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Analysis of the Need Development of E-Content Based on Problem Based Learning (PBL) using Moodle on Basic Chemical Law Material

Analisis Kebutuhan Pengembangan *E-Content* Berbasis *Problem Based Learning* (PBL) Menggunakan *Moodle* pada Materi Hukum Dasar Kimia

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Abstract

This research explores the development of digital teaching materials using Moodle based on Problem-Based Learning (PBL) on Basic Laws of Chemistry for SMA/MA phase E students. Despite the increasing growth of internet users in Indonesia, its utilization is still dominated by messaging and social media activities, indicating the lack of use of information technology in the context of learning. E-Content Moodle was identified as a solution that supports the development of IT in learning, provides personalized learning experiences and enhances accountability. A needs analysis was conducted to understand E-phase SMA/MA students' characteristics, learning preferences, technology skill levels and learning challenges. The research aimed to identify specific needs in such learning environments with a participatory approach involving teachers and students. The literature review reinforced the basic concept of problem-based learning (PBL) and the role of Moodle in interactive online learning. Previous studies highlighted the success of PBL in improving concept understanding, critical thinking skills and student motivation. As a learning management system, Moodle is recognized for its ability to create an interactive and practical online learning environment. The research method used an Educational Design Research (EDR) approach with preliminary and prototyping phases. Data were collected through questionnaires to teachers and students for analysis.

Keywords: *e-content, problem-based learning, PBL, moodle, chemistry, primary chemical law material,*

Abstrak

Penelitian ini mengeksplorasi pengembangan bahan ajar digital menggunakan *Moodle* berbasis *Problem Based Learning* (PBL) pada materi Hukum Dasar Kimia untuk siswa SMA/MA fase E. Meskipun pertumbuhan pengguna internet di Indonesia meningkat, pemanfaatannya masih didominasi oleh aktivitas pertukaran pesan dan media sosial, menunjukkan kurangnya penggunaan teknologi informasi dalam konteks pembelajaran. *E-Content Moodle* diidentifikasi sebagai solusi yang mendukung pengembangan IT dalam pembelajaran, memberikan pengalaman belajar pribadi dan meningkatkan kemampuan bertanggung jawab. Analisis kebutuhan dilakukan untuk memahami karakteristik siswa SMA/MA fase E, preferensi belajar, tingkat keterampilan teknologi, dan tantangan pembelajaran. Dengan pendekatan partisipatif, melibatkan guru dan siswa, penelitian ini bertujuan untuk mengidentifikasi kebutuhan spesifik di lingkungan pembelajaran tersebut. Tinjauan pustaka memperkuat dasar konsep pembelajaran berbasis masalah (PBL) dan peran *Moodle* dalam pembelajaran *online* yang interaktif. Studi sebelumnya menyoroti keberhasilan PBL dalam meningkatkan pemahaman konsep, keterampilan berpikir kritis, dan motivasi siswa. *Moodle*, sebagai sistem manajemen pembelajaran, diakui karena kemampuannya menciptakan lingkungan belajar *online* yang interaktif dan efektif. Metode penelitian menggunakan pendekatan *Educational Design Research* (EDR) dengan fase pendahuluan dan *prototyping*. Data dikumpulkan melalui angket kepada guru dan siswa untuk analisis kebutuhan. Hasil penelitian menunjukkan bahwa PBL melalui *Moodle* memberikan pendekatan pembelajaran yang lebih kreatif, mandiri, dan praktis bagi siswa. Integrasi *Moodle* berbasis PBL meningkatkan kualitas pembelajaran kimia di tingkat SMA. Hasil penelitian ini memberikan implikasi praktis dalam pengembangan bahan ajar digital. Penggunaan *Moodle* berbasis PBL diharapkan dapat meningkatkan kualitas pembelajaran kimia dan relevansinya dengan kebutuhan siswa. Studi lanjutan dapat mengevaluasi dampak jangka panjang dari penerapan *Moodle* berbasis PBL terhadap prestasi belajar dan keterlibatan siswa.

Kata Kunci: konten elektronik, berbasis masalah, PBL, *moodle*, kimia, hukum dasar kimia,

1. Introduction

Education has experienced rapid development over the past years, especially in adopting Information Technology (IT) in the learning process. (Septiani, 2023). However, the actual results of using information technology for learning are still inadequate (Temaya, Repi & Yalindua, 2023). This is evidenced by data from the APJII (Association of Indonesian Internet Service Providers) survey results, where internet users in Indonesia reached 215.63 million people from 2022 to 2023. This number increased by 2.67% compared to the previous period of 210.03 million users, but its utilization is used chiefly to change letters/messages (89%) and social media (87%). This proves that information technology is not maximally utilized to increase learning capacity, especially in learning (Setya Raharja, Lantip Diat Prasojo, 2019). This research is also related to facts in the field and adjustments to the current independent curriculum, so it is necessary to develop interactive and innovative learning media so that it can be used both online and offline, one of which is E-Content Moodle (Sari & Zainul, 2021).

