An Evaluation of UAJY Learning Management System's Usability using USE Questionnaire and Eye-tracking

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Abstract. One of the influential learning resources utilized today is a web-based learning management system. The web-based e-learning usability is influenced by the user interface. In measuring usability, eye-tracking technology can be employed to examine the eye gaze of an individual when looking at a specific point at a certain time. The use of eye-tracking is beneficial in obtaining objective data. This study aims to evaluate the usability of the UAJY Learning Management System (LMS) website interface and examine the user's interaction with the website interface. Thirty-five participants were recruited in a usability testing experiment. Participants were asked to do three tasks related to the use of e-learning features while their eye movements were recorded. The USE Questionnaire and task-related question data were processed using statistical descriptive methods and eye movement data generated into heatmaps. The Usefulness, Ease of Use, Ease of Learn, and Satisfaction aspects of the UAJY LMS gains more than 80% feasibility percentage. Overall results of feasibility categorized the UAJY LMS as Very Feasible. There was no difference found in usability aspects between gender, faculty background, and eye condition groups. Heatmaps results show that navigational elements in the LMS are utilized properly and successfully help participants in performing tasks.

Keywords: usability, LMS, eye-tracking, USE questionnaire, heatmaps.

1. Introduction

E-learning is an implementation of technology advancement in which learning activities utilize computer network [1]. E-learning brings considerable flexibility to modern study methods. It serves as an alternative to the conventional education process and also becomes complementary to it [2]. Without reducing educators' roles, the learning process can take place anywhere and anytime [3]. Web-based learning management systems (LMS) have become a compelling learning media utilized by many educational institutions nowadays. Through the suitable design of the web interface, users easily get information and enhance the learning process.

The e-learning interface becomes a considerable aspect as the user interface is the place where the user process and interact with the learning source [1], [4]. Web interface design will influence how learners navigate and interact with the learning content. The color combination, the combination of navigation elements, visualization of bullets or numbers in a list, and font size configuration are considered important to improve the distinctness of web page elements toward, learners [4], [5].

The user interface display affected web-based applications' usability since the user interface becomes an essential component of all computer applications [6]. The user interface of a multimedia learning platform affects user interaction and cognitive activities. The learning process including platform usage relies on the user interface design [7]. Many studies concentrate on the website's usability to optimize web design for specific groups of users [8]. Previous studies about usability show the importance of usability examination through usefulness, ease of use, ease of learn, and satisfaction aspects included in the USE Questionnaire [8]–[10]. USE questionnaire's reliability is on par with other usability questionnaires and sensitive in capturing the differences in usability aspects between different products [9]. A study by Hendra et al. [10] measured usability aspects of a system to process students' grades using the USE Questionnaire. High usability value indicates the high advantages of the information system in aiding the users' work. Three parameters from the USE questionnaire were usefulness, ease of use, and ease of learn. The usability measurement results proved that there was a significant influence between the three examined variables and the system was considered "Feasible" with a 75.23% feasibility percentage. Firdaus et al. [11] in West Sulawesi University (UNSULBAR) developed an e-learning system to support learning from home. Along with e-learning system development, this study aims to examine the level of UNSULBAR's e-learning usability from the users. Usability aspects such as usefulness, ease of use, ease of learning, and satisfaction were measured using the USE Questionnaire. Then, the questionnaire data were analyzed using Microsoft Excel and SPSS. The results showed that all usability aspects were categorized as feasible with usefulness gains 68.18%, ease of use acquires 69%, ease of learning by 72.2%, and satisfaction by 64.52%. The overall usability result was 68.2% which later was determined as a feasible category. A study by Asnawi [12] inspected Google classroom's usability as open-source e-learning used in the Information Systems study program, Faculty of Engineering, UNIPMA. The usability aspects were measured using the USE Questionnaire. The results of the questionnaire were measured using a Likert scale. From the measurement results, the usefulness factor value was 3.13 which indicated that the Google Classroom application was useful as e-learning. The ease-of-use factor was 2.93, which indicated that the application had poor ease of use. The ease of learning factor was 2.75, which indicated that the application lacked ease in learning. The satisfaction factor value was 2.8, which indicated that the Google Classroom application had poor satisfaction. The values showed that the low satisfaction score was influenced by the lack of ease of use and ease of learning factors.

