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Design of the KIMIMIX Learning Management System as a future practicum innovation

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ABSTRACT
Innovation in chemistry laboratories can be integrated with the help of a Learning Management System (LMS). This innovation allows educators to provide video content, modules, and auxiliary tools to enhance students' performance in conducting experiments in the laboratory. This research aims to develop a Moodle-based KIMIMIX Learning Management System Design that adapts the Outcome Based Education (OBE) theory, developed by the skills needed by chemistry students who will be oriented toward future practical innovation. This research and development method adapts the ADDIE model at the Analysis and Design stage. The research sample comprised 24 students taking the first semester of the Chemistry study program at Gorontalo State University. The research process is a preliminary study, needs analysis, material analysis, media analysis, and media innovation analysis with data collection techniques using an open-ended questionnaire given to 114 students. The results of the design stage include media specifications (media formats, text fronts, grammar, themes, supporting software), flowcharts, and design implementation. The KIMIMIX LMS research design as a future practicum innovation is declared ready to implement the design at the product development stage. The detailed design is hoped to produce a sophisticated LMS product for chemical practicums.

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ABSTRAK
Inovasi dalam praktikum kimia dapat diintegrasikan dengan bantuan Learning Management System (LMS), inovasi ini memungkinkan pendidik menyediakan konten video, modul dan tools pembantu untuk meningkatkan performa praktikan dalam melakukan eksperimen di laboratorium. Penelitian ini bertujuan untuk mengembangkan Desain Learning Management System KIMIMIX berbasis Moodle yang mengadaptasi teori Outcome-Based Education (OBE) yang dikembangkan sesuai dengan keterampilan/skill yang dibutuhkan mahasiswa kimia yang akan berorientasi pada inovasi praktikum masa depan. Metode penelitian dan pengembangan ini mengadaptasikan model ADDIE pada tahap Analisis dan Desain. Sampel penelitian ini yaitu 24 mahasiswa Program studi Kimia Universitas Negeri Gorontalo yang sedang menempuh semester satu. Tahapan penelitian ini yaitu studi pendahuluan, analisis kebutuhan, analisis materi, analisis media, dan analisis inovasi media dengan teknik pengumpulan data menggunakan jenis angket terbuka yang diberikan kepada 114 mahasiswa. Hasil tahapan design meliputi spesifikasi media (format media, font teks, tata bahasa, tema, software pendukung), flowchart, dan implementasi desain. Desain penelitian LMS Kimimix sebagai inovasi praktikum masa depan dinyatakan telah siap untuk mengimplementasikan desain pada tahap pengembangan produk. Desain yang telah terancang dengan detail diharapkan dapat menghasilkan sebuah produk LMS yang mutakhir untuk pelaksanaan praktikum kimia.

Kata Kunci: *inovasi praktikum; KIMIMIX; learning management system; moodle; outcome-based education*

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INTRODUCTION

Information and communication technology development has significantly disrupted various sectors of life, including education. Technological disruption refers to profound changes in learning, teaching, and accessing knowledge. Technological breakthroughs such as artificial intelligence, data analytics, online learning, and mobile devices have fundamentally changed the educational landscape. Technological disruption can have significant impact on many fields, including education.

For many years, education could only take place in classrooms directly, where teachers were the main transmitters of information. However, the educational paradigm has changed significantly due to the emergence of technology. Teachers are challenged to develop the ability to create learning media for use with technology support (Purnama et al., 2023). We now have unlimited access to online lessons, interactive learning platforms, and collaborative tools that make distance learning possible. One of the technological developments that underlies the development and progress of science is chemistry. Chemistry is a branch of natural science that studies matter's composition, structure, properties, and changes. This science covers various topics such as chemical reactions, chemical bonds, thermodynamics, kinetics, reaction mechanisms, molecular structure, and physical and chemical properties of various substances. Chemistry also studies interactions between atoms and molecules, which are the basis for forming chemical compounds (Hidayah et al., 2023). In chemistry education, students must master concepts and practices that are best achieved through laboratory experimentation.