E-content Moodle is one of the learning media that supports the development of Information Technology (IT) in the Era of Industrial Revolution 5.0. E-content Moodle offers advantages in facilitating distance teaching, allowing students to access teaching materials anytime and anywhere. Teachers can create text-based learning modules, online assignments, discussion forums, and other assessments—diverse formats and functionality. Moodle e-content in the learning process has four advantages: providing an individualized learning experience, saving costs, being easily accessible and fostering student responsibility skills (Staples, 2023). In addition to providing preparation for students, the use of IT in learning also provides provisions for educators to face the era of the Industrial Revolution 5.0 (Sari & Zainul, 2021). In this learning media, videos and images can be added to reduce student boredom while learning (Setiadi & Zainul, 2019).

The application of Moodle e-content in the teaching-learning process provides convenience for students and teachers, supporting learning effectiveness in the classroom (Amarodin, 2020). Moodle-based e-content presents a variety of features that can be optimized to boost students' interest in learning and understanding of concepts during classroom learning (Prestiadi, 2020). In line with the development of technology and information, learning media has progressed, both in the form of software and hardware, which changes the role of the teacher from a source of knowledge to a facilitator (Rohani, 2020). A clear example of the utilization of information technology in learning is Moodle e-content, which can be considered as an adaptation of learning activities in schools into a digital format associated with information technology and the internet (Syaifudin, 2023). Digital teaching materials can also help improve students' understanding of concepts and creativity. Information technology makes teachers' attention to students' attitudes and character more important than aspects of cognitive intelligence. (Permana, Sukma & Wahyono, 2021). Integrating Moodle with problem-based learning can create an interactive and motivating online learning environment. However, a comprehensive needs analysis needs to be conducted beforehand to ensure that the development of e-content based on problem-based learning with Moodle follows the characteristics of students and learning needs at the E-phase Senior High School level (Ismail Marzuki, 2023).

Based on this view, this research will conduct an in-depth needs analysis. The previous literature review highlighted the need to understand the characteristics of high school/madrasah aliyah students in phase E, including their learning preferences, technology skill levels, and learning challenges faced (Liriwati, 2023). In addition, the research will also involve a participatory

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approach by involving teachers as well as students in the process of data collection or data clustering to gain a broader and more accurate insight into the specific needs of the learning environment (Oliver *et al.*, 2007).

2. Literature Review

2.1 Characteristics of Students in Phase E SMA/MA

According to the cognitive development theory Piaget (1970), adolescents in phase E of SMA/MA begin to enter the formal operational stage, where they can think abstractly and logically. This process allows them to understand better abstract concepts, such as the fundamental laws of chemistry. Meanwhile, social development theory Sokol (2009) highlights that at the stage of identity versus role confusion, adolescents search for their identity, including appropriate career choices (Adiansah *et al.*, 2019). Learning preferences and cognitive styles are essential to understanding students in phase E. The Learning model (Afnanda, 2023) shows that students have different learning preferences, such as learning through concrete or reflective experiences. This needs to be considered in the development of PBL-based e-content to meet students' diverse learning styles (Muhid, 2021). In addition, the existence of digital natives emphasizes that students in this era have grown up in a digital environment, so they have high digital skills (Fernandes, 2019). Therefore, integrating technology, including Moodle, in learning is relevant (Gunawan *et al.*, 2021).

Learning challenges and difficulties are also essential concerns in this phase. Eccles and Roeser (2011) emphasize the importance of creating developmentally appropriate learning environments, given the significant role schools play in shaping students' academic motivation and self-understanding (Paputungan & Paputungan, 2023). In addition, critical thinking and problem-solving skills are also an important focus, along with the emphasis on students' intellectual development (Manurung *et al.*, 2023). By understanding the characteristics of students in phase E SMA/MA, the development of PBL-based e-content using Moodle can be designed more contextually and following the needs and potential of students at that level (Anam, Ismanto & Purnomo, 2020).

2.2 Effectiveness Problem-Based Learning (PBL)

Problem-based learning (PBL) highlights the success of this learning method in improving students' conceptual understanding and skills. Research (Amelia, 2019) showed that PBL can improve students' problem-solving ability, critical thinking skills, and motivation. PBL provides a natural context for learning, allowing students to apply their knowledge in real-life situations, which can improve concept understanding and relevance of learning (Astuti, 2019).

