Perceived Usability Evaluation of MOLS (Mulawarman Online Learning System) During COVID-19 Pandemic Using System Usability Scale (SUS), Performance Measurement, and Thinking Aloud Methods

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Abstract

Due to COVID-19 pandemic, teaching learning process has changed from traditional classroom method to online learning. To cope with this situation, Engineering Faculty of Mulawarman University introduced MOLS (Mulawarman Learning Online System) to allow students interact with learning tools via web browsers. This paper aims to evaluate the student's perceived usability of MOLS based on effectiveness, efficiency, and user satisfaction. Furthermore, this paper attempts to improve MOLS to meet the students' need. For this purpose, three methods are applied, i.e., using SUS (System Usability Scale) to measure student's satisfaction, Performance Measurement to evaluate effectiveness and efficiency and Thinking Aloud to gather data about what users' opinion about MOLS design. This opinion usually turn into redesign recommendations. A number of 96 students of Engineering Faculty participated in SUS Questionnaire and 10 students were involved in Performance Measurement and Thinking Aloud process. Result showed that SUS score was 61.64 which is below marginal score 68. The effectiveness was 99% and efficiency was 0.0035 task/second. Thus, MOLS application is effective and efficient, yet its needs further improvement to meet the students' needs, such as adding more features, design interesting and interactive user interface and improve the response time.

Keywords
Usability, MOLS, SUS, Performance Measurement, and Thinking Aloud

1. Introduction
Pandemic of COVID -19 has affected all the aspect of life, including education. Traditional classroom method changed into online learning. Actually, online learning is not a new method for teachers and lecturers since the successful spread out of open online courses and high-speed internet connection. However, before the covid-19 pandemic, online learning was a complement to traditional classroom method. But currently, the approach of lesson delivery is strictly online only. To cope with this situation, Mulawarman University introduced MOLS (Mulawarman Online Learning System) which allows students to experience learning process via web browsers using any operating system, computer or mobile devices.

MOLS has features that allow to simplify the following processes: course registration and delivery (i.e., distribute materials, assignments and quizzes and also upload the answer of a quizzes or assignments), tracking student's performance, course administration (i.e., filling in the attendance list) and communication between student and lecturer. Preliminary survey showed that MOLS has few usability problems (see Figure 1). Firstly, notification of MOLS is not connected to email or short message service, so that students do not update with current course issue immediately. Secondly, MOLS has redundancy command, for example class menu located in "beranda", but after one click, it shows different page with the same previous information. Thirdly, name of file attachment changed after upload. It occurs when students upload their assignment file. And finally, few of MOLS commands are dysfunctional, such as following, followers and activity.

Another issue is with respect to the devices used by students to utilize MOLS. Previous study by Fatimahhayati, Tambunan and Pawitra (2020) showed that 84% of Industrial Engineering students in Mulawarman University use smartphone for online learning during the pandemic of Covid-19 and this condition are also believed to be happened in other departments in Engineering Faculty of Mulawarman University. Since MOLS usages primarily involve watching preloaded video/power point slide contents that are uploaded by the lecturers, the type of device used for this purpose may influence its users' experience. Furthermore, Pal and Vanijja (2017) asserted that end user experience depends on the screen size of the device used. As the screen size of smartphone is smaller than PC or laptop, it is essential to evaluate the perceived usability of MOLS in order to understand the students' experience. According to Diefenbach, Kolb, and Hassenzahl, (2014), the success of online learning platform depends on students' satisfaction level and greater level of satisfaction relies on good students' experience.

The usability problems and the issues regarding the device used to apply MOLS, emphasize that perceived usability of MOLS is important to be evaluated. In this study, usability was measured based on effectiveness, efficiency, and users' satisfaction (ISO 9241–11:2018). Effectiveness and efficiency of MOLS was measured using Performance Measurement, while users' satisfaction was evaluated using System Usability Scale. Furthermore, Thinking Aloud Method was applied to gather data about what user's opinion about MOLS' design. This data, usually, can be developed into design recommendation.

The purposes of this study are to (1) measure perceived usability of the MOLS application; (2) improve the MOLS application to meet the students' need.