In measuring usability, eye-tracking technology is used to examine the eye gaze of an individual when looking at a specific point at a certain time and how their eyes move from one direction to another [13]. When the individual receives a visual stimulus, eye movements and attention can be analyzed to understand the cognitive processes during the experiment [14] [15]. Eye movement data can support the usability evaluation as a source of real-time information on the user's behavior when interacting with webpage interface elements. Previous studies show that the use of eye-tracking is beneficial in obtaining objective data which is less biased [4] [15]. Ujbanyi et al. [14] explored the contrasts of eye movements between students who have reviewed a learning topic and students who have not yet learned the topic when attending a quiz. Fifteen students were sorted based on their test scores. Five students were classified as lower than the average, seven students in the average group, three students in the group better than the average. OGAMA (Open Gaze and Mouse Analyzer) software was used to analyze the eye movement data. The experimental results showed existing disparities between groups in the eye-tracking metrics (the average length of saccades and duration of fixation) that were represented in the attention heatmap and gaze path. Research by Zander et al. [16] examined the implementation of the personalization principle in the multimedia learning materials' design. Personalized language usage in multimedia learning is more advantageous than using standard language (eg, ’you’ rather than ’that’). A group consisting of thirty-seven students learned about brain hemorrhage with formal or personal versions of multimedia materials. Their eye movements were recorded using the eye-tracking device. The results showed the number of fixations and the average duration of fixation on image AOI in the personalized version was less than the formal version. Yulianandra et al. [15] studied the effect of task complexity and web-based e-learning display on the students' cognitive load. Forty-two participants were separated into groups according to the type of e-learning interface complexity and their eye movements were recorded. Cognitive load questionnaires measurement results and eye-tracking data show that task complexity and display complexity affect the task completion times, the number of fixations, duration of user fixation, and user's cognitive load.

Orthodox approaches (e.g., interviews and behavioral assessments) in investigating information processing, do not serve as direct measurements of the interaction between user and multimedia platform. When the user interacts with a visual stimulus, the user's visual attention could be investigated to understand the user's behavior during the multimedia learning platform usage. The combination of questionnaire statistics, interviews, and eye-tracking help researchers provide a deeper description of user behavior in learning using multimedia platforms. Therefore, this study aims to evaluate the usability of the UAJY LMS website interface and examine the user's interaction with the website interface.

2. Usability and USE Questionnaire

Based on ISO 9241-11:2018 [17], “usability is the extent to which a product or a service can be used by the user to achieve specific goals with effectiveness, efficiency, and satisfaction in a specific context of use”. Effectiveness is defined as the accuracy and completeness of specified goals by a designated user in a particular environment. Efficiency is the resources spent on the accuracy and completeness of the achieved goals. Satisfaction is the acceptability of the system to its users.

According to Rubin and Chisnell [18], a product or service can acquire a certain degree of usability if it fulfills several criteria such as usefulness, effectiveness, efficiency, learnability, satisfaction, and accessibility. Usefulness is defined as to what extent the product or service can help accomplish the user’s goal. Efficiency is described as how fast a product or service accomplishes the user’s goal with desired accuracy and completeness. Effectiveness measures how far a product or service can behave as the user wants. Learnability is a part of the effectiveness aspect and is related to the user’s ability to operate the product or service. The satisfaction aspect is related to the user’s perception and opinion about the product or service after engaging in a certain usage experience. Accessibility is related to the user’s access to a product or service needed to achieve a specific goal.

2.1. Usefulness, Satisfaction, and Ease of Use (USE) and Task-related Questionnaire

The questionnaire, which was developed by Arnold Lund, has been commonly used to measures the self-perceived usability aspects of a system [19]. The questionnaire consists of 8 questions regarding the usefulness, 11 questions about the ease of use aspect, 4 questions about the ease of learn aspect, and 7 questions regarding user satisfaction [20]. Each question is provided with five-points a Likert scale ranging from “Strongly Disagree” that equals 1 to “Strongly Agree” that equals 5. Questions in the USE questionnaire, likewise, maintain adequate validity with appropriate and clear descriptions [9]. The current study (see Table 1) adopted seven usefulness questions, ten ease of use questions, three ease of learn questions, and four satisfaction questions. The task score aspect adopted a similar study by Menzi-Cetin et al. [21] regarding the users' tasks completion related to accessibility, navigation, and e-learning content.

