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Recommended features of learning management system using feature-oriented method software development on moodle

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Article Info

Abstract

Learning Management System (LMS) serves as a learning media effective for online learning during Covid-19. The rising use of LMS these days indicates that LMS features need to be further measured for their relevance to the National Standards of Higher Education (SN-Dikti). This measurement is also essential to be applied for five blended learning criteria for flexible time and place to access lessons. The objective of this research is to analyze the features of the LMS implemented on Moodle version 3.10. The analysis of the features was carried out by employing the methods of Feature-Oriented Software Development (FOSD), a method that elaborates software system relating to existing features of LMS, involving: 1) Canvas; 2) Edmodo; 3) Google Classroom; 4) Moodle; 5) Zoom Meeting; 6) Google Meet; 7) efront, and 8) Microsoft Teams. In accord with the testing and validation by experts, the research revealed that there were 56 features of LMS pertinent to learning and assessment standards of SN-Dikti and E-learning self-study criteria with other blended-media or events, instructor-led program, live e-learning, on the job training, simulation, and lab centered on blended learning. Those 56 features were approved by experts and implemented by employing Moodle version 3.10 relevant to the SN-Dikti and blended learning.

1. Introduction

During Covid-19, learning is conducted online on the Internet as a primary communication tool. The application of online learning is getting more massive as long as studying from home remains in place. Especially in higher education, the learning media must be pertinent to the standards of higher education set by the government. A learning management system (henceforth referred to as LMS) is utilized to present teaching materials and to help distribute class assignments to students effectively and efficiently. The utilization of LMS amidst the pandemic is deemed helping learning activities online [1][2].

In accord with Law of Higher Education Number 12 the Year 2012 and Regulation of Ministry of Culture and Education Number 3 the Year 2020, curriculum design and learning administration must comply with the national standards of higher education (henceforth referred to as SN-Dikti). SN-Dikti represents the national standards set by the government, consisting of 8 National Standards, constituting: 1) graduates' competence standard; 2) learning standard; 3) learning content standard; 4) standard of funding in learning; 5) learning management standard; 6) infrastructure and facility standard; 7) learning assessment standard; 8) academic staff standard [3]. Learning and assessment standards of SN-Dikti are inextricable since they serve as a measurement of success in a learning process conducted based on assessment [4]. The results of the features of LMS as obtained from research that employed the provisions set forth by SN-Dikti are further completed and merged with blended learning. This learning method is intended to achieve learning objectives combining face-to-face-based learning and online learning [5].

Moreover, higher education is required to administer education based on a blended learning approach [6]. Blended learning provides simplicity in learning, and this learning approach combines interaction and learning styles in the learning and teaching process. Blended learning also combines face-to-face and online learning, embracing the following five criteria: 1) E-learning self-study with other blended media or events; 2) instructor-led program; 3) live e-learning; 4) on-the-job training; 5) simulation and lab centered [7].

Previous studies have recommended LMS features pertinent to learning and assessment standards as set forth by SN-Dikti [1][8][9]. The LMS, principally, has several features ranging from uploading and downloading materials in varied formats [10], lesson plan [11], learning management [12], administrative-based management such as attendance reporting and data backup [13], recording [14], class organization [15], assignment distribution [10], assessment [16], to parent supervision [17].

LMS and software used as the basic references involve 1) Canvas; 2) Edmodo; 3) Google Classroom; 4) Moodle; 5) Zoom Meeting; 6) Google Meet; 7 Efront; and *) Microsoft Teams. The preferences of the use of LMS come in variety according to the excellence of the features in each LMS. Canvas is deemed supporting online learning, known for its interface feature and designed to save time [18]. Edmondo comes with features that allow parents to watch their children in a learning process [19]. Google Classroom is designed to allow teachers and students to interact [20]. Moodle is an LMS with more features functioning to optimize the online learning and teaching process [21].

