried out in the pre-production stage. The following will describe some user interface designs based on user access rights.



Figure 1. Initial Display of E-Learning.

Figure 1 shows the initial display when the user visits the Moodle Learning Management System of SMK Bina Karya Mandiri with the link: <https://smkbikama.edukati.com/>

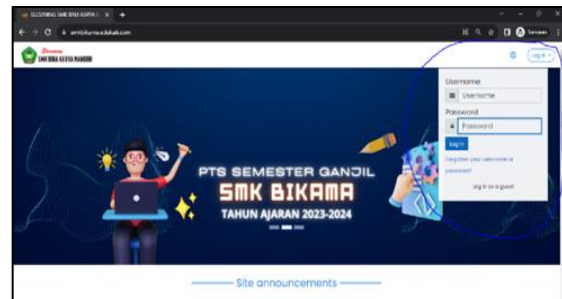


Figure 2. E-Learning Login Form.

Figure 2 shows the login form that serves as an entry point for users, including administrators, teachers, and students. The image also provides a "lost password" feature, which helps users who forget their password by sending the password to their email. There is also a "Create new account" feature that can be used to create a new account. However, in this case, Moodle users, whether teachers or students, do not register their own accounts, but instead, they are registered by the administrator.

Unlike the administrator, the administration features for teachers are limited to managing subjects, lesson schedules, and the initial display of the subjects they teach. Teachers can provide various learning resources to students that can be uploaded or studied, such as.

- Files and Folders Moodle offers an easy way for teachers to present materials to students. These materials can include files like Word documents and presentations.

- LMS Content Packages: These can be created using various content-authoring software, and the output is a zip file.
- Labels: Different from other resources, labels consist of text and graphics only.
- URL (Moodle page): A URL (Uniform Resource Locator) is an internet address for Moodle or online files. Teachers can use the URL module to provide Moodle links for students to research, saving time.
- Page: On the resource page, links are created to a screen that displays content created by the teacher, allowing the page to show various types of learning content.

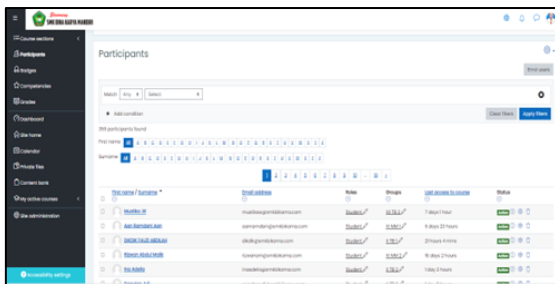


Figure 3. E-Learning.

c. Post-Production Stage

At this stage, the researcher conducts product evaluation by experts or specialists before testing it with users.

5. Design Validation

The design of the Moodle-based e-learning system is 96.

6. Design Revision

This phase is carried out after the first product design validation. The revisions are made based on several revisions from media experts (validation sheets are

attached). Some of the features in the LMS that were revised include:

- Banner on the main page;
- User access rights;
- User access rights were not previously configured because the users had not been registered, so experts could not yet see the difference in access rights for each user;
- Presentation of the "courses" category to make it easier for users to access. On the main page, before the researcher grouped the subject list according to categories, which made it difficult for users to select subjects by category, such as academic year, expertise competence, and grade level.

7. Limited Trial

The limited trial was conducted with several students to determine the quality of the Moodle-based e-learning system that was developed, system familiarity, and ease of access. This trial was carried out twice to ensure that the tested features could be understood by the students. The trials included: User login test (access rights), menu test, profile settings application test, display test, material access per session test, quiz/test test, and grade processing test (Muntu, 2017).

8. Product Revision 1

Product Revision 1 was conducted based on the evaluation of the limited trial. At this stage, the revision only focused on the default settings for the language configuration, which was set to Indonesian.

9. Main Field Trial

In the main field trial phase, the researcher tested the feasibility of the system by applying e-learning materials

using Moodle in the Basic Programming subject for class X Multimedia Expertise Competency.

10. Dissemination and Implementation

This phase is where students and teachers can use the Moodle-based e-learning system in their daily teaching and learning activities. The Moodle-based e-learning system is now ready to be used in teaching and learning activities according to the conditions and needs.

B. Effectiveness of Implementing Moodle-Based E-Learning System

The researcher collected respondent data to evaluate learning outcomes while using the Moodle-based e-learning system. The results of the reliability test during data collection for learning evaluation with the Moodle-based e-learning system are as follows.

$$\begin{aligned}
 R_{11} &= \left(\frac{k}{k-1}\right) \times \left(1 - \frac{\sum S_i}{S_t}\right) \\
 &= \left(\frac{20}{20-1}\right) \times \left(1 - \frac{7,75}{66,045}\right) \\
 &= 0,929
 \end{aligned}$$

Decision = Reliable

Data processing in researching the effectiveness of learning using the Moodle-based e-learning system is done through surveys of actual conditions that occur when teaching and learning activities cannot be carried out effectively, as well as using surveys to evaluate the use of the Moodle-based e-learning system. The data presented is as follows for the improvement of learning effectiveness.