Practicum is essential to chemistry learning because it provides direct experience in handling chemicals, equipment, and scientific methods, which helps deepen the theoretical understanding gained through classroom learning (Harta et al., 2020). Learning chemistry is based on understanding concepts and requires laboratory skills to test theories and discover the benefits of studying chemistry in everyday life (Zuhaida & Imaduddin, 2019). These modern digitalization changes have yet to be implemented in several necessary fields, especially laboratory chemistry learning. It is also strengthened by the results of preliminary studies carried out by researchers at several colleges and schools, and it was found that chemical analysis work is still carried out conventionally, such as making chemical solutions. Apart from that, the practicum modules are still printed, which requires much money. Moreover, the problem of the minimal number of laboratory assistants/lab assistants causes the practical implementation to be less than optimal. In addressing this fundamental issue, innovation in learning is required.

Learning innovations can be integrated with e-learning technology. This innovation allows educators to provide methods, materials/tools to introduce chemistry laboratories through electronic learning. E-learning digitalization innovations can be adapted using a Learning Management System (LMS). LMS is a technology-based platform that can help with administrative issues, documentation, searching for learning resources, activity reports, and tools for delivering learning materials online (Warsono, 2021). One learning management system (LMS) platform that is widely used in learning is Moodle. Moodle (Modular Object-Oriented Dynamic Learning Environment) is website-based software for online learning (Widya et al., 2021). LMS Moodle Developing an LMS using Moodle is an alternative step to improve the quality of learning without being limited by place and time to learn to be more efficient and flexible. Because Moodle uses a competency-based approach, designing customized courses is possible (Qin et al., 2022).

Developing a learning management system requires periodic procedures to create a platform that meets users' needs and provides a learning solution. In designing a Learning Management System (LMS), students generally agree that the main course page should have a suitable layout and color. Even though this aspect does not directly improve learning or memory retention, a more positive perception of the visual appearance of LMS is associated with increased student satisfaction (Stoesz, 2022). Meanwhile, other research indicates indicators of student engagement in LMS through systematic literature observation, with 27 indicators divided into three themes (LMS usage, student performance, and communication) and

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six categories (log-in and usage, access to materials, assignments, assessments, message delivery, and participation in forums) (Ahmadi et al., 2023). Access to course materials and forum participation are identified as the most significant indicators of student engagement. In line with this, other research also found that the use of Moodle and learning planning significantly affects learning outcomes, emphasizing the importance of educators and curriculum designers in enhancing student learning outcomes by using a Learning Management System by focusing on actively using online learning platforms and supporting effective learning planning strategies (Aida, 2023).

Various research results on using technology for laboratory activities have been conducted. Some of these studies are (1) Developing Integrated Triplet Multi-Representation Virtual Laboratory in Analytic Chemical Materials (Widarti et al., 2021); (2) The Development of a Virtual Laboratory on Qualitative Chemical Practicum Analysis (Widarti et al., 2022); (3) The Need of Using Videos to Teach Distance Education Students in Chemistry Practicum (Adji & Nurhayati, 2022). The study results show that virtual laboratories are valid and valuable for students and teachers and contribute to improving students' understanding and memory retention during experiments. However, virtual laboratories cannot replace actual physical practical work. Therefore, virtual laboratories should be considered a supplement to enhance traditional laboratory activities. However, in the development of a practicum learning platform, much more focus is placed on creating virtual laboratories that do not directly address the main issues; with the help of technology, it should be able to streamline conventional laboratory work and improve the accuracy of experimental results. Such research needs to be conducted as it can provide a concrete picture of a practicum learning management system design that can meet the needs in the laboratory.

Based on the preliminary study and background above, It is necessary to support and assist chemistry course teachers in innovation in learning (Harta et al., 2020). The development of LMS KIMIMIX has the advantage of being designed using the OBE (Outcome Education) approach. Martini et al. state that the OBE approach prioritizes outcomes and focuses on students in their book “Inovasi Pembelajaran yang Berorientasi Pada OBE (Outcome-Based Education di Pendidikan Tinggi”. This system requires students to actively participate in the learning process and optimize the resources they have. Learning activities no longer focus on face-to-face interactions between teachers and students. Instead, they switch to innovative, creative, and varied learning methods and strategies using technology. In addition, several supporting tools are included in LMS KIMIMIX, such as solution calculators, MR calculators (Relative Mass of Compounds), and periodic tables of elements, and they are equipped with exciting content and materials. Furthermore, LMS KIMIMIX can also serve as a basis for developing LMS for other laboratory practices that require specific skills. Laboratory practitioners can also use these results to develop new operational standards in practical work tailored to future needs. Therefore, this research aims to develop a Moodle-based KIMIMIX Learning Management System Design that adapts the Outcome Based Education (OBE) theory, developed by the skills needed by chemistry students who will be oriented toward future practical innovation.