The preferences of some communication software through video conferences involved zoom Meeting available with features to help with writing, oral presentation, and videos that fit the need of the users [22]. Google Meet is preferred for its user-friendly features [23]. eFront helps users build online learning communities, and this software also offers opportunities for collaborations and icon-based interface interaction among users [24]. Microsoft Teams has functionality that integrates conversation, contents, assignments and gives the experience of distance learning connected with others like learning in a classroom [25].

This research employed the Feature-Oriented Software Development (FOSD) method that could elaborate software systems regarding the feature available in a previous system [26]. FOSD method also differs from the method employed in previous studies commonly referring to the Feature-Oriented Domain Analysis (FODA) method. FOSD could build a more explicit feature with the design that leans to artifact design and implementation, while the FODA method is more focused on a feature analysis without any implementation [9]. This research also analyzes more features from different LMSs according to two basic standards in SN-Dikti, namely learning and assessment standards and five criteria of blended learning as references of feature recommendation. This research also added validity by experts to the results of the formulation of features which are expected to increase the validity of recommended features [1]. This research aims to formulate and recommend features of LMS relevant to the SN-Dikti and fitting the need of blended learning and to implement recommended features based on Moodle version 3.10, selected as a media of implementation of feature recommendation due to the plug-in feature available [12][13][27].

2. Research Method

This research involved several stages, beginning with literature study, data collection, domain analysis, domain design, domain implementation, and product configuration, all referring to the flow of FOSD.

2.1 Literature Review

This research involved several sources including books, journals, legislation, and scientific articles to discover learning and assessment models relevant to SN-Dikti, LMS, blended learning, and the FOSD method.

2.2 Data Collection

Data collection is intended to list all components of learning and assessment standards in the criteria of SN-Dikti set by the government through Regulation of Minister of Education and Culture Number 3 of 2020 [3]. The observation result came out as the criteria of SN-Dikti as presented in Table 1.

Table 1. Standards of SN-DIKTI

No	National Standards of Higher Education	Criteria of SN Dikti
1.		Interactive
2.		Holistic
3.		Integrative
4.		Scientific
5.	Learning Standard	Contextual
6.		Thematic
7.		Effective
8.		Collaborative
9.		Student-focused
10		Educative
11		Authentic
12		Objective
13	Assessment Standard	Accountable
14		Transparent
15		Integration

Data collection was intended to discover the criteria of ideal blended learning referring to some references [7][28][29]. In accord with the analysis technique and the studies of literature, blended learning was categorized into five criteria as shown in Table 2. The design of LMS features providing services to support the application of blended

learning was performed in three patterns of interaction, involving face-to-face, synchronous, and asynchronous. Moreover, three interaction models were formulated, involving interaction between students, lecturers, and learning contents/media through LMS as shown in Figure 1.

Table 2. Blended Learning Criteria

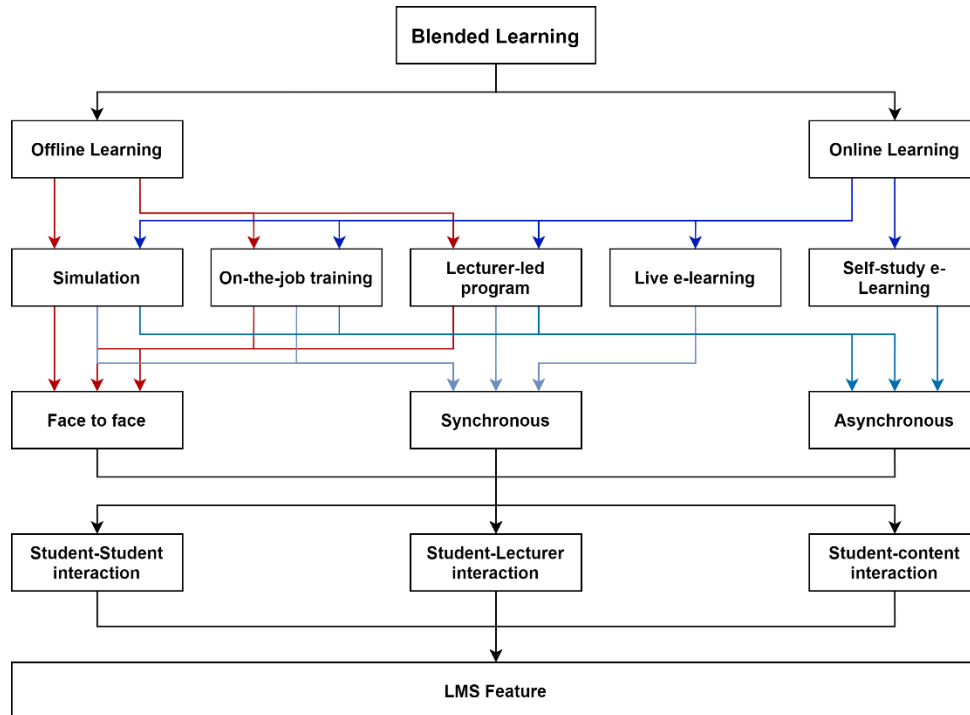| No	Blended Learning Criteria
1.	E-learning self-study with other blended-media or events
2.	Instructor-led program
3.	Live e-learning
4.	On the job training
5.	Simulation and lab centered