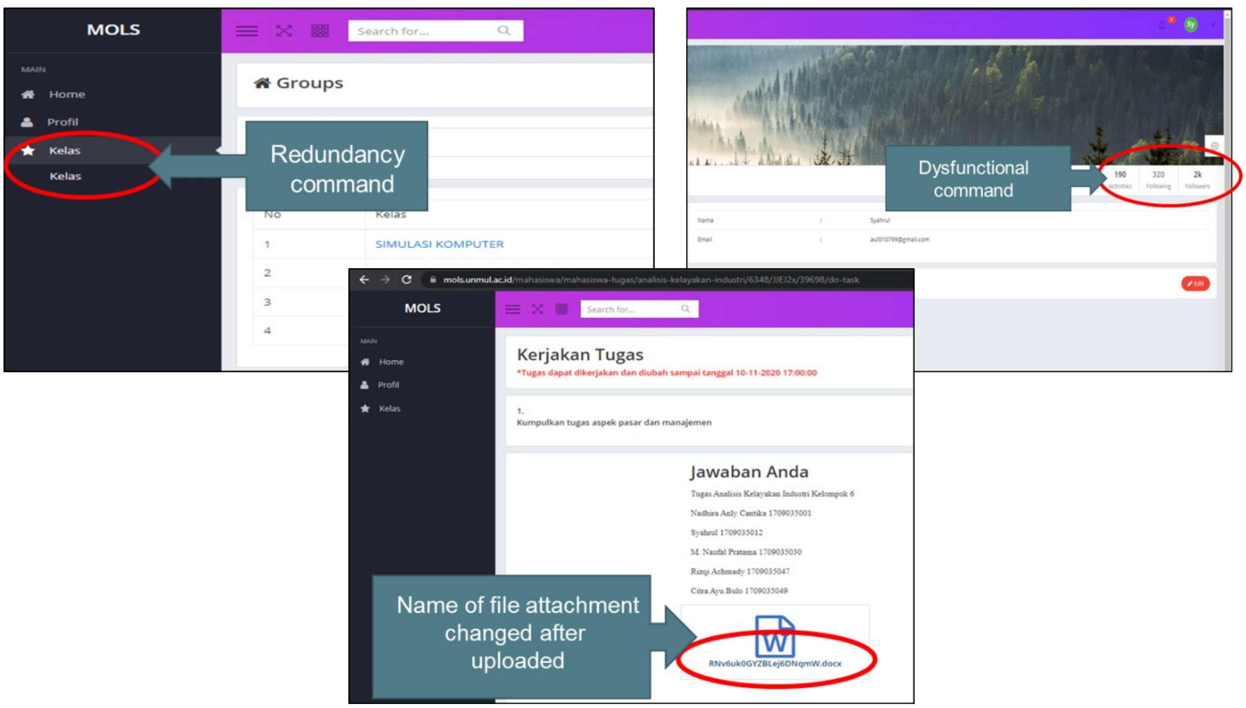

Figure 1. Usability problems of MOLS application

2. Literature Review

2.1. Usability

Usability is a measure of how well a product/system can be utilized by users to achieve particular goals effectively, efficiently and satisfactorily (ISO 9241–11:2018). Thus, according to ISO 9241–11:2018, usability is more than "easy to use" and "user friendly". Usability is important in online learning platform, as it can increase students' academic performance (Tselios et al., 2008). ISO/IEC 9126-4 advocates that usability metrics should comprise:

- Effectiveness. It refers to how accurate the product/system can complete particular goals

- Efficiency. It refers to how much time the users need to achieve the goals accurately; the faster the better.
- Satisfaction. It refers to how comfortable the user when utilizes the product/system.

2.2. Efficiency and Effectiveness

Efficiency and effectiveness are usually evaluated using performance measurement. Completion time, number of error and completion rate are the indicators of efficiency and effectiveness. Completion rate and number of errors are the indicators of effectiveness, while completion time is an indicator of efficiency. Completion rate is calculated by dividing number of tasks completed with total number of tasks assigned. It is usually represented as a percentage. The formula of effectiveness is as follows (Wardani et al. 2019):

$$Effectiveness = \frac{number\ of\ tasks\ completed}{total\ number\ of\ task}\ x\ 100\%$$