Table 1. Items in the USE and Task-related Questionnaire

Items	Content	Items	Content	Items	Content
USE1	In my opinion, e-learning help me be more effective in learning.	ESU5	In my opinion, e-learning website is flexible	SAT3	In my opinion, e-learning works the way I want it to work
USE2	In my opinion, e-learning help me be more productive.	ESU6	In my opinion, e-learning website is effortless to use	SAT4	In my opinion, e-learning is pleasant to use
USE3	In my opinion, e-learning is useful	ESU7	I can use e-learning without written instructions	TASK1	I can access web pages in e-learning
USE4	In my opinion, e-learning gives me control over my activities on the website	ESU8	In my opinion, the regular and occasional users would like e-learning	TASK2	I can access a web page in e-learning I have never visited
USE5	In my opinion, e-learning make things I want to accomplish easier to get done	ESU9	I can recover from mistakes quickly and easily	TASK3	I can collect enough information about visuals in the e-learning
USE6	In my opinion, e-learning saves me time when I use it	ESU10	I have always successfully used e-learning	TASK4	In my opinion, link names in the e-learning direct me correctly
USE7	In my opinion, e-learning meet my needs	EOL1	I learned to use e-learning quickly	TASK5	In my opinion, the web page in e-learning is easily navigated
ESU1	In my opinion, e-learning is easy to use	EOL2	I easily remember how to use e-learning	TASK6	When using e-learning, I know my position in what page
ESU2	In my opinion, e-learning is simple to use	EOL3	I quickly become skillful using e-learning	TASK7	In my opinion, general structure of e-learning page is similar one to another
ESU3	In my opinion, e-learning is user friendly	SAT1	I am satisfied using e-learning	TASK8	E-learning content can be easily followed
ESU4	In my opinion, e-learning website requires the fewest steps possible to accomplish what I want to do with it	SAT2	In my opinion, e-learning is fun to use		

2.2. Eye-tracking

Eye-tracking is a technology to record eye movements so that researchers can find out how an individual's eye sequence moves from one direction to another [13]. The human eye is a fundamental element of the information processing mechanism. Users receive information from visual stimuli and the intentional eye movements indicate the occurrence of neurological processes with a specific purpose [14]. The device used for estimating the eye position is called an eye-tracker. Two infrared cameras with an infrared light source are set with a determined width difference in the device as shown in Figure 1. The infrared light is emitted from the device toward the user's eyes. Both corneas that reflected infrared light are then tracked using the eye-tracker device. This method is called pupillary center corneal reflection. The position and movement direction of eye gaze can be calculated using a three-dimensional geometry function.

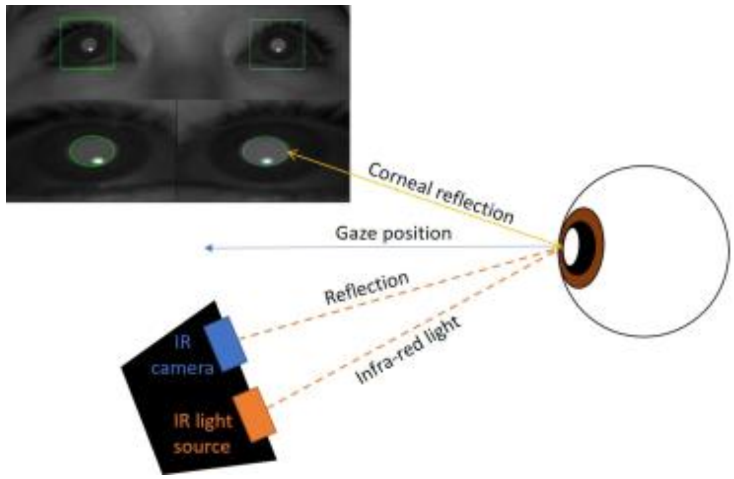

Figure 1. Illustration of eye-tracker system

3. Method

3.1. Participants

Participants were recruited from the Faculty of Industrial Technology and the Faculty of Business and Economics. The LMS website has been commonly used by these faculties' students. Thirty-five participants were recruited for the usability testing experiment. The number of participants to fit the central limit theorem with sample size being equal to 30 or more. Demographic data forms and informed consent were provided for participants.