Table 1.
E-Learning Effectiveness Survey

No	Type of Trial	Score	Average
1	Actual condition	1607	45.91

No	Type of Trial	Score	Average
	(needs analysis)		
2	Limited trial	679	67.90
3	Main field trial	2435	69.57
4	Operational field trial	2994	85.54
5	Effectiveness trial (evaluation)	3048	87.09

C. The Relationship Between the Implementation of the Moodle-Based E-Learning System Developed and the Improvement of Learning Effectiveness at SMK Bina Karya Mandiri

The researcher conducted a study to determine the positive and significant relationship between the development of the Moodle-based e-learning system and the improvement of learning effectiveness at SMK Bina Karya Mandiri. The calculated Z value above is then compared with the Z table value for a two-tailed test, where the error level of 1% is divided by 2, resulting in 0.5%. The Z value can be seen on the curve with Z = 0.495 (0.495 is obtained from 0.5 = 0.0005). In the normal curve table, the number 495 is not available, but the closest number is 4951. Based on this number, the Z value is 2.58. Therefore, using the rule that if the calculated Z is greater than the table value, the correlation coefficient found is significant. It turns out that the calculated Z of 642 is greater than the Z table value of 2.58. Thus, it can be concluded that the correlation between the development of the Moodle-based e-learning system and the improvement of learning effectiveness of 0.77 is significant.

In principle, educational technology exists to assist in simplifying and solving learning problems. Among these educational technology products is

Moodle-based e-learning, which is one of the learning media with several advantages, such as being very practical, accessible both online, and not limited by space and time, able to create an interactive learning atmosphere, and motivating students to engage actively in the learning process (Abdurahman, et al., 2024; Simanjuntak, 2023).

According to Siahaan (Sari & Priatna, 2020), there are three functions of e-learning in classroom activities (classroom instruction), namely as a Supplement (optional), Complement (complementary), or Substitution (replacement).

1. Supplement (additional)

E-learning serves as a supplement, meaning that students have the freedom to choose whether or not to utilize e-learning materials. There is no obligation for students to access the e-learning material, but those who do will gain additional knowledge or insights (Sagita & Nisa, 2019).

2. Complement (complementary)

E-learning functions as a complement, meaning that its materials are programmed to supplement the learning materials received by students in the classroom. Therefore, e-learning materials are programmed to serve as reinforcement or remedial content for students participating in conventional learning activities (Sharipuddin, et al., 2019).

3. Substitution (replacement)

E-learning serves as an alternative model for learning activities for students. In this case, it aims to allow students to flexibly manage their learning activities according to their schedules and daily

activities. There are three alternative models of learning activities from which students can choose: 1) Fully face-to-face (conventional); 2) Partially face-to-face and partially using the internet; or 3) Fully through the internet (Hadisi & Muna, 2015).

Meanwhile, the term Moodle stands for Modular Object-Oriented Dynamic Learning Environment, which means a dynamic learning environment using an object-oriented model or a dynamic web-based educational environment package developed with an object-oriented concept. Moodle can be downloaded for free from www.moodle.org. In its provision, Moodle offers a complete software package (Moodle + Apache + MySQL + PHP).

The application of Moodle in learning can help educators and students understand the material. This is because Moodle has certain advantages, some of which are as follows.

1. It is suitable for online classes (Buto, et al., 2018);
2. The learning outcomes are relatively as good as learning through direct face-to-face interaction with the instructor (Tyas, et al., 2024);
3. Instructors have special privileges, such as the ability to modify learning materials. Instructors can set up lessons, including prohibiting other instructors from providing lessons. Additionally, they can choose forms or methods of learning, such as weekly-based, topic-based, or discussion-based formats (Prasetyo, 2017);

4. The technology used is simple, making it easy, relatively inexpensive, and efficient (Suyetno & Solichin, 2020);
5. The program is easy to install (Mulatsih, 2014);
6. Only one database is needed for the program (Zulkifli, 2013);
7. Lessons are equipped with explanatory displays. Additionally, lessons can be categorized into several groups and support multiple subjects (Putri, 2017);
8. It ensures good security (Nuryadi, et al., 2022);
9. It provides language packages, making it easier for users to choose the language they wish to use, such as Bahasa Indonesia, English, Chinese, French (Putri, 2017).

IV. CONCLUSION

Based on the results of the research and discussions presented, the conclusions of this study are as follows:

The development of Moodle-based e-learning developed by the researcher through online methods is easier. This is because developers do not need to build a database; they only need to rent hosting and purchase a domain to ensure the e-learning runs stably. This is in contrast to free services, which have limited features. Additionally, developing e-learning online is easier because developers do not need to manually configure the system initially.

The implementation of the Moodle-based e-learning system assists both teachers and students in the learning process when face-to-face interactions are not possible. The Moodle-based e-learning system has been proven to support the

improvement of learning effectiveness at SMK Bina Karya Mandiri.

According to the research conducted, there is a significant positive relationship between the development of Moodle-based e-learning and the improvement of learning effectiveness at SMK Bina Karya Mandiri. The application of this e-learning system only helps facilitate teaching and learning activities that cannot be carried out according to the predetermined school schedule. Therefore, ideal learning still requires the direct involvement of a teacher to achieve effective learning.

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