Figure 1. Blended Learning Design in LMS Feature

In addition, data collection was also intended to list features of the four systems of referred LMS. According to the listing result, as shown in Table 3, the features recorded in the previous studies referred to the FODA method that was used more than that of this research [1] because there were some features with the same functions that could be integrated. Table 4 presents the list of features of LMS references.

Table 3. Comparison of The Number of Features

No	Feature	FOSD	FODA
1.	Lecturers	32	36
2.	Students	24	26

Table 4. List of Features from Referred LMS

Code	Feature
FD001	Lecturers can organize profile
FD002	Lecturers can communicate via inbox
FD003	Lecturers can make an announcement
FD004	Lecturers can enclose files or the documents for an announcement
FD005	Lecturers can add new students
.	.
.	.
FM051	Students can view their assignment marks

Code	Feature
FM052	Students can view comments/feedback from their lecturers regarding their assignments
FM053	Students can view their quiz marks
FM054	Students can give comments in a discussion forum
FM056	Students can participate in a video conference

2.3 Feature-Oriented Software Development (FOSD)

The method of FOSD present in Figure 2, has a series of processes relevant to the need for feature modeling according to the reference of the standards in SN-Dikti and blended learning criteria.
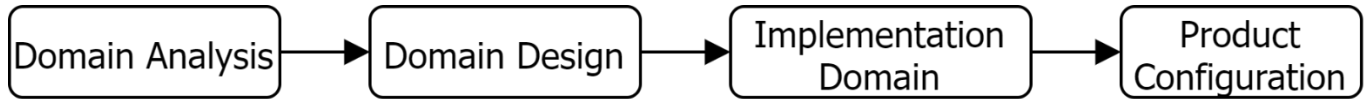

Figure 2. Methods FOSD

2.3.1 Domain Analysis

Domain analysis is intended to set up the similarity between features with two standards in SN-Dikti, namely learning and assessment standards, and five blended learning criteria. The domain analysis was created in the form of feature modeling, illustrated in a tree diagram connecting the main features and sub-features [30][31]. Figure 3 presents a diagram of general features in LMS. Black circles indicate that those features have to be implemented and white circles of 'search' feature indicate that it is not compulsory to implement. Figure 4 presents a more specific class feature, showing that the five features have to be implemented: search a class, join a class, view marks, view participants, and show materials.
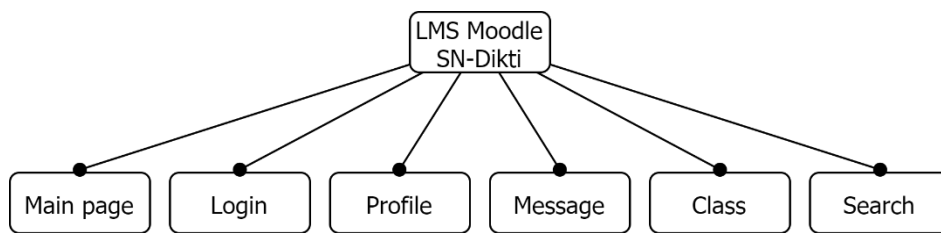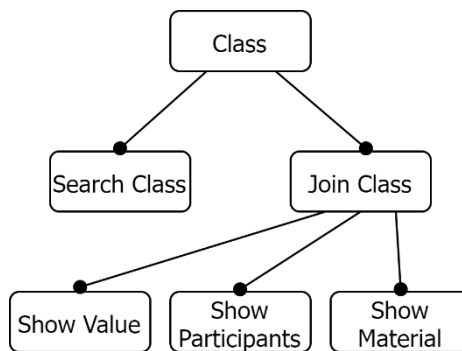