3.2. Tools and Materials

The tools and materials used in this study were:

- A laptop with a Core i3 processor and 8 GB of memory. The computer display was extended to an external monitor with 1366 x 768 pixels of resolution. The secondary monitor was used by participants to interact with e-learning while the eye-tracker was mounted under the monitor.
- Tobii eye-tracker 4C with sampling rate of 90 Hz, binocular eye tracker, operating distance of 50-95 cm, track box of 40 cm x 30 cm, 6 points calibration modes, USB 2.0 connection, the physical dimension of 17 x 15 x 335 mm. Raw data were acquired using Tobii Software Development Kit based on C language.
- JASP 0.11 for statistical descriptive processing and Jupyter Notebook for generating heatmaps using Python programming language libraries.

3.3. Data Collection Procedures

Before the experiment, a description of research activities was explained to the participants. Then, participants were asked to fill in the informed consent form and demographic form. The design of the experimental task was similar to that of preceding research [14] where participants were asked to do three tasks related to the use of basic features in e-learning namely:

1. User authentication
2. Accessing user profile
3. Accessing specific course

In the early stages of the experiment, the eye-tracking device was calibrated using six-points calibration to match each participant's eye movements. Participants performed the task without the experimenter's help and each task completion time was recorded. After finishing the data collection procedure, the data records were checked to confirm the results. Later, participants filled in the Usability, Satisfaction, Ease of Use (USE) questionnaire after the experiment. The questionnaire’s data was obtained from 35 participants: twenty-six students of the Faculty of Industrial Technology and nine students of the Faculty of Business and Economics. There were twenty-five male students and ten female students. Seventeen participants have normal vision, and eighteen participants have myopia and/or astigmatism corrected with glasses.

3.4. Data Processing Procedures

The questionnaire data were processed using descriptive statistical analysis. Gender, faculty background, and eye condition were accounted as independent variables. The questionnaire adopted from the USE Questionnaire contains usefulness, ease of use, ease of learn, and satisfaction. The task score aspect was adopted from a previous study by Menzi-Cetin et al. [21]. The questionnaire’s results were considered as dependent variables.

Outliers’ detection was employed using box plot representation. There were four participants assumed as an outlier in each usability aspect measurement. One participant had a usefulness aspect score out of the score data distribution. There were two participants accounted as outliers in the satisfaction aspect. One outlier was also found in the data distribution of task scores. Therefore, the number of participants’ data used in the statistical analysis was thirty-one participants. Reliability tests were performed on thirty-two items of the questionnaire.

4. Result and discussion

4.1. The Questionnaire’s Statistical Descriptive Results

A reliability test measures each questionnaire’s item Cronbach’s alpha value. Table 2 shows that questionnaire item acquired more than 0.8. Therefore, the questionnaire has good reliability.

Table 2. Items’ Cronbach’s Alpha Coefficient

Items	Cronbach’s Alpha	Items	Cronbach’s Alpha	Items	Cronbach’s Alpha
USE1	0.910	ESU6	0.911	TASK1	0.910
USE2	0.910	ESU7	0.914	TASK2	0.912
USE3	0.907	ESU8	0.914	TASK3	0.914
USE4	0.906	ESU9	0.910	TASK4	0.915
USE5	0.909	ESU10	0.910	TASK5	0.911
USE6	0.909	EOL1	0.910	TASK6	0.914
USE7	0.909	EOL2	0.907	TASK7	0.914
ESU1	0.909	EOL3	0.906	TASK8	0.910
ESU2	0.910	SAT1	0.909		
ESU3	0.912	SAT2	0.909		
ESU4	0.914	SAT3	0.909		
ESU5	0.915	SAT4	0.909		

Table 3 shows the descriptive statistics results of the questionnaire's aspects variables. The p-value from the Shapiro-Wilk test on the Ease of Learn aspect was significant with a p-value less than alpha ($\alpha = 0.05$). Therefore, the tested variables assumed violated the normality assumption. If the normality assumption was violated, a parametric statistical test cannot be employed. Thus, non-parametric statistical tests were used as an alternative.

