

## Measurement of Usability for Multimedia Interactive Learning Based on Website in Mathematics for SMK

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**Abstract.** Web usability, if evaluation done correctly, can significantly improve the quality of the website. Website containing multimedia for education should apply user interfaces that are both easy to learn and easy to use. Multimedia has a big role in changing the mindset of a person in learning. Using multimedia, learners get easy to obtain information, adjust information and empower information. Therefore, multimedia is utilized by teachers in developing learning techniques to improve student learning outcomes. For students with self-directed learning, multimedia provides the ease and completeness of the courses in such a way that students can complete the learning independently both at school and at home without the guidance of teachers. The learning independence takes place in how students choose, absorb information, and follow the evaluation quickly and efficiently. The 2013 Curriculum 2013 for Vocational High School (SMK) requires teachers to create engaging teaching and learning activities that students enjoy in the classroom (also called invitation learning environment). The creation of learning activity environment is still a problem for most teachers. Various researches reveal that teaching and learning activities will be more effective and easy when assisted by visual tools. Using multimedia, learning material can be presented more attractively that help students understand the material easily. The opposite is found in the learning activity environment who only rely on ordinary lectures. Usability is a quality level of multimedia with easy to learn, easy to use and encourages users to use it. The website Multimedia Interactive Learning for Mathematics SMK Class X is targeted object. Usability website in Multimedia Interactive Learning for Mathematics SMK Class X is important indicators to measure effectiveness, efficiency, and student satisfaction to access the functionality of website. This usability measurement should be done carefully before the design is implemented thoroughly. The only way to get test with high quality results is to start testing at the beginning of the design process and continuously testing each of the next steps. This research performs usability testing on of website by using WAMMI criterion (Website Analysis and Measurement Inventory) and will be focused on how convenience using the website application. Components of Attractiveness, Controllability, Efficiency, Helpfulness, and Learnability are applied. The website in Multimedia Interactive Learning for Mathematics SMK Class X can be in accordance with the purpose to be accepted by student to improve student learning outcomes. The results show that WAMMI method show the usability value of Multimedia Mathematics SMK Class X is about from 70% to 90%.



## 1. Introduction

There are many things to consider when building a new website for education. Basically, the site needs to be attractive enough that students want to use at it. It also needs to contain all of the materials that students need in order to help them achieve the objective for learning targets. One of the most important aspects of building a website is testing for usability. Internet users (students) are accustomed to being able to figure out how to use a website quickly. Most of them will not take the time to figure out a site that is not usable.

Web usability is how easy a website is to use. The main reason that usability is so important is because there are so many similar websites that people will go to the next site if the first one they visit is not usable. Beautiful website may not achieve its presence if users are unable to figure out how to navigate the site quickly. Web usability testing aims to determine whether a website is in accordance with the needs of the user (students) or not.

This research does usability testing on Website containing Multimedia Interactive Learning Based in Mathematics for SMK on by using field observation method is by observing users how they use the application. The website is not only a cost efficient and timely method to communicate with various students. That's vitality of usability issue for the websites. Usability is importance in terms of satisfying website users' needs and expectations. In this research, usability components tested consist of attractiveness, controllability, efficiency, helpfulness, and learnability. It also presents a description of two such methods developed by [1] and [2].

## 2. Related Research

The criteria used in the research of usability websites are quite diverse and vary from one journal to another. There are two papers that become reference in doing this research, i.e.,:

- "Assessing the Usability of University Websites: An Empirical Study on Namik Kemal University" [1]
- "Common Usability Problems on Educational Websites" [2]

[1] uses five usability criteria defined by WAMMI (Website Analysis and Measurement Inventory). These criteria can be seen in table 1.

**Table 1.** Criteria used in paper 1 "Assessing the Usability of University Websites: An Empirical Study on Namik Kemal University"

	Criteria	Definition
1	Attractiveness	Website have a visually pleasing appearance and can draw the user's attention to visit the web.
2	Controllability	The level of control that a user perceives when a person interacts with a website. The site with good controllability enable users to navigate the website easily and can do the things they want to do.
3	Efficiency	Users can achieve their target with a short visit without the need to use a lot of cognitive effort.
4	Helpfulness	Website has the structure and content that matches the expectations of users.
5	Learnability	Ease in the time and effort of users to learn the website.