Completion time is the time (in seconds or minutes) that user needs to finish the task successfully. Time-based efficiency can be calculated by following formula (Wardani et al, 2019):

$$\text{TBE}=\frac{\sum_{j=1}^{N}\sum_{i=1}^{N}\frac{n_{ij}}{t_{ij}}}{NR}$$

Where: TBE = Time- Based Efficiency, N = total number of tasks, R = number of users, n_{ij} = the result of task i by user j; if the user successfully completes the task, then $N_{ij} = 1$, if not, then $N_{ij} = 0$, t_{ij} = the time used by user j to complete task i. If the task is failed to be completed, then time is measured until the user gives up doing the task

2.3. SUS (System Usability Scale)

System Usability Scale (SUS) was developed by John Brooke in 1986. It is applied to evaluate the usability of products and services, including hardware, software, mobile devices, websites and applications. It comprises a 10- items questionnaire with five response options, ranging from strongly agree (5) to strongly disagree (1). The benefits of applying SUS are (Broke, 1986):

- It is easy to administer since the respondent only needs to choose one among five responses for each of 10 items questionnaire
- It can be applied on small sample size with reliable result
- It is valid since it can differentiate between usable and unusable system

These are the steps to calculate SUS score:

1. Score of each of the odd numbered questions need to be subtracted by 1.
2. Score of each of the even numbered questions need to be subtracted by 5.
3. Sum up the total score then multiply by 2.5.

The SUS Score resulted on a scale of 0-100. The marginal value of SUS score is 68. Table 1 depicts the guideline on the interpretation of SUS score (Broke 1986).

Table 1. Guideline on SUS score interpretation

SUS Score	Letter Grade	Adjective Rating
Above 80.3	A	Excellent
Between 68 and 80.3	B	Good
68	C	OK
Between 51 and 67	D	Poor
Below 51	F	Awful

2.4. Thinking Aloud

Thinking aloud is a method that is widely applied in usability testing. In a thinking aloud test, the observer asks the participants to complete several tasks using the system while verbalizing their thought about the system's design.
The thinking aloud method also offers benefits of being: (Someren et al. 1994)

- Cheap since no special device is required
- Robust, since the facilitator only needs to take note and understand what the participant's talk about the system
- Flexible since this method can be used at any stage in the product/system development lifecycle
- Easy to learn.

In this study, effectiveness and efficiency of MOLS were measured by performance measurement, since the observer could calculate time-based efficiency and number of tasks completed directly from the respondents. SUS method was used to measure students' satisfaction of MOLS because its questionnaire was short and easy to understand. Furthermore, thinking aloud methods was applied to identify what users really feel about MOLS design as well as how to improve its usability, because it was cheap, robust and easy to learn.

3. Methods

In this study, MOLS usability was measured based on effectiveness, efficiency and students' satisfaction. User's satisfaction was evaluated using SUS (System Usability Scale). SUS was applied to measure student's satisfaction because it's well-research, widely used and has several numbers of advantages as follows (Orfanou et al. 2015):

a. SUS Questionnaire is very brief; it consists of 10 items to be rated on a five-response scale (strongly disagree (1) to strongly agree (5))
b. The SUS score is from 0 to 100. Therefore, its results can be easy to understand , even to non-experts;
c. It is a robust measurement of system usability even with small sample size; and
d. SUS uses to assess wide variety of product or system

In addition, effectiveness and efficiency were measured by using performance measurement method. This method was used to obtain quantitative data about test user' performance (i.e., completing time and number of error) when they performed the tasks. Before analyzing the SUS and performance measurement data, validity and reliability test were conducted using SPSS Statistics software. If the data was valid and reliable then analysis phase could be started.

Finally, Thinking Aloud Method was applied to gather data what users really feel about MOLS design. This data usually can be developed into redesign recommendations. Figure 3 shows the methodology of this study.

4. Data Collection

In order to measure user satisfaction of MOLS, SUS Questionnaires were distributed to 96 students of Engineering Faculty, Mulawarman University who already used this learning management system for minimum 1 year. This pre-requisite was applied to ensure that the respondents already familiar using MOLS. Sample size of the respondents was determined by Slovin formula, which was arrived at 96 respondents with 90% confidence level and 10% margin of error. The questionnaire was distributed using Google form. The respondents chose one out of five responses scale that ranging from strongly disagree to strongly agree. The respondents accessed MOLS using their smartphones and rated their experience accordingly. The respondents were advised to choose rating of 3, if they did not have any opinion related to any specific item (Pal and Vanijja 2020).