LITERATURE REVIEW

Chemistry and Practicum Science

Chemistry is a branch of science consisting of scientists' concepts, principles, laws, theories, and findings. Chemistry is also a scientific process (Widarti et al., 2021). In the context of education, chemistry is considered a field of study important for understanding scientific principles and as a means for developing scientific skills that can be applied in science learning (Mellyzar et al., 2023). Chemistry is also called experimental science and is an integral part of practical work in the laboratory. A chemistry practicum is a laboratory activity that involves experiments and observations to learn chemical concepts practically.

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During the practicum, practitioners conduct experimental procedures to test hypotheses, understand chemical reactions, learn laboratory techniques, and interpret data (Harta et al., 2020). Through practicum, students can study the theory known in class with actual practice in the laboratory, thereby deepening their understanding of chemical concepts. Practicums also help students develop science process skills such as observation, analysis, and inference, essential to understanding and applying chemical concepts (Juwairiah, 2023).

Chemical Science and Future Practicum Innovation

Based on a preliminary study carried out before, it was found that: 1) Chemical analysis activities were still carried out conventionally; 2) practical modules were still printed on paper, which used up quite a large budget; and 3) the number of laboratory assistants/supervisors was minimal so that it is difficult to reach all students in conducting experiments. Based on the preliminary study and background above, it is necessary to support and assist chemistry course teachers in innovation in learning (Harta et al., 2020). Learning innovations can be integrated with e-learning technology. It aligns with the rapid development of web and internet technology today. This innovation allows educators to provide methods, materials, and tools to introduce chemistry laboratories through electronic learning and become a practical innovation in the future.

One of the learning innovations based on e-learning technology is using LMS software features with the help of a Modular Object-Oriented Dynamic Learning Environment (Moodle). Moodle with LMS is the most advanced and popular e-learning system. Moodle LMS is a learning platform that involves learning groups in discussion, assessment, reflection, and interactive design (Zabolotniaia et al., 2020). Moodle is an effective learning medium because it is interactive, can introduce multimedia content, and allows students to collaborate (Alkina & Bolsunovskaya, 2020). LMS has been proven significant in learning (Watts et al., 2014) and significantly improved learning (De Medio et al., 2020). It is also based on research by Aldiab et al. (2019), which has recommended the development of chemical science features in virtual laboratory practicums with the help of LMS to improve practical learning experiences for students

Practicum innovation with the help of LMS, MOODLE, and OBE

LMS is an abbreviation for Learning Management System, a software platform designed to provide a framework for sending, tracking, and managing the learning process. LMS allows educational institutions to create, distribute, and manage online learning materials and facilitate interaction between students and teachers (Gunadi, 2023). The Moodle LMS system provides a complete learning process with a learning control system that monitors and assesses the quality of knowledge. Moodle LMS allows the creation of comprehensive learning products necessary for higher education integration (Zabolotniaia et al., 2020).

This Moodle LMS innovation applies to the Outcome Based Education (OBE) system. OBE is a learning model initiated by William G. Spandy in the 1990s to direct formal education that focuses on what students learn, not what teachers teach (Rao, 2020). This concept is inspired by John Piaget's theory that "in principle, education aims to create people who can do things creatively, inventively, and discover." It means that a student's ability in education must be measurable, and it is known as a learning outcome (Wang, 2013). OBE curriculum is a learning process involving evaluation assessment practices to display learning achievements and mastery in a field (Prihantoro, 2020). It is undoubtedly an efficient innovation, namely integration with the help of e-learning LMS Moodle in learning, and it can also clearly measure learning abilities and chemistry practicum through an Outcome-based Education-based curriculum.