That research aims to measure the usability of the Namik Kemal University (NKU) web site via the five factors of usability: attractiveness, controllability, helpfulness, efficiency and learnability. The

results reveal that the five usability factors are positively related with usability perception, i.e., attractiveness, helpfulness, efficiency, learnability, and controllability. [2] uses five different criteria. The criteria used in the paper and its definition can be seen in table 2 below.

**Table 2.** Usability criteria for paper 2 “Common Usability Problems on Educational Websites”

	Criteria	Definition
1	Navigation	Assessing whether a site has the tools and links that facilitate user navigation on the site.
2	Architecture	Associated with the information structure where the site structure is divided into logical groups and each group contains related information.
3	Ease of use and Communication	Relates to the cognitive effort required to use a website.
4	Design	Visual Attraction website, use of good design and use of images, fonts, good color.
5	Content	Assessing whether a website already has the information the user needs.

The criteria in Table 2 comprehensively evaluated the usability of three large public university websites in Jordan, using the heuristic evaluation method. The results identified a list of 34 specific types of common usability problems that were found on the selected Jordanian university websites, and described the frequency number of these problems. The results of 34 problems that were uniquely identified in this research included: Misleading links, links don't open the destination pages, links cause disappearance of the menu, broken links, various types of inconsistency problems, inappropriate orientation of the page design, ineffective text format, broken images, inappropriate choice of color, empty page, inappropriate content, difficult interaction with a website, and lack of support to the Arabic language.

Futhermore, the common and specific usability problems that were uniquely identified in that research, could be used as guidelines for universities in Jordan, to investigate and improve their universities' websites, and therefore to achieve the advantages of usable educational websites.

Therefore, given the different criteria used by the two papers, further studies were conducted by investigate and improve their educational websites followed by comparing the definitions of the two groups. Table 3 shows the results of the comparison:

**Table 3.** Comparison of Criteria

	Paper 1	Paper 2
1	Attractiveness: Website have a visually pleasing appearance and can draw user's attention to visit the web.	Design: Visual Attraction website, use of good design and use of images, fonts, good color.
2	Controllability: The level of control that a user perceives when a person interacts with a website. The controllability enable users to navigate	Navigation: Assessing whether a site has the tools and links that facilitate user navigation on the site.

the website easily and can do the things they want to do.

- 3 Efficiency: Users can achieve their target with a short visit without the need to use a lot of cognitive effort. Ease of use and Communication: Relates to the cognitive effort required to use a website.

**Table 3.** Comparison of Criteria

	Paper 1	Paper 2
4	Learnability: Ease in the time and effort of users to learn the website.	Architecture: Associated with the information structure where the site structure is divided into logical groups and each group contains related information.
5	Helpfulness: Website has the structure and content that matches the expectations of users.	Content: Assessing whether a website already has the information the user needs.

Based on the review results of the two papers above, it is known that both groups of criteria have the similar form of definition but criteria in Paper 1 is more extensive coverage than Paper 2, therefore in this research, criteria in the Paper 1 will be used.

**3. Method and Tools**

Set up a website usability testing is carefully construct activities to build a scenario wherein a person performs a list of tasks that someone who is using the website for the first time is likely to perform. This form will be used to evaluate a product (in this case a website) by testing is on users (students). Researcher observes and listens to the students who is performing the tasks while taking notes. Watching students perform common tasks on a website is a great way to test whether the site is usable because quick response will immediately be able to see whether they are able to perform the tasks and any difficulties they have while doing so.

The following is a brief description of the main usability testing methods that are used.