Nugraha, Supriadi & Firmansyah, (2023) investigated the effectiveness of PBL in helping students understand the subject matter more deeply. The study showed that PBL can improve students' understanding of concepts and encourage them to develop higher cognitive skills, such as analysis and synthesis of information(Sulaiman & Azizah, 2020). In addition, PBL can stimulate students' curiosity and intrinsic motivation, which are essential factors in successful learning (Reski, Hutapea & Saragih, 2019). The importance of PBL in improving critical thinking and problem-solving skills is also emphasized by recent studies Siswanti & Indrajit, (2023) present evidence that PBL can help students develop critical thinking and problem-solving skills, essential in their preparation for real-world challenges. With this, PBL is an effective learning method in transferring knowledge and building the 21st-century skills required by students (Kurniawati, Raharjo & Khumaedi, 2019).

2.1 The Role of Moodle in Learning

This learning management system creates an interactive and practical online learning environment (Surani, 2019). Nazika (2021) investigated the usability and accessibility of Moodle as a Learning Management System (LMS). This study shows that Moodle has a user-friendly interface and provides various features that support online teaching, such as discussion forums, online assignments, and rubric-based assessment Prayogi (2020) conducted a case study on the role of Moodle in e-learning at a university. The results show that Moodle provides a platform to deliver learning content online and supports collaboration between teachers and students through features such as forums and online assignments (Sulistyorini & Anistyasari, 2020). Moodle also facilitates the evaluation and feedback process, enhancing interactivity in online learning.

The importance of Moodle's role in supporting e-learning is also emphasized by other literature. Moodle can be an effective tool for creating an interactive and personalized learning experience. By providing a range of collaborative tools, Moodle provides flexibility in designing and delivering learning materials (Rasiman, 2023). Thus, this study underlines that Moodle is an online content delivery platform and a collaborative tool that can enhance interaction and engagement in learning.

2.3 Technology Integration in Chemistry Learning

Technology integration in chemistry learning shows that technology can contribute significantly to students' understanding of concepts and skills (Kurniawan, Hidayati & Surdyanto, 2023). Chittleborough & Treagust (2007) investigated the use of technology in developing students' understanding of the submicroscopic level in chemistry. They found that animation and simulation models can facilitate students' understanding of abstract concepts in chemistry, such as the Fundamental Laws of Chemistry. A problem-based learning model that utilizes technology to improve students' understanding of chemical equilibrium. Integrating technology in the form of interactive simulations helps students visualize the concept of chemical equilibrium dynamically, which can enhance their knowledge (Nurlianingsih, 2021). This study shows that technology can be an effective tool to help students understand complex chemistry concepts.

In chemistry teaching, the success of technology integration also depends on the teacher's ability to utilize these tools Budiyono (2020) underscores the importance of teacher training in integrating technology with chemistry learning. This study shows that teachers who are skilled in using technology can realize a more attractive and efficient learning experience (Gemnafle & Batlolona, 2021). The integration of technology in chemistry learning can positively contribute to student understanding. Still, it also emphasizes the importance of the teacher's role in managing and optimizing the use of this technology in the context of chemistry learning.

2.4 Needs Analysis in Moodle Development

The needs analysis in Moodle development highlights the importance of understanding user needs and the learning environment before designing and implementing this platform. Fitria & Indra (2020) propose an authentic learning design framework emphasizing the need to understand the learning context and students' needs before designing an online learning experience. The emphasis on needs analysis enables developers to identify the most relevant and useful Moodle features and functionality to achieve learning objectives (Akbar *et al.*, 2023).

Pardede (2020) discusses the importance of assessment alternatives in e-learning development using learning management systems such as Moodle. Carefully assessing students' needs through needs analysis can assist teachers and developers in designing assessment

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instruments that are appropriate to the learning context. By profoundly understanding students' needs, assessments integrated into Moodle can become more relevant and meaningful to students' learning experiences. Fajri, Suryadi & Anggraeni (2021) explored the usability and accessibility of Moodle as a Learning Management System. The study highlighted that the needs analysis included understanding the students' level of technological skills and the learning approaches teachers use (Moscato & Embre, 2023). By understanding these needs, developers can customize the Moodle interface and integrate features that support different skill levels and student learning preferences. The emphasis on needs analysis in Moodle development highlights that an in-depth understanding of student characteristics, learning objectives and context is critical to designing and implementing an effective e-learning platform.