Figure 3. General Features

Figure 4. Class Features

2.3.2 Domain Design & Specifications

Domain design represents feature modeling using contextual analysis that generally explains the flow of features of LMS that can be performed by actors, which is further elaborated into Data Flow Diagram (DFD) to help visualize the process of the design of LMS [30][32].

The diagram of context shown in Figure 5 highlights several actors that could perform the request process to LMS to get feedback from LMS. For instance, a lecturer could request the data of student assignments given in the form of the results of the assignment list. DFD level 0, as shown in Figure 6, represents the derivative of the diagram of context. The DFD at this level elaborates on the flow actors can perform. For example, a lecturer can input assignments, marks, and additional information into LMS, and this input can be downloaded by both lecturers and students.
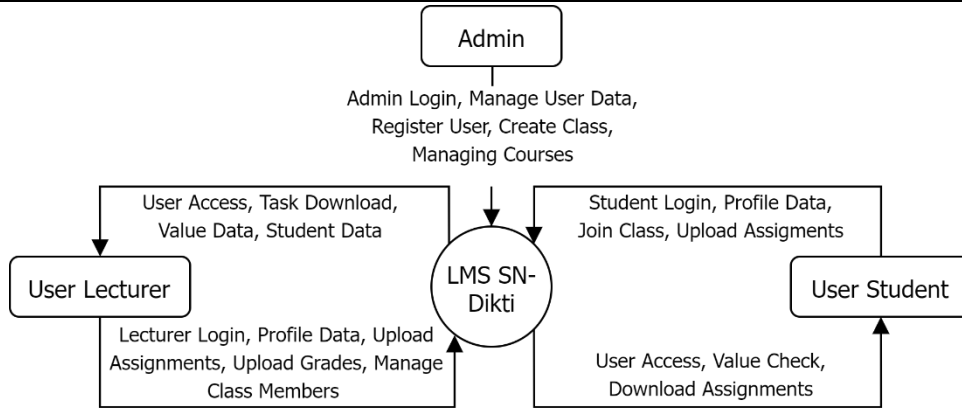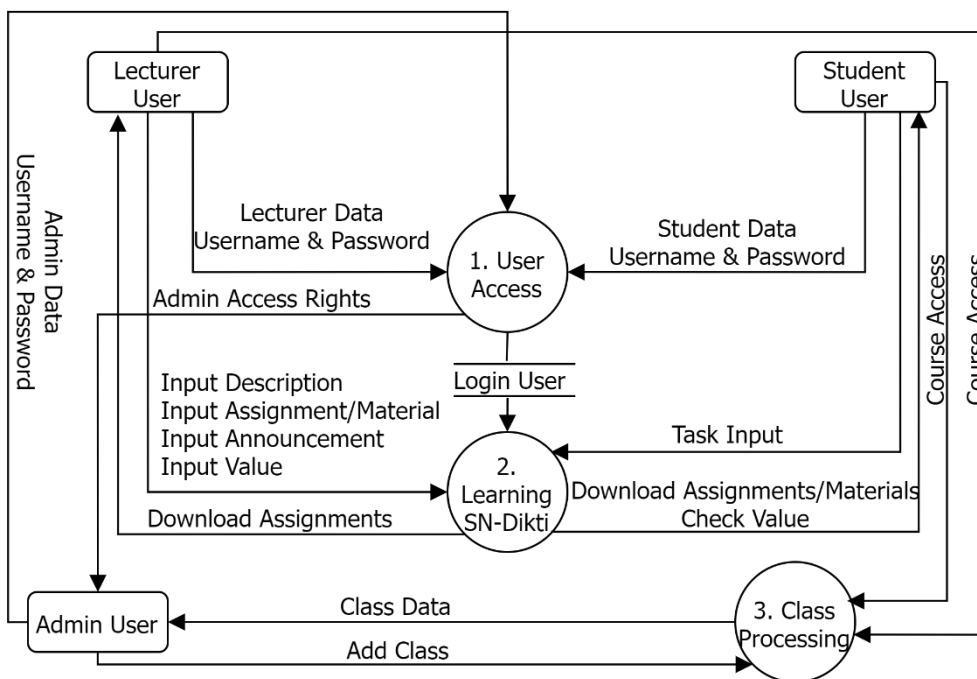
Figure 5. Diagram of Context