**Table 4.** Description of Criteria

	Main Criteria	Sub-Criteria	Definition
1	Attractiveness	View	Applied good resolution at least 640 x 480 Can be viewed using mobile with a resolution of 1280 x 800 (HD) to 320 x 240 (QVGA)
		Color	Color used is dominant cool color (pastel color or grey color)
		Font	Selected of fonts is readable (Arial 10-15 pt or Calibri 10-15 pt)
		Images	Images have good quality that is type PNG or type TIFF
		Video	Video is encoded with minimum resolution of 480p: 854x480
	Animation	Animation embedded is not auto play	
2	Controllability	Design	Website visualization is easy to understand by users in the form of buttons and links with no different from the usual looking of Facebook.
		Menu navigation	Menus are grouped according to their similarity
3	Efficiency	Speed launch/display	Time needed to load/display the entire web in a short time from the beginning of the click (is ranging from 1-5 to 21-25 second)

**Table 4.** Description of Criteria

	Main Criteria	Sub-Criteria	Definition
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4	Learnability	Ease of use	Users can use the website without any constraints even though it has not opened for 1 month
5	Helpfulness	Content architecture	Information is divided into logical groups and each group contains updated regularly

The criteria above need to be quantitative to make student’s perceptions on usability of website could

**Table 5.** Ranking of Criteria

Main Criteria	Sub-Criteria	A	B	C	D	E		
1	Attractiveness	View	Website use 1280x800 resolution	Website use 1024x768 resolution	Website use 1024x600 resolution	Website use 800x600 resolution	Website use 640x480 resolution	
			Could open via mobile with 1280x720 resolution (HD)	Could open via mobile with 960x540 resolution (HD)	Could open via mobile with 800x600 resolution (SVGA)	Could open via mobile with 640x480 resolution (VGA)	Could open via mobile with 320x240 resolution (QVGA)	
			Dominant color is cool (green, blue, purple)	Dominant color is warm (red, yellow, orange)	Dominant color is neutral (chocolate, grey)	Dominant color is black and white	Dominant color is black	
			Arial size 10-15	Open Sans size 10-15	Times New Roman size 10-15	Verdana size 10-15	Calibri size 10-15	
			Format (Portable Network Graphics)	Format PNG	Format JPEG (Join Photographic Expert Groups)	Format JPG	Format BMP	Format TIFF (Tagged Imaged Format File)
			Format MKV, MOV	Format MP4	format WMV	Format FLV, SWF	Format AVI, MPEG, 3GP	
2	Controlability	Animation	Format 3D	Format SWF, SWI	Format EXE	Format PPTX	Format GIF	
		Design	Button underlined, Pointer hover	Button in individual frame, Pointer hover	Pointer hover	Pointer change size	No effect	
		Menu navigation	Grouped according to head menu	Grouped	Some are grouped	Few are grouped	None	
3	Efficiency	Speed launch/display	1-5 secs	6-10 secs	11-15 secs	16-20 secs	21-25 secs	
4	Learnability	Ease of use	Users capable using the website after 30 days	Users capable using the website after 20 days	Users capable using the website after 15 days	Users capable using the website after 10 days	Users capable using the website after 7 days	
5	Helpfulness	Content architecture	Updated regularly every 3 days	Updated regularly every 5 days	Updated regularly every week	Updated regularly every month	Updated regularly every 2 months	

be analyzed. This quantitative fulfilment restriction is useful for each sub-criteria to have a maximum and a minimum constraints response that can be fulfilled. The limits used letters A-B-C-D-E, each representing the mark of the criteria. The letter "A" representing the best rating of fulfillment and the lowest rating represented by letter "E". Students will provide value in accordance with column that has been provided. The Table 5 below is the criteria and quantitative description of usability website used in the research.

The website become research object is named <http://www.sukardjo-lipurs.com>. The website usability testing was using the famous browser Google Chrome. In terms of this test, only 3 pages from the website will be tested. Almost all of usability criteria were evaluated through visual or eyesight not get

into the elements of the website source code. Students and 3 expert (teachers) are involved during this testing. Several criteria require a period to complete the usability testing. Researcher also perform testing using online tools to measure of a website portfolio. The chosen online tools are responsivepx.com; fontface. Ninja; and pingdom (<https://tools.pingdom.com/>). For helpfulness, these sub-criteria is verified with 16-item questionnaire was administered manually using PSSUQ (Post-Study Usability Questionnaire) template.

Website usability testing was conducted on 27 July 2017 until 10 September 2017. The research was conducted in SMKN 39 Jakarta Pusat.

#### 4. Result and Analysis

The result of the website usability testing based on criteria showed in Table 6. below.