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METHODS

This study utilizes Research and Development (R&D) by adapting the ADDIE model. The ADDIE model is suitable because when used in development, the process is sequential and interactive, where the evaluation results of each stage can bring the learning development back to the previous stage. Maribe's book "*Instructional Design: The ADDIE Approach*" mentioned that the ADDIE model consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. However, in this study, the researcher only applies it until the Design stage. The analysis stage discusses needs, content and material analysis, media analysis, and media innovation analysis. Meanwhile, the design stage includes media specifications, flowchart design, design implementation, and learning design using KIMIMIX.

The Moodle-based KIMIMIX Learning Management System will be developed in this research, oriented towards experimental training application products in chemistry laboratories. This research and development adapt the Outcome Base Education (OBE) theory, where every activity, content, and tool in the KIMIMIX LMS is developed following the skills needed by chemistry students, with the hope that students will have graduate learning outcomes with the title of being skilled in conducting experiments in the laboratory.

This research was conducted in the Department of Chemistry, Faculty of Mathematics and Natural Sciences, Gorontalo State University, and the research period started from March to November 2023. The subjects of the study were chemistry students who were taking the first-semester credit units. The population consisted of 80 students, with the research sample selection using a purposive sampling technique based on specific criteria, namely chemistry undergraduate students who have basic laboratory skills, resulting in 24 students (1 class) being selected as samples. Data collection techniques for the analysis stage used open-ended questionnaires given to 114 students to analyze technical issues often encountered during laboratory experiments.

RESULTS AND DISCUSSION

Analysis Results

1. Needs Analysis

   At this stage, the researcher conducted a needs analysis through literature and field studies. The literature study aims to find similar research as a reference in development. In contrast, the field study was conducted through interviews with laboratory assistants in the chemistry department of Gorontalo State University. This study resulted in conclusions from the interviews with laboratory assistants, including (1) The implementation of practical work is still done conventionally; (2) facing technical obstacles such as lack of laboratory assistants/lab assistants who are responsible for guiding the practical work; (3) the problem of students' lack of skills in applying tools and materials in the chemistry laboratory; and (4) the chemical solution-making process is still calculated manually.

Table 1. Technical Problems in Practicum Implementation

Problems in Practicum	Field findings data			
	1	2	3	4
Time-consuming work in the laboratory	Preparation of materials (15,8%)	Tool Calibration (19,3%)	Making chemical solutions (34,2%)	Sample Testing (63,2%)
Student skills in making chemical solutions	Expert (1,8%)	Just Mastering (50,9%)	Lack of control (49,1%)	Not mastering (3,5%)

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Problems in Practicum	**Field findings data**			
	1	2	3	4
The time required to make one chemical solution	5-10 minutes (25,4%)	10-15 minutes (31,6%)	15-20 minutes (36%)	25-30 minutes (17,5%)

Source: Research 2021

In the analysis stage, open questionnaires are distributed to 114 chemistry students. Data collection through this questionnaire was conducted for three days, from November 1st to November 3rd, 2021. From the findings, it was obtained that 34.2% admitted that the process of making chemical solutions takes a considerable amount of time, and 49% admitted to not mastering the techniques of making chemical solutions. In comparison, 36% of students needed 15-20 minutes to make a chemical solution. This is undoubtedly a problem that needs to be resolved so that laboratory practices can be optimized. Based on the research gap, it was found that this aligns with the study that integrated learning with digital assistance can increase students' motivation to achieve optimal learning outcomes in chemistry education (Purba et al., 2019).

2. Content and Material Analysis

At this stage, the researcher conducted an in-depth analysis of the Semester Lesson Plan (RPS) document for the Basic Chemistry 1 practicum at Universitas Negeri Gorontalo. The RPS document has been prepared following the Outcome Based Education (OBE) curriculum framework, which focuses on the expected learning outcomes. In this analysis, the evaluation results of Learning Achievement/analysis Graduates (CPL/ILO) and Course Learning Outcomes (CPMK) became the primary basis for determining the contents and materials to be included in the Learning Management System (LMS).

The selected materials include various basic chemistry concepts such as Exothermic and Endothermic Reactions, chemical changes, Separation and Purification techniques, principles of chromate and dichromate ion equilibrium, and Stoichiometry of reactions. In addition, the LMS content is also supplemented with tutorial videos presenting various practical laboratory techniques, such as preparing acid-base solutions, recrystallization, using a Centrifuge, distillation, filtration, titration, reflux, and Thin Layer Chromatography (TLC). These materials and video content are determined based on the analysis of the Basic Chemistry 1 practicum RPS document, ensuring alignment with the established curriculum and supporting the effective achievement of learning objectives.