3. Research Methods

This study applies the Educational Design Research (EDR) approach by applying a development model that follows the Plomp model, and this model consists of three phases: preliminary research, prototyping phase, and assessment phase (Plomp *et al.*, 2010). The first research procedure is the primary research phase, which includes needs analysis, context analysis, literature study, and conceptual framework development. The second is the prototype formation phase, prototype I is the initial design, prototype II is a revision of the self-evaluation of prototype I, then prototype III which at this stage includes expert assessment and one-on-one trials, after which a valid prototype IV is obtained. The third assessment phase, where the product's practicality is tested and a valid and practical product is received (Mufidati, 2021). This research aims to develop an E-content product based on Problem-Based learning (PBL) using the Moodle platform on primary chemical law material for phase E SMA / MA students. Based on the research methodology, this article will highlight preliminary research findings. The data analysis method used is descriptive analysis, and the research instrument is questionnaire-based. This questionnaire consists of a needs analysis questionnaire filled out by teachers (5 respondents) and a student analysis questionnaire (126 respondents). The questionnaire was prepared using a teacher questionnaire sheet and a student questionnaire using Google form and distributed via WhatsApp media.

4. Results and Discussion

4.1 Research Results

The research results presented in this article cover the preliminary research and design stages. The results of the research can be detailed as follows: First, at the preliminary research stage. Overall, the initial research on developing Moodle teaching materials based on problem-based learning on primary chemical law material consisted of three main steps: needs analysis, student analysis, and concept analysis. The analysis results at this stage are described as follows: 1) Needs analysis, conducted through the distribution of questionnaires and questionnaire sheets to teachers and students in three schools in Padang. This questionnaire sheet covers aspects of teaching materials and learning methods. The research results at the needs analysis stage are regarding integrating digital teaching materials, namely Moodle, based on problems in Basic Law of Chemistry material. After conducting a feasibility test and then giving an interest questionnaire to students, the assessment results showed that the aspect of interest before learning with e-modules, 51% agreed and 8% strongly agreed with chemistry lessons. This indicates that the research conducted with acid-base e-modules as a whole can be used to increase student interest

and learning outcomes in Table 1. The teacher's response to the teaching materials used by students can be seen. Furthermore, the use of learning methods can be seen in Table 1.

Table 1. Teacher's Response to the Teaching Materials Used

No	Statement	Answer (%)			
		SS	S	TS	STS
1.	Teaching materials used for learning vary	72,3	24,5	3,2	0
2.	Moodle digital teaching materials make learning more practical	82,5	16,1	1,4	0
3.	Moodle integrated with problem-based learning	67,8	31,1	1,1	0
4.	As a teacher, having digital teaching materials is indispensable	56,4	42,8	0,8	0
5.	Teaching materials with problem-based methods are also needed	44,5	54,3	1,2	0
6.	Digital teaching materials containing various images and videos are interesting and varied topics.	88,6	11,4	0	0

Description: SS (Strongly Agree); S (agree); TS (Disagree); STS (Strongly Disagree)

In Table 1, the analysis results can be concluded as follows. (a) Almost all teachers strongly agree that the teaching materials used are varied. (b) Teachers strongly agree that digital teaching materials such as Moodle make learning more practical. (c) The majority of teachers agree that Moodle uses problem-based learning methods. (d) Teachers also need varied teaching materials to make teaching more interesting and innovative.

Table 2. Learning models used by teachers

No	Type of Learning Model	Percentage (%)
1.	Collaborative Learning	7,0
2.	Cooperative Learning	8,9
3.	Inquiry	70,5
4.	Discovery Learning	25,4
5.	Problem-based Learning	89,0
6.	Project-based Learning	49,7
7.	Task-based Learning	26,8

The questionnaire results explain that PBL is a very common approach practiced by teachers in the context of chemistry learning today. The reasons for using this approach can be described as follows. (1) This approach can encourage students to be more creative in formulating

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solutions, especially related to problems. (2) Students' understanding of material concepts becomes better after understanding the context of the problem. (3) This approach makes it easy for students to learn individually or in groups, and they can independently learn at home. (4) Applying PBL has proven easy in a classroom learning atmosphere. (5) The tasks given become more accessible to students, including those with digital devices, thus facilitating the process of practical assignments.

The application of Problem-Based Learning in chemistry learning by teachers is as follows. (1) Teachers provide many pictures and videos that students can access to understand learning. (2) Students are given a room to discuss and solve the problems together. (3) Students complete the task coherently according to the teacher's procedure. (4) This approach can also be implemented by providing tasks using various media such as images, videos, and audio. (5) Provide self-evaluation sheets to students for learning evaluation.