Table 3. Descriptive Statistics of Questionnaire's Variables

	Usefulness	**Ease of Use**	**Ease of Learn**	**Satisfaction**	**Task Score**
Valid	31	31	31	31	31
Missing	0	0	0	0	0
Mean	28.452	39.935	12.774	16.000	32.355
Median	28.000	39.000	13.000	16.000	32.000
Std. Deviation	2.755	3.915	1.521	2.017	2.524
Shapiro-Wilk	0.947	0.933	0.919	0.942	0.966
P-value of Shapiro-Wilk	0.133	0.055	0.023	0.092	0.413
Minimum	24.000	32.000	10.000	11.000	27.000
Maximum	35.000	47.000	15.000	20.000	38.000

To check the homogeneity of variance between the groups, a Levene test was performed. Table 4 shows that the usefulness aspect was violated the homogeneity of variance between gender groups ($\alpha = 0.05$). Thus, to examine the difference between the two groups, the Mann-Whitney U test was performed as the non-parametric substitution for Independent Sample T-Test. The test results indicated no significant difference between the usability metrics.

Table 4. Levene's Test Results of Questionnaire's Variables

	F	**df**	**p**
Usefulness	5.836	1	0.022
Ease of Use	3.309	1	0.079
Ease of Learn	0.772	1	0.387
Satisfaction	0.008	1	0.930
Task Score	0.036	1	0.850

F: the results of F-test df: degree of freedom, p: calculated p-value

4.2. Usability Aspects Evaluation

To measure the usability aspect from the questionnaire, the ideal score for each criterion was determined by calculating the highest score on each question answer [15]. The observed score was calculated by multiplying the score according to the Likert scale of participants' overall answers on each usability aspect. The acquired scores were then compared with the system feasibility standard [16] as shown in Table 5.

Table 5. System Feasibility Classification in Percentage

Score (%)	Classification
< 21	Very poor
21 – 40	Poor
41 – 60	Fair
61 – 80	Feasible
81 - 100	Very Feasible

Based on the evaluation results shown in Table 6, Usefulness and Ease of Learn aspects of UAJY LMS acquired more than eighty percent score and were classified as Very Feasible. Ease of Use and Satisfaction aspect categorized as Feasible with acquired percentage 79.87% and 80.00%, respectively. Task aspect that measures the participants' performance in doing experimental tasks acquires 80.89% of the feasibility percentage. Overall results gained an 80.95% feasibility percentage. These scores indicate that the participants carried out the tasks on the web-based e-learning with ease for completion and the UAJY LMS accounted as Very Feasible for the user.

Table 6. Measured Usability Aspects Score in Percentage

Usability Aspects	Participants' Score	Expected Maximum Score	Feasibility Percentage
Usefulness	882	1085	81.29%
Ease of Use	1238	1550	79.87%
Ease of Learn	396	465	85.16%
Satisfaction	496	620	80.00%
Task	1003	1240	80.89%
Overall results	4015	4960	80.95%

Descriptive statistics results of Usefulness, Satisfaction, Ease of Use (USE) questionnaire scores combined with Task Score imply that there is no difference in participants' perceived usability toward UAJY LMS user interface. Table 7 shows the results of the Mann-Whitney U test of the Usefulness, Ease of Use, Satisfaction, and Task Score against gender, faculty background, and eye condition aspects. The calculated p-value shows no value less than $\alpha = 0.05$. This means there is no significant difference in the usability metrics.

Table 7. Mann-Whitney U Test Results of The Questionnaire's Aspects

	Usefulness		Ease of Use		Ease of Learn		Satisfaction		Task Score	
Factor	W	p	W	p	W	p	W	p	W	p
Gender	142.500	0.059	110.000	0.646	117.000	0.435	133.500	0.130	96.500	0.930
Faculty	88.500	0.891	102.500	0.650	91.500	1.000	114.500	0.310	124.000	0.149
Eye condition	108.000	0.647	120.000	1.000	141.000	0.406	136.500	0.518	116.500	0.904

W value (Mann-Whitney statistic): the sum of the ranks of the first sample, p : calculated p-value

Table 8. Participants' Average Task Completion Time

Average Task Completion Time (seconds)		
tLogin	tProfile	tCourse
58.06	38.96	56.38

Table 8 shows that on average the participants needed 58.06 seconds to accomplish the authentication task (tLogin) since there was two-step of activity: click the login link and input the user credentials. As observed from the video record, most of the participants took time to input their username and password after accessing the login page. The participants needed 38.96 seconds to access the user profile, and 56.38 seconds to access a specific course. Spearman's method was used to discover the correlation between measured usability aspects also time for task completion. The test results (see Table 9) shows that Task Score has correlated with the usability aspects namely Usefulness, Ease of Use, Ease of Learn, and Satisfaction ($p < 0.05$). This result indicates how participants perform the task on web-based e-learning is also influenced by the perceived usefulness, ease of use, and satisfaction aspects.