The respondents were also informed that half of the statements were positive and the other half negative, so they should choose the rating accordingly. In addition, demographic and behavior data of user (name, age, sex, frequency using MOLS, obstacles of using MOLS) was also recorded.

Thinking Aloud test was conducted to 10 respondents who is familiar with MOLS. A number of 10 respondents were sufficient to obtain dependable result, since Nielsen (1993) stated at least 5 user respondents are needed for this purpose, while 8 or more respondents would be more desirable. Then, a concurrent think-aloud protocol was conducted in which respondents were given 10 tasks to complete and simultaneously, they were verbalizing their thoughts regarding MOLS design. At the same time, usability performance metrics (number of tasks successfully completed and task completion time) were assessed. Audio and video were recorded during the tests. Since the data was collected during Covid-19 pandemic, the Thinking Aloud Test was administered via zoom application.

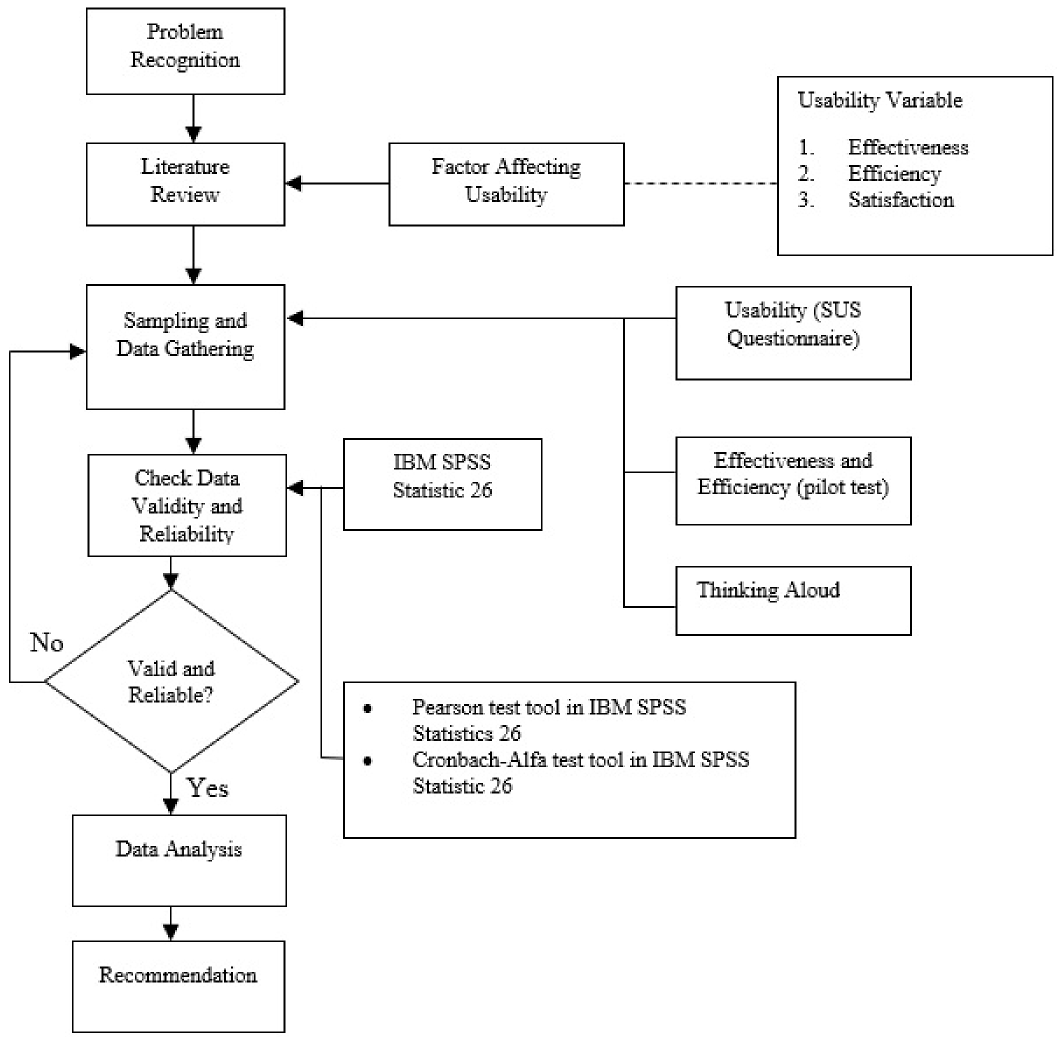

Figure 3. Methodology

5. Results and Discussion

5.1. Validity and Reliability

In this study, the original version of the SUS was translated and revised into Bahasa Indonesia. Internal reliability of a sample of 96 respondents was high since the Cronbach's alpha for the SUS was 0.845, greater than 0.7 (Yusup 2018). Furthermore, SUS questionnaire was also considered valid, since the significant value of Pearson correlation < α (0.05). Table 2 shows the Pearson product moment correlation value.

5.2. Demographics

In total 96 respondents, 41 males and 55 females filled in SUS Questionnaire. The age range of the MOLS users were 19 to 23 years whereas 46.8% respondent is 21 years old. 57.9% of the respondents had been used MOLS for more than 40 times. Furthermore, more than 90% respondents accessed MOLS for filling in attendance list and upload and download assignment. Table 3 demonstrated detailed demographics data of the respondents.

Table 2. Pearson product moment correlation value

Correlations

		X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	TOTAL