**Table 6.** Result of Testing

Main Criteria	Sub-Criteria	Result
1 Attractiveness	View	A
		A
	Color	A
	Font	B
	Images	A
	Video	A
2 Controllability	Animation	B
	Design	B
3 Efficiency	Menu navigation	A
	Speed launch/display	B
4 Learnability	Ease of use	A
5 Helpfulness	Content architecture	B

##### 4.1. Usability Website of Attractiveness

Website has been using the resolution of 1280 x 800 then the rating is “A”. The screenshot view using responsivepx.com is given below. Website can be accessed via mobile (Smart Phone) with the best size 1280 x 720 (HD) hence the rating is “A”.



**Figure 1.** Website view using <http://responsivepx.com/?sukardjo-lipurs.com%2F#816x984&scrollbars>

The “A” was marked on sub-criteria for color, because the dominant color in the homepage of the website is cool (blue and green). Psychologically, the cool color is able to attract the attention of users because of its beauty and cool mind for whom views the website.

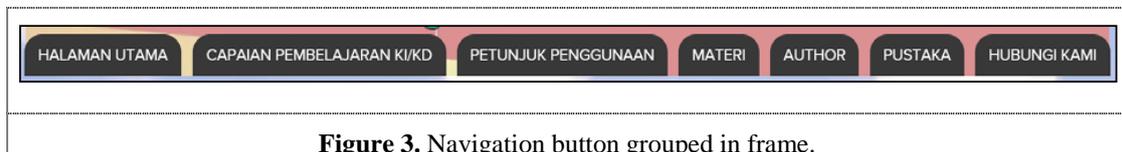
Mark “B” on the sub-criteria Fonts because the selection of fonts from the website in accordance with the website in the academic world, (most of) using "Open Sans" font size 10-13pt. This font has a distinctive feature as a clear, easy to read and often used by students in academic activities. Verification of this font using software called “font face ninja”.



**Figure 2.** Font view using FontFace Ninja.

#### 4.2. Usability Website of Controllability

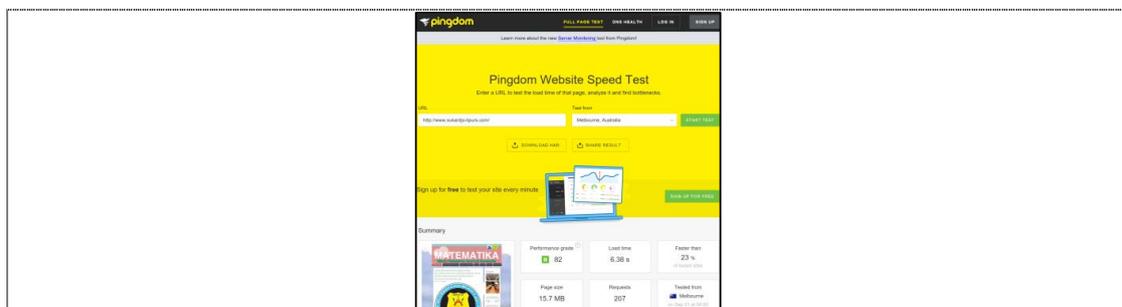
Mark “B” on the design sub-criteria because the navigation on the website can be distinguished by the frame limit that as shown below figure 4.3. The key menu and navigation is easy to understand because it uses language commonly used by most websites and textbooks. Navigation buttons position is designed stay in place even though visitors move pages of the website.



**Figure 3.** Navigation button grouped in frame.

#### 4.3. Usability Website of Efficiency

Mark “B” in the sub-criteria loading time obtained from the testers using online tools called pingdom (<https://tools.pingdom.com/>). This tool is useful to measure time required (seconds) for the entire website to load. The result of loading time website is 6,38 s with capacity of website size equal to 15,7 MB.



**Figure 4.** Navigation button grouped in frame.

*4.4. Usability Website of Learnability*

Learnability is defined as the capability of a website to enable the student to learn how to use it. This is a key usability feature that is often disregarded. In this case, the testing whether website is learnable is over a certain period (month or week), using the same students testing the interface multiple times at regular intervals. A more learnable website is one that reduces the time it takes to complete tasks as users spend more time with a website faster than others. This sub-criteria is marked with “A”. Student can use the website even though not open for 30 days. That website rank relies on the familiarity and simplicity design.