Table 9. Spearman's Correlation of Usability, Task, and Task Completion Time

		tLogin	tProfile	tCourse	Usefulness	Ease of Use	Ease of Learn	Satisfaction	Task Score
tLogin	Spearman's rho		0.636***	0.511	-0.162	0.033	-0.088	0.047	-0.230
	p-value		1.211e-4	0.003	0.385	0.861	0.640	0.803	0.214
tProfile	Spearman's rho	0.636***		0.490**	-0.065	0.086	-0.195	-0.061	-0.236
	p-value	1.211e-4		0.005	0.728	0.645	0.292	0.746	0.201
tCourse	Spearman's rho	0.511	0.490**		-0.100	0.054	0.138	0.254	-0.239
	p-value	0.003	0.005		0.593	0.773	0.458	0.168	0.195
Usefulness	Spearman's rho	-0.162	-0.065	-0.100		0.667	0.571***	0.542**	0.461**
	p-value	0.385	0.728	0.593		4.191e-5	8.048e-4	0.002	0.009
Ease of Use	Spearman's rho	0.033	0.086	0.054	0.667***		0.771***	0.579***	0.582***
	p-value	0.861	0.645	0.773	4.191e-5		3.836e-7	6.379e-4	5.981e-4
Ease of Learn	Spearman's rho	-0.088	-0.195	0.138	0.571***	0.771***		0.583***	0.516**
	p-value	0.640	0.292	0.458	8.048e-4	3.836e-7		5.791e-4	0.003
Satisfaction	Spearman's rho	0.047	-0.061	0.254	0.542**	0.579***	0.583***		0.410*
	p-value	0.803	0.746	0.168	0.002	6.379e-4	5.791e-4		0.022
Task Score	Spearman's rho	-0.230	-0.236	-0.239	0.461**	0.582***	0.516**	0.410*	
	p-value	0.214	0.201	0.195	0.009	5.981e-4	0.003	0.022	

* p<.05, ** p<.01, *** p<.001

Although Task Score is correlated with Usefulness, Ease of Use, Ease of Learn, and Satisfaction; the perceived usability aspects and task performance were not correlated with task completion time. Statistically, time for accessing profile correlated with authentication task. Time for accessing a specific course also correlated with time for accessing profile and authentication tasks.

4.3. Eye-tracking Heatmaps

To visualize user interaction with the LMS user interface, acquired data from eye-tracker were generated into a visual representation named heatmap. Participants' gaze and focus points presented on the heatmap explain specific user interface elements that users interacted with [22]. Thirty-one participants' eye gaze data were generated into a heatmap on the representative user interface from each experimental task. The user interface was divided into several areas of interest that represented each area's functionality and elements.

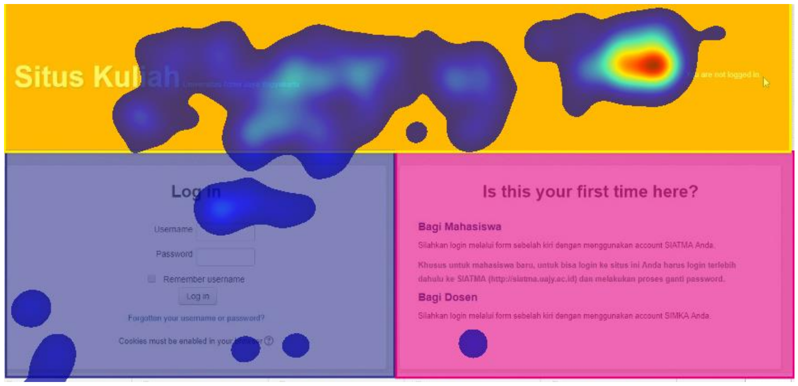

Figure 2. Heatmap of Authentication Task

The first task carried out by the participants was authentication on the LMS. The areas of interest were divided into the header area, authentication input area, and message area. The authentication process was carried out in two steps. First, the user must click on the login link on the top right corner of the LMS homepage. Then, the login page loaded, and the user input the username and password. Participants' focus points were accumulated on the login link in the top-right corner of the header area as shown in Figure 2. During the input process for authentication, the participants tend to focus on the username textbox. The questionnaire items of TASK4 assessing the correctness of link element direction, and TASK5 of the easiness in navigation shows average scores of 4.16 out of 5 and 4.03 out of 5, respectively. Participants' attention focused on the designated elements as the participants concurred on the correctness of function and ease of navigation from the task-related elements.