3. Media Analysis

This stage produces a choice of media that will be used in developing the KIMIMIX LMS. The media chosen is Web Moodle. Moodle is software that delivers web-based online learning materials and multimedia resources, manages learning activities and the results of learning implementation, and facilitates interaction and cooperative communication between teachers and students (Putra et al., 2019). Moodle Web also has built-in features that are complete and easy to run. The Moodle web can also integrate with learning support platforms and tools.

This is in line with other research that emphasizes the importance of choosing an LMS that suits the specific needs of educational institutions. Criteria to consider include ease of use, customization capabilities, integration with other tools, and support for virtual laboratories (Aldiab et al., 2019). LMS Moodle's implementation in the educational process provides a competitive advantage for the university in the educational space. LMS Moodle extends information and educational space and implements the

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principle of continuous learning, increasing the student population (due to distance learning) (Zabolotniaia et al., 2020).

Based on the findings of several experts, Moodle Web has been chosen as the development platform for the KIMIMIX LMS. The selection of Moodle web is also based on previous research findings, which found that the Learning Management System (LMS) developed using the Moodle platform has shown positive results during testing phases, making it highly effective as a practicum medium (Wijayanti et al., 2020; Sudana et al., 2022; Isroqmi et al., 2023). Moodle also facilitates integration with other learning platforms, including virtual laboratories, which is advantageous for subjects facing limitations in physical teaching aids. As a result, this allows students to gain a deeper understanding of scientific and mathematical concepts.

4. Analysis Media Innovation

Once it is a known problem, the main thing is determining the content and media used. In the next stage, innovation/renewal will be carried out. These innovations include: 1) adding a calculator feature for making chemical solutions. This innovation is considered to speed up the process of making solutions with accurate results; and 2) addition table period elements and an atomic mass determination calculator. With this innovation, it is believed that apart from improving students' skills, this development product can also solve problems with frequent technicalities found during the experiment.

Design Results

1. Media Specifications

The specifications of KIMIMIX LMS media are described in **Table 2** as follows.

Table 2. KIMIMIX LMS specifications

Specification	Information
Media formats	The media format used is web with the address kimimix.com
Text Fonts	The fonts used are Roboto Condensed and Futura size 12
Grammar	Grammar follows general Indonesian spelling guidelines (PUEBI)
Theme	Basic Chemistry Practicum 1
Media creation support software	web Moodle, portable, cleantech, PHP with the Codeigniter framework, and Vs. Studio code.
Supporting software for creating media elements	Canva, Microsoft Office Word, CapCut PC

Source: Research 2023

KIMIMIX'S web-based Moodle Learning Management System for chemistry laboratory training provides a user-friendly platform with access to kimimix.com. Utilizing Roboto Condensed and Futura fonts size 12 for text and following the general guidelines of Indonesian Spelling (PUEBI), this system ensures visual consistency and language accuracy. Designed explicitly for basic chemistry laboratory 1, KIMIMIX utilizes Moodle for web development, integrated with Codeigniter and Visual Studio Code for a strong backend structure. Periodic tables and cleantech are used to find scientific data on chemical elements and calculate the relative mass of compounds, using Canva, Microsoft Office Word, and CapCut PC to create media content. This creates a compelling and easily accessible learning environment, supporting teachers and students in learning.

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2. Flowchart Design

A flowchart is a symbolic representation of an algorithm or procedure for solving a problem. Flowcharts will make it easier for users to check forgotten parts in problem analysis and as a facility for communicating between programmers working in a project team (Santoso & Nurmalina, 2017). The Flowchart Design contains a complete image of the KIMIMIX LMS development plan.