Figure 6. DFD Level 0

2.3.3 Implementation

The features analyzed in the previous two stages were implemented, which is intended to simulate each feature in order to adjust it to the standard of SN Dikti and the criteria of blended learning and to allow testing to take place based on the Black Box method. The implementation of LMS employed Moodle version 3.10 [9].

2.3.4 Product Line Configuration

This stage required LMS testing. According to the scenario, as shown in Figure 7, the users of LMS involved lecturers/administrative staff, and students. This testing method used Black Box, giving evaluation results of the features implemented [33].
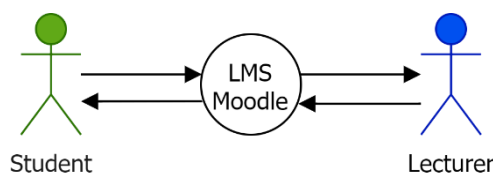

Figure 7. System Design

2.4 Expert Validation

This stage aims to reinforce the results of LMS feature recommendation and implementation of LMS. Validation was performed by experts in education, involving interview methods carried out in two stages. The first stage validated the domain analysis result that extracted the main features. The second feature validated 56 recommended features according to learning and assessment standards of SN-Dikti and blended learning criteria as implemented in Moodle.

3. Results and Discussion

Implementation result referred to the LMS using MOODLE version 3.10, available as an open-source from its official website. This research used a local web server for the configuration of Moodle with the following specifications: PHP version 7.2.34, Apache version 2.4.46, and MariaDB version 10.4.14.

At the implementation stage, researchers listed the relevance of recommended features of FOSD with those of LMS available on Moodle. Furthermore, features not available on Moodle of standard version were added by installing plug-in Moodle such as video conference and an attachment downloaded from Moodle official website.

LMS was also simulated by creating several courses, adding several accounts of the lecturers and students, and some other activities to test the recommendation of features of LMS as evaluated in Figure 8 and Figure 9. Feature testing referred to lecturers and students for comprehensive implementation.
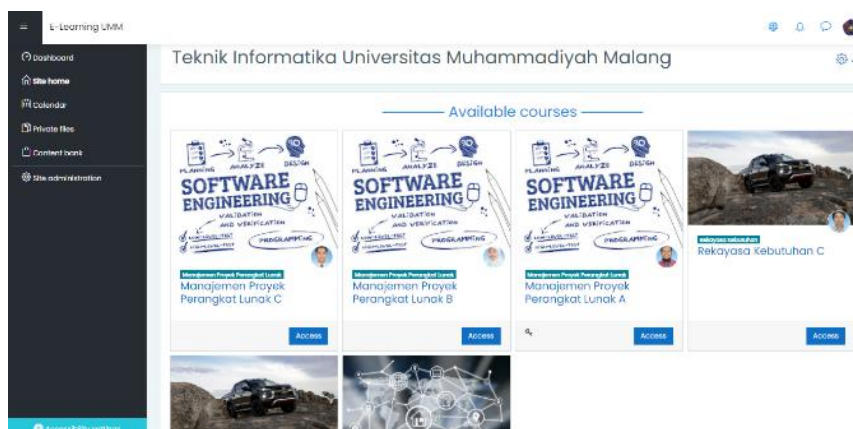