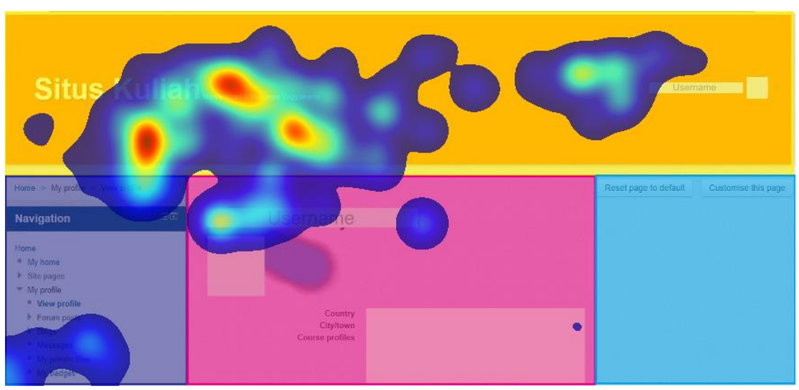

Figure 3. Heatmap of Accessing Profile Task

The second experimental task was accessing the user account profile. The areas of interest were divided into the header area, left navigation area, middle content area, and right functional area. In this task, participants tended to use two different approaches to access the profile page. Nineteen participants used the navigation bar on the left (see Figure 3) and clicked on the "View Profile" link. Twelve participants used dropdown on the top right corner. This dropdown also worked as a navigation element as it contained links to access the LMS homepage, student's profile, messages, student's private files, student's badges and log out function. Therefore, on the header area of interest, several participants' focus points accumulated on the top right corner dropdown. Meanwhile, the navigation bar area of interest found a few focus points. Aside from accessing the profile page, participants tended to explore the profile page on the header area that contained the LMS homepage link and the content area in the middle that contained information such as student's profile photograph and enrolled course information. Although the participants had different approaches in using appropriate elements for navigation, the participants' average score on items ESU1 and ESU2 about ease of use and simplicity of e-learning elements were 4.26 out of 5 and 4.23 out of 5. The score indicates that participants agree on the ease of use of the navigational elements. Item ESU4 described the minimum possible steps for the participant to accomplish a certain goal. Both dropdown and navigation bar provided a designated link to access the profile. The average score on the ESU4 was 4.06, which implied that participants agreed with the effectiveness of the navigational elements' usage.

Figure 4. Heatmap of Accessing Course Task

The third task performed by participants was accessing specific courses as instructed in the experiment. The areas of interest were divided into the header area, left navigation area, middle content area, and right functional area. Participants' focus points mostly accumulated in the middle of the page (see Figure 4). The middle area of interest contained the list of courses available on the LMS. Participants looked for the specific course by scrolling on the page. Therefore, the focus points were still gathered on the top-middle position. The average score of TASK3 and TASK7 were 3.87 and 3.9. Item TASK3 described the adequacy of visual information displayed on the webpage element. TASK7 represented the similarity in the general structure of the web page. The average scores of TASK3 indicated that some of the participants were unsure of their opinion about the sufficiency of visual information on the course list element. Five participants gave score 3 ("Neither agree nor disagree") and one participant answered "Disagree". However, 22 participants agreed, and 3 participants strongly agreed that the information displayed on the element was already sufficient, as supported by the eye focus points on the heatmap in Figure 4. Most of the attention was gathered on the course name labels. Meanwhile, for item TASK7, 25 out of 31 participants agreed that the general structure of the main page was like other pages. For example, the main page consisted of a header area, a navigation area on the left, another function area on the right, and a content area in the middle. The profile page also contained a similar structure. It shows that the consistency of web interface design would ease the user to learn and use the web-based e-learning features.