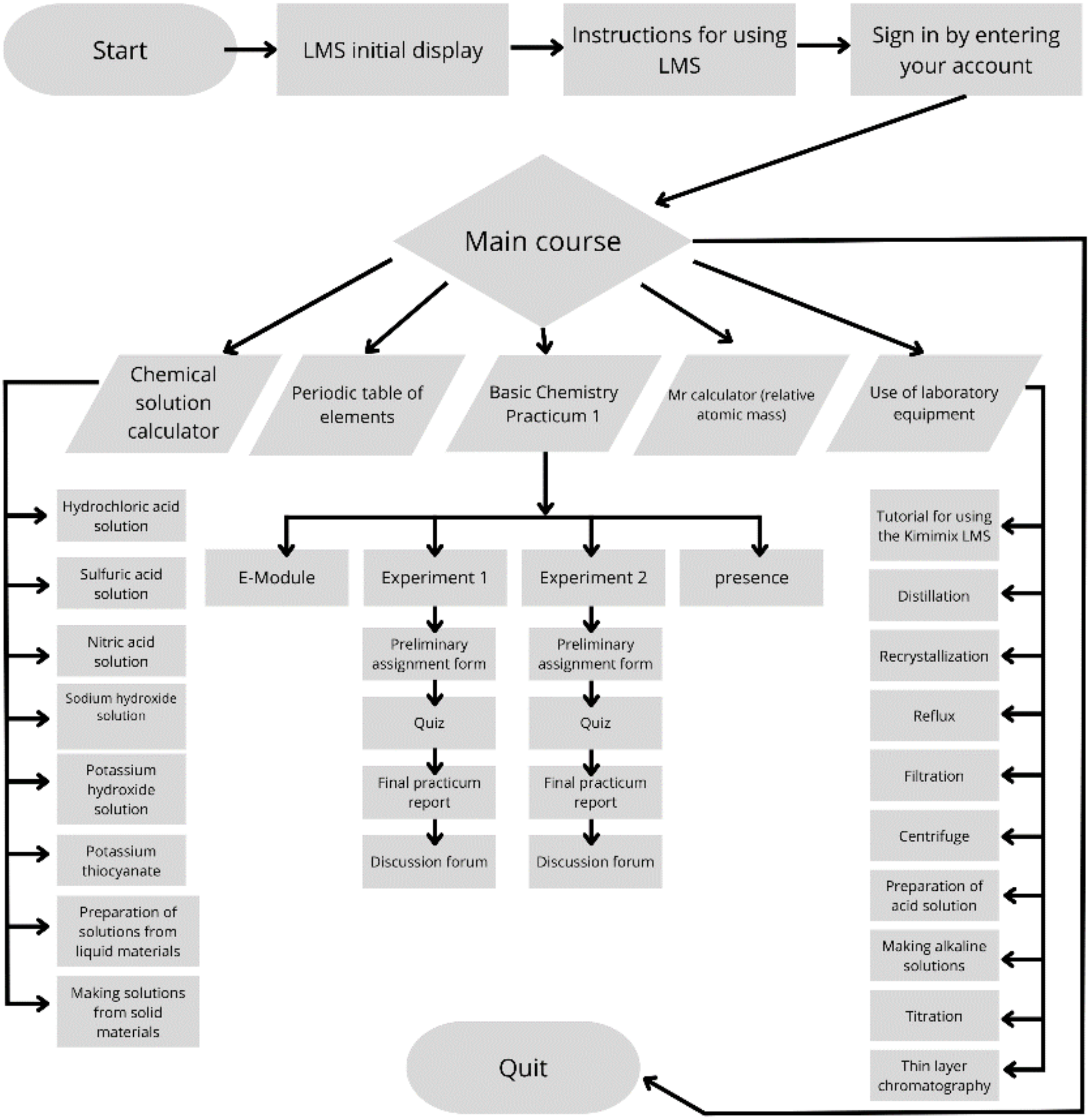

Figure 1. KIMIMIX LMS Flowchart Design
Source: Authors' documentation

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Design Implementation

1. Home Menu Display

Figure 2. KIMIMIX initial menu display
Source: Authors' documentation

The initial menu of the system presents users with a login option, requiring a username and password. In addition to the login feature, the menu displays headlines showcasing the available classes. This gives users an overview of the classes offered within the LMS. Furthermore, general information about the LMS is provided in the initial menu, offering users an introduction to the platform's features and functionalities. The menu acts as a gateway, providing access to login credentials and valuable information about the available classes and the overall LMS.