*4.5. Usability Website of Helpfulness*

Helpfulness is degree to which students feel that the site enables them to solve their problems with finding information and navigating. Website is updated regularly every 5 days. This sub-criteria is marked with “B”. Students find the website attractive, and also find it helpful.

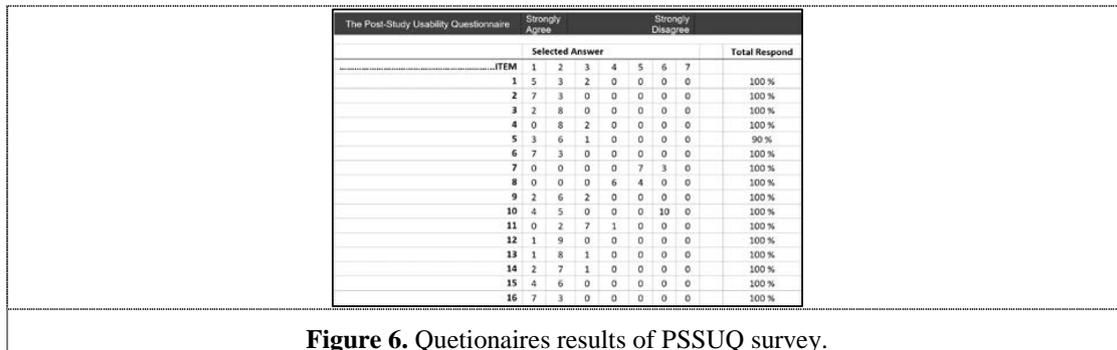
This sub-criteria is verified with 16-item questionnaire was administered manually using PSSUQ (Post-Study Usability Questionnaire) template. The PSSUQ is a 16-item survey that measures users’ perceived satisfaction with a product or system. Obtaining an overall satisfaction score is done by averaging the four sub-scales of System Quality (the average of items 1-6), Information Quality (the average of items 7-12), and Interface Quality (the average of items 13-16). The PSSUQ is highly reliable (0.94 of 1.00) and is entirely free. (<https://chaione.com/blog/ux-research-standardizing-usability-questionnaires/>)

The Post-Study Usability Questionnaire Version 3		Strongly agree							Strongly disagree	NA
		1	2	3	4	5	6	7		
1	Overall, I am satisfied with how easy it is to use this system.	<input type="radio"/>								
2	It was simple to use this system.	<input type="radio"/>								
3	I was able to complete the tasks and scenarios quickly using this system.	<input type="radio"/>								
4	I felt comfortable using this system.	<input type="radio"/>								
5	It was easy to learn to use this system.	<input type="radio"/>								
6	I believe I could become productive quickly using this system.	<input type="radio"/>								
7	The system gave error messages that clearly told me how to fix problems.	<input type="radio"/>								
8	Whenever I made a mistake using the system, I could recover easily and quickly.	<input type="radio"/>								
9	The information (such as online help, on-screen messages and other documentation) provided with this system was clear.	<input type="radio"/>								
10	It was easy to find the information I needed.	<input type="radio"/>								
11	The information was effective in helping me complete the tasks and scenarios.	<input type="radio"/>								
12	The organization of information on the system screens was clear.	<input type="radio"/>								
13	The interface* of this system was pleasant.	<input type="radio"/>								
14	I liked using the interface of this system.	<input type="radio"/>								
15	This system has all the functions and capabilities I expect it to have.	<input type="radio"/>								
16	Overall, I am satisfied with this system.	<input type="radio"/>								

\*The "interface" includes those items that you use to interact with the system. For example, some components of the interface are the keyboard, the mouse, the microphone, and the screens (including their graphics and language).

**Figure 5.** PSSUQ survey.

Using PSSUQ instrument, the questionnaire was distributed to 10 respondents chosen from the sample, ie students and teachers who have used the website online. From the answers, all questions were answered validly. Reply of the questionnaires produce an output shows in figure 5.