The critical aspects that affect users' satisfaction in using e-learning are interface design, navigation, interaction, and usability [23]. In this study, interface design and navigation were present on the e-learning interface and utilized in the task performed by participants. The interaction between user and e-learning interface was recorded using an eye-tracker and represented by heatmaps. The perceived usability aspects of the e-learning website were assessed by a usability evaluation questionnaire. Previous studies mention that navigation improves users' participation and interaction [24]–[26]. In the authentication task, navigational elements such as the login link have already proved user expectation in terms of correctness and navigation measured by TASK5 and TASK5 items. Efficiency in e-learning is highly related to its usability [27]. However, the authentication page interface design is lacking in terms of efficiency. Faraday [28] theorized two cognitive processes occur when users interact with a web page. In the initial step, the user observes a specific area to find an anchor. Next, the user utilizes the chosen anchor to gather the information placed around the anchor point. This theory of visual search behavior has been commonly used by web designers to avoid potential design problems and provide a more beneficial learning experience [29]. Visual search behavior can be examined from the eye movement data. During the authentication task, participants were able to identify the login link element on the top right corner as an anchor to access the authentication. Later, the username and password textboxes were accessed as another anchor by the participants' eye gaze on the left side. From the task heatmap, it can be seen that participants need to shift their focus to different directions and the time taken on the task was longer than the other task. Improvement could be done by putting the authentication input text boxes on the top right corner of the home page. This would reduce the time needed to access the authentication page and the user's attention would not be shifting too far.

Ease of use, ease of learn, and ease of navigation are critical aspects of human-computer interaction. They affect the other usability aspects, especially satisfaction and usefulness [30], [31]. In this study, the task of accessing the profile page reflected the ease of use (ESU1) and simplicity (ESU2) of the e-learning navigational elements. The participants' eyes gazed the dropdown on the top right corner and navigation bar on the left. Both navigational elements provided a direct link to access the profile, thus the participants' interaction indicated flexibility in utilizing navigational elements to accomplish the same goal. The dropdown on the top right corner has an iconic representation by using the participant's photo icon and profile name that attract participants' attention [32][33]. The navigation bar placed on the left had a hierarchical structure and contained selection items with fixed positions. Another assumption is participants' visual attention tends to focus from webpage content to items with selection [34].

To access the specific course as instructed in the third task, participants tended to use the list of courses available in the middle area of interest. The general structure of the e-learning page with content was displayed in the middle and its similarity on the other page would provide ease of learn and memorability to the user. Availability on control, ease in navigation, and flexibility on e-learning interface would indirectly affect the satisfaction and motivation of the e-learning users. It has been proven by correlation of the satisfaction toward the usefulness, ease of use, ease of learn, and task-related assessment. The generated heatmaps also show that usefulness and ease of use of the e-learning interface elements have successfully fulfilled their purpose.

5. Conclusion

Web-based learning management systems (LMS) have become a compelling learning media utilized by many educational institutions nowadays. Web interface design acts as a crucial function in learners' interactions. Web interface design will influence how learners navigate and interact with the learning content. The user interface display affected web-based applications' usability since the user interface becomes an essential component of all computer applications. Studies about usability show the importance of usability examination through usefulness, ease of use, ease of learn, and satisfaction aspects included in the USE Questionnaire. In measuring usability, eye-tracking technology can be employed to support the usability evaluation as a source of real-time information on the user's behavior when interacting with webpage interface elements.

In this study, the usability of UAJY learning management system was measured using USE questionnaire and eye-tracking which data were generated into heatmaps to represent participants' visual interaction with the user interface. The Usefulness, Ease of Use, Ease of Learn, and Satisfaction aspects of UAJY LMS gained feasibility percentages of 81.29%, 79.87%, 85.16%, and 80.00%, respectively. Overall results of feasibility categorized UAJY LMS as Very Feasible with an 80.95% percentage. Statistical inference results show that there is no difference found in usability aspects between gender, faculty background, and eye condition groups. This concludes that UAJY LMS can be used by any student. Heatmaps results also show that navigational elements in the LMS were utilized properly and successfully helped participants complete tasks. The dropdown list, navigation bar, and the list of courses were accounted as useful navigational elements. However, further improvement on authentication process efficiency could be done by repositioning the username and password text boxes in the place that got more users' attention.

6. Limitation

This study can be further developed into research in examining users' behavior when interacting with static or dynamic multimedia elements in learning using eye-tracking. User interaction toward displayed learning materials such as text, pictures, or even videos can be examined. Quantitative metrics from eye-tracking data can be extracted to provide detailed analysis of user's attention and interaction with the user interface.

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