2. Main Menu Display

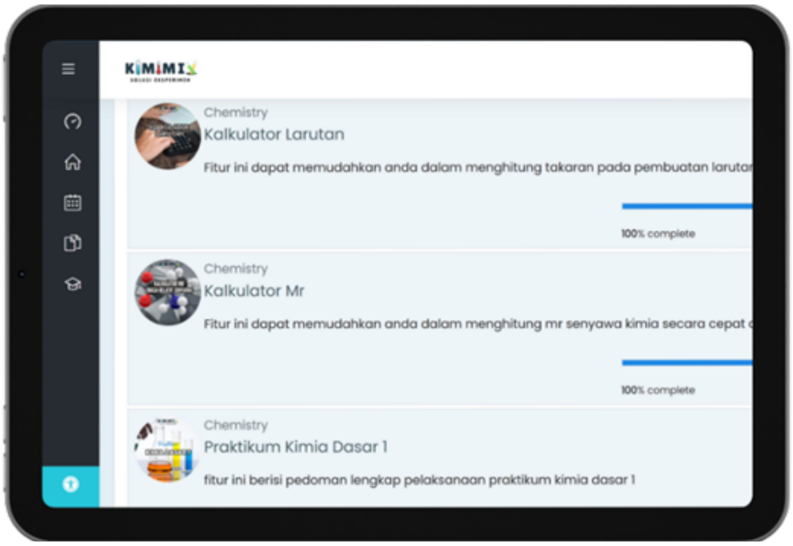

Figure 3. KIMIMIX LMS main menu display
Source: Authors' documentation

The KIMIMIX LMS's main menu includes a list of contracted classes and a few supporting features. These characteristics were specially developed to aid in the execution of practical tasks. The accessible

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features include a solution preparation calculator, a periodic table of elements, and a relative atomic mass (MR) calculator. These tools give students easy access to computations and data relevant to their practical investigations. The primary menu attempts to improve the overall learning experience and make the practicums more efficient.

3. Chemistry Practical Class Display

Figure 4. KIMIMIX display of the chemistry practical class
Source: Authors' documentation

The basic Chemistry 1 practical class menu includes both information and exercises. The material offered in the menu is in the form of an e-Module. These e-modules include thorough learning resources on the subjects covered in the practical class. In addition to the e-modules, the menu consists of various activities for students. These activities include tests, preliminary assignments, valuable reports, Discussion Forums, and an Attendance function. This menu aims to give students a comprehensive learning experience with educational content and engaging activities.

4. Appearance Calculator Solution

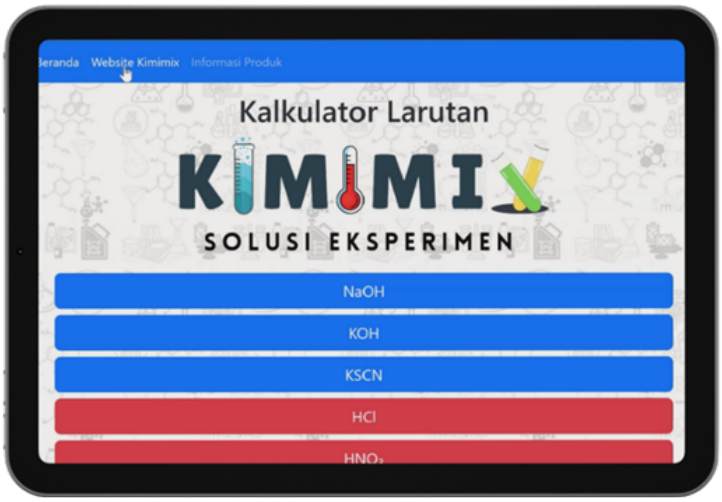

Figure 5. KIMIMIX Solution Calculator Display
Source: Authors' documentation

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A solution calculator is designed to facilitate practitioners' creation of chemical solutions quickly and accurately. This tool is specifically designed so that practitioners can determine the amount and concentration of the solution according to experimental needs. Users can handle various chemical compounds with a solution calculator, including acids and bases. Additionally, this calculator helps deal with base materials that are in either solid or liquid form. Overall, the solution calculator speeds up the process of making solutions while ensuring precision and accuracy in every step.

5. Implementation of KIMIMIX Learning Design

The learning design in the KIMIMIX LMS involves the following steps: 1) Practice using KIMIMIX LMS starting by first uploading preliminary assignments on the LMS page; 2) continuing with filling in attendance; 3) taking a quiz for 15 minutes; 4) reading the work procedures available in the E-Module.