X1	Pearson Correlation	1	.423**	.593**	.315**	.401**	.334**	.497**	.547**	.425**	.291**	.725**
	Sig. (2-tailed)		.000	.000	.002	.000	.001	.000	.000	.000	.004	.000
	N	96	96	96	96	96	96	96	96	96	96	96
X2	Pearson Correlation	.423**	1	.671**	.332**	.372**	.315**	.502**	.561**	.382**	.226*	.732**
	Sig. (2-tailed)	.000		.000	.001	.000	.002	.000	.000	.000	.027	.000
	N	96	96	96	96	96	96	96	96	96	96	96
X3	Pearson Correlation	.593**	.671**	1	.389**	.431**	.362**	.579**	.722**	.488**	.199	.819**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000	.000	.052	.000
	N	96	96	96	96	96	96	96	96	96	96	96
X4	Pearson Correlation	.315**	.332**	.389**	1	.163	.106	.312**	.388**	.139	.259*	.512**
	Sig. (2-tailed)	.002	.001	.000		.113	.305	.002	.000	.176	.011	.000
	N	96	96	96	96	96	96	96	96	96	96	96
X5	Pearson Correlation	.401**	.372**	.431**	.163	1	.558**	.376**	.415**	.365**	.089	.632**
	Sig. (2-tailed)	.000	.000	.000	.113		.000	.000	.000	.000	.387	.000
	N	96	96	96	96	96	96	96	96	96	96	96
X6	Pearson Correlation	.334**	.315**	.362**	.106	.558**	1	.233*	.368**	.255*	.069	.549**
	Sig. (2-tailed)	.001	.002	.000	.305	.000		.022	.000	.012	.504	.000
	N	96	96	96	96	96	96	96	96	96	96	96
X7	Pearson Correlation	.497**	.502**	.579**	.312**	.376**	.233*	1	.531**	.431**	.269**	.716**
	Sig. (2-tailed)	.000	.000	.000	.002	.000	.022		.000	.000	.008	.000
	N	96	96	96	96	96	96	96	96	96	96	96
X8	Pearson Correlation	.547**	.561**	.722**	.388**	.415**	.368**	.531**	1	.349**	.301**	.787**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		.000	.003	.000
	N	96	96	96	96	96	96	96	96	96	96	96
X9	Pearson Correlation	.425**	.382**	.488**	.139	.365**	.255*	.431**	.349**	1	.155	.621**
	Sig. (2-tailed)	.000	.000	.000	.176	.000	.012	.000	.000		.130	.000
	N	96	96	96	96	96	96	96	96	96	96	96
X10	Pearson Correlation	.291**	.226*	.199	.259*	.089	.069	.269**	.301**	.155	1	.457**
	Sig. (2-tailed)	.004	.027	.052	.011	.387	.504	.008	.003	.130		.000
	N	96	96	96	96	96	96	96	96	96	96	96
TOTAL	Pearson Correlation	.725**	.732**	.819**	.512**	.632**	.549**	.716**	.787**	.621**	.457**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	
	N	96	96	96	96	96	96	96	96	96	96	96

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 3. Respondent's characteristics and behavior