Figure 8. System Implementation
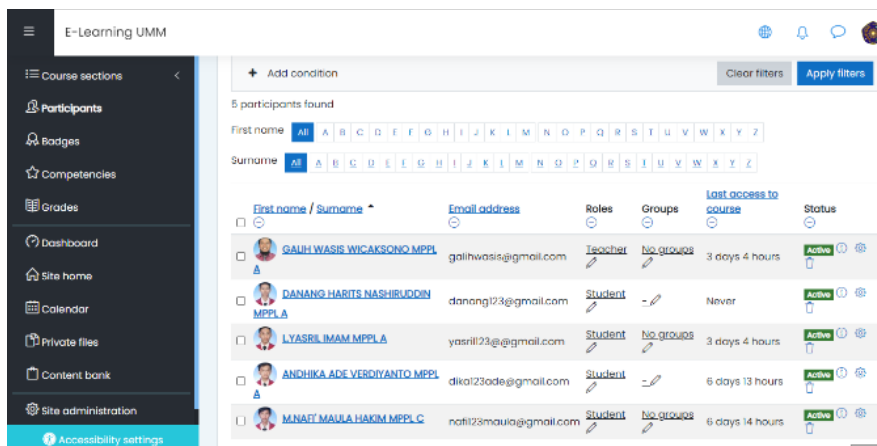
Figure 9. Class Feature

3.1 Feature and Validation Testing

Feature system testing aims to find out the functionality of overall features of LMS according to learning and assessment standards of SN Dikti and blended learning. Feature testing also serves as a tool to discover the shortcomings of an LMS system developed [34]. Moodle feature testing was performed by utilizing the Black Box method, regarded relevant to carry out testing at a final stage of a project or to find out whether the software functioned appropriately and could provide services to its users efficiently and be used to investigate glitches [35].

In the testing scenario, all features of Moodle were simulated and used by both lecturers and students. If there were any glitches, another plug-in available on Moodle could be added or used till it met the recommendation as

required. The Black Box testing result shows in Table 10, revealed that 56 features on Moodle were reported successful and pertinent to the recommendation of FOSD.

The validation given by experts managed to set 68 features of LMS for assessment standard, 87 features for learning standard, and 37 features for blended learning. The recommendation result of the FOSD is in line with SN Dikti and blended learning. The number of features is parallel to the standards of SN-Dikti as shown in Table 5 and Table 6. Other findings show the results of expert validation for the blended learning criteria shown in Table 7, Table 8, and Table 9.

Table 5. The Result of Expert Validation for Learning Standard

No	SN-Dikti Criteria	Total
1	Interactive	15 Features
2	Holistic	12 Features
3	Integrative	15 Features
4	Scientific	13 Features
5	Contextual	9 Features
6	Thematic	5 Features
7	Effective	8 Features
8	Collaborative	6 Features
9	Student-focused	4 Features

Table 6. The Result of Expert Validation for Assessment Standard

No	SN-Dikti Criteria	Total
1	Educative	13 Features
2	Authentic	25 Features
3	Objective	5 Features
4	Accountable	7 Features
5	Transparent	11 Features
6	Integration	7 Features

Table 7. The Result of Expert Validation for Blended Learning Criteria

No	Blended Learning Criteria	Total
1	E-learning self-study with other blended-media or events	7 Features
2	Instructor-led program	30 Features
3	Live e-learning	2 Features
4	On the job training	5 Features
5	Simulation and lab centered	0 Features

Table 8. The Result of Expert Validation for Interactive Pattern in Blended Learning