**Figure 6.** Questionnaires results of PSSUQ survey.

Data processing produces the users' interpretation of 70% satisfaction with the website. This satisfaction is based on the simplicity of the application (> 70%), ease of use (> 70%), application response to errors (> 70%), appropriate content (> 70%) and pleasant interface > 80%). The results of data processing are as follows:

The Post-Study Usability Questionnaire	Result
1 Overall, I am satisfied with how easy it is to use this system	From 10 respondents, 5 people (50%) chose the item "1", 3 people (30%) chose item "2" and 1 person (20%) chose item "3". It can be said for item "1" generally satisfied enough.
2 It was simple to use this system	From 10 respondents, 7 people (70%) chose the item "1", 3 people (30%) chose the item "2". It can be said for item "2" generally the website used is quite simple.
3 I could complete the tasks and scenarios quickly using this system	From 10 respondents, 2 people (20%) chose item "1", 8 people (80%) chose item "2". It can be said for item "3" generally learning task can be quickly can be done after using this website.
4 I felt comfortable using this system	From 10 respondents, 8 people (80%) chose the item "2" and 2 people (20%) chose item "3". It can be said for item "4" the website is very convenient.
5 It was easy to learn to use this system	From 10 respondents, 3 people (30%) chose the item "1", 6 people (60%) chose item "2" and 1 person (10%) chose item "3". It can be said for item "5" generally very easy to use this website.
6 I believe I could become productive quickly using this system	From 10 respondents, 7 people (70%) chose the item "1" and 3 people (30%) chose item "2". It can be said for item "6" the website is very productive.
7 The system gave error messages that clearly told me how to fix problems	From 10 respondents, 7 people (70%) chose the item "5" and 3 people (30%) chose item "6". It can be said for item "7" generally website show a clear error message when there is a problem.
8 Whenever I made a mistake using the system, I could recover easily and quickly	Similar with question 7 that the majority of respondents stated whether appear a misuse, it is easy to fix. 6 people (60%) answered item "5" and 4 people (40%) answered answer "5". It can be said that if there are errors of use then it is easy to fix it.
9 The information (such as online help, on-screen messages and other documentation) provided with system was clear	From 10 respondents, 2 persons (20%) chose the item "1", 6 people (60%) chose the item "2" and 2 people (20%) chose item "3". It can be said for item "1" information submitted in website is clear.
10 It was easy for me to find the information I needed	From 10 respondents, 4 people (40%) chose the item "1", 5 people (50%) chose the item "2" and 1 person (10%) chose the item "6". It can be said for item "1" that 90% of respondents said it is very easy to get the required information.
11 The information was effective in helping me complete the tasks and scenarios	From 10 respondents, 2 persons (20%) chose the item "1", 7 people (70%) chose item "3" and 1 person (10%) chose item "4". It can be said for item "1" that 90% of participants say information is complete enough to help learning tasks.
12 The organization of information on the system screens was	From 10 respondents, 9 people (90%) chose the item "1", 1 person (10%)

The Post-Study Usability Questionnaire	Result
clear	selects item "2". It can be said for item "1" generally the organization of website on the screen quite clear.
13 The interface* of this system was pleasant	From 10 respondents, 1 person (10%) selects item "1", 8 people (80%) selects item "2" and 1 person (10%) selects item "3". It can be said for item "1" interface in this website is fun.
14 I liked using the interface of this system	From 10 respondents, 2 persons (20%) chose item "1", 7 people (70%) chose item "2" and 1 person (10%) chose item "3". It can be said for item "1" that the participants really like to use interface in this website program.
15 This system has all the functions and capabilities I expect it to have	From 10 respondents, 4 people (40%) chose the item "1", 6 people (60%) chose the item "2". It can be said for item "1" that program in website got function and capability as expected.
16 Overall, I am satisfied with this system	From 10 respondents, 7 people (70%) chose the item "1", 3 people (30%) chose the item "2". It can be said for item "1" that user feel satisfied with this website.

## 5. Conclusion

Web usability is how easy a website is to use. The website has fulfilled usability testing aimed to determine whether a website is in accordance with the needs of the user (students) or not. The website <https://www.sukardjo-lipurs.com/> in usability testing achieved from 70% to 90% of the criteria (Attractiveness = almost A, Controllability = almost A, Efficiency = B, Helpfulness = B, Learn ability = A). Therefore, this website is qualified in order to be used in research to assess the effectiveness of self-learning using the website.

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