Students can also use feature innovative form calculator solutions to calculate chemical solutions in specific concentrations during the practicum. Students can also use the feature table of periodic elements and calculator Mr. If practitioners need scientific data on chemical compounds. When the practicum is finished, the practitioner records the results of the observations and then continues to discuss several findings in the KIMIMIX LMS discussion forum. The findings are then reported and uploaded to the LMS. After completing the activity, the laboratory/lab assistant can provide grades for the practical work results. Innovation and ease during practicum using KIMIMX LMS development products recommends developing virtual laboratory features in the LMS system to improve practical learning experiences for students, especially in scientific disciplines that require laboratory work (Aldiab et al., 2019). This will allow students to access simulations and experiments virtually, which is very useful when access to the laboratory is limited.

Discussion

In developing the KIMIMIX learning management system, it conducted a preliminary study in 2021 by distributing open questionnaires to chemistry students. Data was obtained from 114 respondents. From this survey, the fundamental problems frequently complained about by chemistry students during experiments, such as the low skills of students in making chemical solutions, can be identified. The data obtained was further supported by interviews with laboratory assistants who accompanied students during laboratory experiments. In this study, no new data was collected in the needs analysis process, as the preliminary study data in 2021 depicted the technical problems frequently complained about by students during experiments.

The development of learning management systems has been researched quite a lot. It is just that, on average, the development of content and materials is still limited. Even though the problems in the field are pretty complex, more steps are needed to overcome the problems at the root. In this development research, the novelty brought up is designing an LMS based on the OBE curriculum by Martini et al. In their book, internal and external factors are two possible impacts students feel when applying the learning model experience-based (OBE) in the classroom. The internal impact involves the learning atmosphere created in the OBE class: 1) learning becomes more active, creative, fun, liberating for students, comfortable, and makes them feel like they belong to the class; 2) the role of students becomes lighter; 3) classroom management becomes more lively; and 4) students can learn more.

The temporary impact from external factors can positively influence other learning subjects and classes, while stakeholders greatly value the abilities possessed by students. Other researchers working in education, business, and industry have proven the significant effects of OBE on the learning process. Additionally, this research has introduced new features to the Chemical Solutions calculator, which is

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designed to facilitate practitioners' work. This is considered to reduce limited practical time so that practitioners can focus more on observing changes in the studied samples. With this, the practical implementation will be of higher quality. This research follows other research that shows that technology accessibility and stability significantly improve students' performance (Bradaric & Tresselt, 2022; Purnama et al., 2023).

This research also added capabilities to the LMS, such as the periodic table of elements and a relative atomic mass (Mr) calculator. This integration makes it easier for students to obtain scientific data on chemical components and compounds being researched. By including these comprehensive elements, students' research quality will increase, and their chemical analysis abilities will be better equipped for practical applications in the workplace. This combination dramatically benefits students by improving their chemistry comprehension and capacity to undertake scientific inquiry. The integrated LMS will make it easier for students to access and use the materials they need for their studies (Wijayanti et al., 2020; Sudana et al., 2022; Isroqmi et al., 2023).

The periodic table function gives a quick reference for the properties and features of numerous elements, allowing students to undertake thorough analysis. The relative atomic mass calculator can help students determine the average mass of atoms in a given element or compound. This function helps to analyze chemical compositions more precisely and accurately. As a result, students' capacity to read and analyze scientific facts about chemical elements and compounds will be considerably enhanced.

CONCLUSION

This research has successfully developed a learning management system (LMS) design named KIMIMIX, specifically designed for practical purposes in chemistry laboratories using the outcome-based education (OBE) approach. KIMIMIX is an innovation in an LMS platform because, in addition to serving as a learning management system, KIMIMIX also provides various additional tools such as solution calculators, periodic tables of elements, and relative atomic mass calculators to support the effectiveness of laboratory practical implementation. Through the development of this LMS design, it is expected to provide technical insights to curriculum developers and educators in developing similar platforms designed based on the needs of students. Furthermore, the results of this research can also serve as recommendations for the industry to disrupt work patterns as chemical analysis.

AUTHOR'S NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The author confirms that the data and content of the article are free from plagiarism.

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