No	SN-Dikti Criteria	Total
1	Face-to-face in a classroom	30 Features
2	Online Synchronous dan Asynchronous	4 Features
3	Blended Synchronous dan Asynchronous	5 Features

Table 9. The Result of Expert Validation for Interactive Model in Blended Learning

No	SN-Dikti Criteria	Total
1	Interaction between lecturers and contents	3 Features
2	Interaction between lecturers and students	14 Features
3	Interaction between students	7 Features

Table 10. Black box Testing Result

Code	Feature	Result
FD001	Lecturers can organize profile	Valid
FD002	Lecturers can communicate via messages	Valid
FD003	Lecturers can create an announcement	Valid
FD004	Lecturers can attach files or documents required to make an announcement	Valid
FD005	Lecturers can add a new student	Valid

Code	Feature	Result
FD006	Lecturers can display all menus in a classroom	Valid
FD007	Lecturers can check the students joining a class	Valid
FD008	Lecturers can view a calendar	Valid
FD009	Lecturers can comment on an announcement	Valid
FD010	Lecturers can compose assignments	Valid
FD011	Lecturers can create groups	Valid
FD012	Lecturers can set assignment load and focus	Valid
FD013	Lecturers can set assignment format	Valid
FD014	Lecturers can access the deadline of assignment submission	Valid
FD015	Lecturers can organize all assignments	Valid
FD016	Lecturers can upload files of learning materials	Valid
FD017	Lecturers can save or download materials	Valid
FD018	Lecturers can form a discussion forum	Valid
FD019	Lecturers can set the duration of a discussion	Valid
FD020	Lecturers can comment on a discussion	Valid
FD021	Lecturers can attach a discussion sheet	Valid
FD022	Lecturers can organize a discussion	Valid
FD023	Lecturers can set points and rubrics for quizzes	Valid
FD024	Lecturers can compose quizzes	Valid
FD025	Lecturers can find types of quizzes	Valid
FD026	Lecturers can find the duration of quizzes	Valid
FD027	Lecturers can give marks and display the marks of the quizzes	Valid
FD028	Lecturers can find out students (not) handing in their assignments	Valid
FD029	Lecturers can comment on the students' assignments	Valid
FD030	Lecturers can view replies between them and students	Valid
FD031	Lecturers can create a room in a video conference	Valid
FD032	Lecturers can perform a student roll call	Valid
FM033	Students can organize profile	Valid
FM034	Students can interact via inbox	Valid
FM035	Students can view group members	Valid
FM036	Students can view the classroom they belong to	Valid
FM037	Students can view an announcement	Valid
FM038	Students can download an announcement file	Valid
FM039	Students can view class members	Valid
FM040	Students can display menu in a classroom	Valid
FM041	Students can join a class	Valid
FM042	Students can do their assignments	Valid
FM043	Students can attach a document to an assignment	Valid
FM044	Students can comment on an assignment	Valid
FM045	Students can download a material	Valid
FM046	Students can join and view the information in a discussion forum	Valid
FM047	Students can view quiz descriptions	Valid
FM048	Students can do quizzes	Valid
FM049	Students can view the descriptions of the questions from other students	Valid
FM050	Students can give answers regarding the answers of other students	Valid
FM051	Students can view their assignment marks	Valid
FM052	Students can view comments/feedback from lecturers on their assignments	Valid
FM053	Students can view their quiz results	Valid
FM054	Students can participate in giving comments in a discussion forum	Valid
FM055	Students can view a calendar	Valid
FM056	Students can join a video conference	Valid

4. Conclusion

The analysis results of LMS features based on the FOSD method result in the recommendation of features pertinent to learning and assessment standards of SN-Dikti, and blended learning criteria have been implemented by employing Moodle version 3.10. The recommendation of 56 features was sourced from referred LMS and system. There are several features meeting more than one criterion of learning and assessment standards of SN-DIKTI. All the features recommended were tested using a black box validated by experts, and these features were proven to fit the two standards of SN-Dikti and five blended learning criteria.

Acknowledgment

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