Furthermore, student analysis. This stage of the research was carried out by giving questionnaires to high school students in Padang city regarding the teaching materials used, especially to find out the understanding of students' concepts using existing teaching materials. The results of this research can be seen in Table 3.

Table 3. Student Analysis Results

No	Statement	Answer (%)			
		SS	S	TS	STS
1.	I only understand the learning material explained by the teacher	78,4	14,8	6,8	0
2.	I can understand learning materials through reading sourcebooks	43,6	45,7	8,9	1.8
3.	I can understand learning materials through digital media	51,2	45,4	3,4	0
4.	I have enough time to understand the material outside of class.	32,6	65,1	2,3	0
5.	I often ask the teacher about material that I have not understood.	64,1	31,8	4,1	0
6.	I prefer to do my assignments independently	48,7	48,2	2,2	0,9
7.	I prefer to do assignments in groups	72,5	18,8	7,3	1,4
8.	I like digital teaching materials like Moodle,	77,9	20,6	1,5	0
9.	I understand learning through images, videos and audio	89,5	7,3	1,7	1,5
10.	I use digital devices for learning purposes	26,4	62,2	10,6	0,8

Second, the design phase (prototype phase) involves the preparation of product prototypes for the development of Moodle digital teaching materials focused on problem-based learning on the basic laws of chemistry for senior high school students. Before the Moodle development phase began, the model to be implemented into the teaching materials (as the learning syntax) was designed. This learning syntax, which is based on a problem-based approach, is tailored to the specific needs in the context of this Moodle development. After the development of the syntax, the validation stage was carried out through three methods: self-evaluation, evaluation by experts, and responses from teachers.

4.2 Discussion

The results of the needs analysis obtained from the research state that the types of teaching materials commonly used by teachers in teaching chemistry are still standardized on printed materials such as books from the Ministry of Education and Culture, privately published books, printed books of LKS (Student Worksheets), printed modules, and printed student worksheets. Through student evaluation, it was found that student's understanding and skills in using digital devices were qualified to implement Moodle digital teaching materials in chemistry learning. The importance of preparing teaching materials tailored to the needs of students is also emphasized (Ramadhan, Sukma & Indriyani, 2019). Moodle's digital teaching materials have created a more efficient and enjoyable teaching and learning atmosphere. The application of digital teaching materials has a significant effect on student development. (Başarmak *et al.*, 2019).

The results also explained that teachers and students positively responded to implementing Moodle as digital teaching material in chemistry learning. Moodle is one of the most attractive and widely used learning platforms to facilitate teachers and students in the teaching and learning process (Zabolotniaia *et al.*, 2020). The development of Moodle teaching materials based on Problem-Based Learning (PBL) showed the primary needs from the perspective of teachers and students. The needs analysis indicated teachers' desire for variety in teaching materials, support for the use of problem-based Moodle, and the need for variety to make teaching more enjoyable. These positive responses reflect the desire for innovation and practicality in chemistry learning. The application of Problem-Based Learning (PBL) is recognized as a practical approach to learning chemistry. Questionnaire data shows teachers prefer PBL because it stimulates student creativity, improves concept understanding, and facilitates independent learning. PBL is also considered easy to integrate into classroom learning and enables students' access to practical tasks.

Teachers' approach in implementing problem-based learning in chemistry learning. Pictures, videos, and discussion rooms give students better access to the material. Tasks are organized coherently according to predetermined procedures, and various media, such as images, videos, and audio, provide variety in learning. Students are given tasks that require them to solve problems individually and in groups using various media. Teachers also offer students with self-evaluation sheets to evaluate their learning. In conclusion, PBL through Moodle offers students a more creative, independent and practical learning approach. Questionnaire data confirms that problem-based learning is the most widely used approach by teachers in chemistry learning in schools, proving its popularity due to its various advantages.

The results of this study provide practical implications in the context of the development of digital teaching materials. Moodle integration based on problem-based learning offers a responsive and innovative learning model, improving the quality of chemistry learning at the high school level. The findings provide a foundation for further development recommendations. Further research could explore the long-term impact of Moodle-based problem-based learning on learning achievement and student engagement during chemistry learning at the high school level.

5. Conclusion

The results of research and discussion can be summarized as follows: The development of digital teaching materials is needed to improve chemistry learning. There is a need for innovation in preparing teaching materials adapted to scientific advances. One option that can be applied is using Moodle digital teaching materials based on problem-based learning and fundamental chemical law material. Moodle was developed based on the needs and context of learning that was relevant at that time. The hope is that the Moodle digital teaching materials that have been made

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can be used effectively both in online and offline learning with optimization on various technological devices.

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