Gender		%
Male	41	42.7
Female	55	57.3
Age		
19	8	8.3
20	21	21.9
21	41	42.7
22	20	20.8
23	6	6.3
MOLS Usage		
10 - 20 times	19	19.8
21 - 30 times	15	15.6
31 - 40 times	10	10.4
> 40 times	52	54.2
MOLS features that frequently used		
Filling in attendance list	92	95.8
Upload and download assignment	88	91.7
Finding information about particular lecturer	36	37.5
Finding information about course content	66	68.8
Asking question	17	17.7
Checking grades	42	43.8

5.3. Effectiveness

Level of effectiveness shows how appropriate MOLS fulfills its objectives. Effectiveness is measured by comparing the tasks that the respondent completed with the total tasks provided in MOLS. In this study, it was found that the effectiveness level of the MOLS application was 99%, only one respondent failed 1 task # 10 (log out from the MOLS application) (see Table 3). Finally, respondent #9 found the log out button however the time was longer than other respondents. The logout button is not clearly visible, so that respondents are confused when they were looking for the logout button on the MOLS application. The MOLS application had a good level of effectiveness, since it was higher than 78% (Sauro 2011).

Table 3. Number of task completed

Respondent	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Task 8	Task 9	Task 10	Task Completed
1	1	1	1	1	1	1	1	1	1	1	10
2	1	1	1	1	1	1	1	1	1	1	10
3	1	1	1	1	1	1	1	1	1	1	10
4	1	1	1	1	1	1	1	1	1	1	10
5	1	1	1	1	1	1	1	1	1	1	10
6	1	1	1	1	1	1	1	1	1	1	10
7	1	1	1	1	1	1	1	1	1	1	10
8	1	1	1	1	1	1	1	1	1	1	10
9	1	1	1	1	1	1	1	1	1	**0**	9
10	1	1	1	1	1	1	1	1	1	1	10
Total Task Completed											99
Effectiveness (%)											99%

5.3 Efficiency

Efficiency analyzes the time required by users to complete tasks successfully. Efficiency level measures completing time to find the required information. Time Base Efficiency of the MOLS application was 0.0036 task/sec (see Table 4). When it was analyzed further (see Figure 4), it showed that respondent #2 took longer time to complete task #2,4,6,8 compared to other respondents. Therefore, t-test was administered to compare the differences completing time among respondents. Table 4 shows that there was no significant difference of completing time between respondent, since the p value (0.298) > α (0.05)

Table 3. Time base efficiency

Respondent	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Task 8	Task 9	Task 10	Total (sec)
1	35	74	35	12	23	15	12	26	21	11	264
2	23	120	50	37	21	37	15	41	31	12	387
3	20	63	30	14	24	12	13	24	20	12	232
4	10	82	24	13	22	12	30	23	22	13	251
5	14	73	36	14	25	13	34	25	26	10	270
6	12	64	32	11	20	12	32	26	24	12	245
7	15	72	47	13	27	15	28	25	21	11	274
8	22	85	30	14	22	16	30	29	28	15	291
9	21	93	50	16	25	15	39	29	32	60	380
10	24	86	41	17	20	14	31	24	26	14	297
Total time					2.891						
Time base efficiency					0.0035						

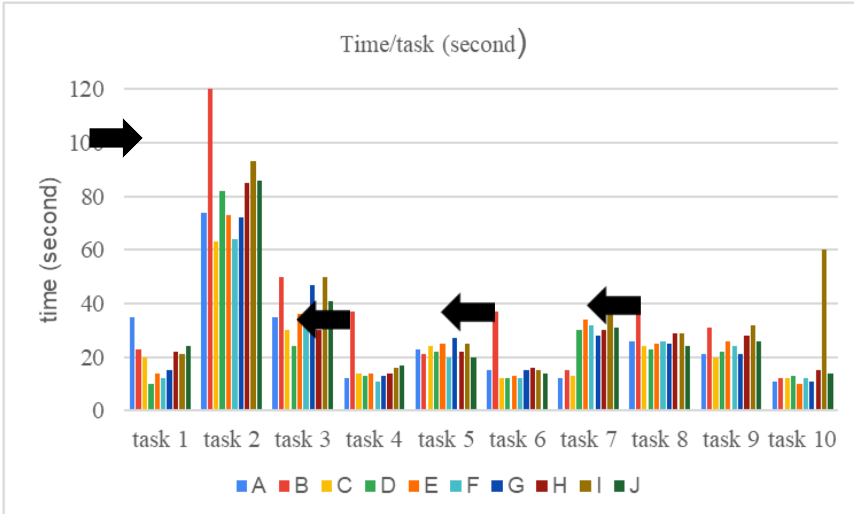

Figure 4. Time for completing task of each respondent

Tabel 4. Independent sample T-test result

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
waktu mengerjakan	Equal variances assumed	.494	.491	-1.071	18	.298	-12.30000	11.48840	-36.43623	11.83623
	Equal variances not assumed			-1.071	14.912	.301	-12.30000	11.48840	-36.79957	12.19957

5.4 Satisfaction

In this study, the level of satisfaction was obtained from SUS score. The SUS questionnaire assesses satisfaction based on the MOLS performance. The results of SUS questionnaires obtained a satisfaction level of 61.64. Based on Table 1, MOLS score is classified as poor and categorized as grade D. It means the MOLS application need improvement. The recommendation for improving MOLS application was gathered from Thinking Aloud process.

5.5 Thinking Aloud

In a thinking aloud test, respondents were given 10 tasks to complete and simultaneously, they were verbalizing their thoughts regarding MOLS design. To provoke the talk, observer also asked respondents opinion regarding suggestions/obstacles that already gathered from 96 respondents previously (see Table 5). In order to maximize the thinking loud results, observer made photograph and recorded the process.

Table 5. Thinking Aloud test's result

No	Suggestions from 96 respondents	Thinking Aloud Result
1	Added audio visual features	Respondents need audio visual features that similar to zoom or Google meet. The feature needs to be users friendly, functional and has unlimited time for meeting.
2	Added notification feature that is connected directly to email	• Notification linked with email and SMS (short message service). • Notification has loud and fun sound such as "shopee" notification,

No	Suggestions from 96 respondents	Thinking Aloud Result
		• There was no large time gap between notification is sent and received
3	Improvement of user-interface	• Ease of using, easy to understand the command, interactive, predictable • Eliminate dysfunctional commands such as follower, activity • Interactive – MOLS has option to change font, color and theme • Ergonomics categorization of menu
4	Automatically fixed file name during upload and download	Adding an option to change the file name
5	Better response times, such as user already filled in attendance list, but it takes times to update the particular list.	Real time response or no large gap between "click" and command execution

5.6 Proposed Improvements

Taking into account thinking aloud results together with obstacles felt by the respondents, this study proposed several points to improve usability of MOLS (see Table 6).

Table 6. Summary of recommendations

	Present	Proposed
Audio visual	There are audio visual features	MOLS provides interaction features between lecturer and student in meeting rooms such as zoom or Google meet
Notification	Notification only showed after user logs in to MOLS	• Notification links to email or SMS, so that students will always update via smartphone without open MOLS application. • Has noticeable sound
User interface	• Poor categorization, • dysfunctional few commands (i.e., activity, follower), command redundancy in different page (i.e., class)	• As from this study, activity and follower command need to be eliminated • Put command "class" only in "beranda" page and delete from another page
Course page	File name change when it is uploaded or downloaded	• Adding option to rename the files or the default name is the original file name.
System	Applications responsiveness	• Faster response time

6. Conclusion

The usability techniques used in this study was based on satisfaction surveys (SUS questionnaire), measurement of users' performance (efficiency and effectiveness), users' observation (Thinking Aloud). The result shows that MOLS usability score was 61.64 which is below the marginal value (68). This score implies that MOLS needs improvement to make it more usable, effective, and efficient at the same time. On the other hand, time-based efficiency was 0.0035 task/sec and effectiveness 99%, which meant MOLS usability in terms of effectiveness and efficiency, was good. This finding confirms that the effectiveness and efficiency of MOLS do not depend on screen size of the device that is used to access the application. The explanation behind the current finding is that if end users are familiar in using a device for a long period of time, then the familiarity will increase the perception of usability (Kortum and Johnson (2013) in Pal and Vanijja 2020). Thus, this study concludes that student can access MOLS effectively and efficiently, but MOLS needs further improvement to meet the students' needs, such as adding more features, design interesting and interactive user interface and improve the responsiveness.

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Biographies

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