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Performance Evaluation And Analysis Of Fisheye, Tree And Linear Menus On A Web Based Interfaces

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Abstract: The study was carried out to compare the usability of fisheye, linear and tree menus on a web based interfaces. Usability concept has been under focus over the years and has evolved with different definitions by researchers. The usability of four Web page layouts were compared: the web pages comprise of tree menu and linear menu of which a fisheye effect was applied to each of the two menu types to make four menus, (tree menu, fisheye tree menu, linear menu, fisheye linear menu). Seventy three (73) participants partake in the experiment. The time to complete tasks for each of the four menu types were measured. There were no significant differences observed in completion times between the two test conditions. This research questions the current leading Web design thought that menus with the fisheye effect may perform faster. However, it was concluded that some participants commented on fisheye linear menu and fisheye tree menu that they are nice and looked attractive although the selection time was not faster than the linear and tree menu.

Keywords: Computer Menu, fisheye Menu, linear Menu, Tree Menu, usability.

I. INTRODUCTION

Usability is an important factor for all software quality models. It is the key factor in the development of successful interactive software applications [1];[2]. [1] Defined usability as a property of the syntactic and semantic analysis of a user interface. [3] Also described usability as a product attribute, which defines the concept by naming product or system characteristics. Usability entails how effectively a software or website is designed, and how satisfied the users of the website or software are. Usability combines factors, like ease of learning, intuitive design, efficiency of use, satisfaction and the rate and severity of errors [4].

Usability evaluation is to determine how well visitors to a website or users of a software product are able to explore content or use the site to meet their need and expectations, and how satisfied the users are with the process [4]. According to [5], usability evaluation assesses the extent to which an interactive system is easy and pleasant to use.

[6] Presented a practical discussion of factors, comparison criteria, usability evaluation methods and performance measures that are useful in studies comparing usability evaluation. Specific challenges that researchers and practitioners face in conducting usability evaluation were also highlighted.

Studies on usability evaluation have been conducted by many researchers. For example, [7] conducted an evaluation of a commercial website. A form of think aloud protocol was used and various usability problems were found, including problems with the navigation. She also found problems with the website content and interactivity. Some of the issues found with the navigation involved users not being able to see controls for moving to another stage of the interaction, users not being able to find certain categories of item, and unclear links and/or buttons. One of the aspects that could have provided more accurate results for the study would have been to use a larger sample of participants. However, the work shows how potentially mainstream websites can fail on simple usability issues.

[8] Developed a questionnaire-based usability evaluation method for e-learning applications. The method was developed according to an established methodology in Human Computer Interaction (HCI) research and combined web and instructional design parameters and associated them with the most prominent affective learning dimension, which is intrinsic motivation to learn. The latter was proposed as a new usability measure that is considered more appropriate in evaluating e-learning designs. In [9] a survey was conducted on the usability evaluation of Virtual Environments (VEs) comparing two existing evaluation approaches: test bed evaluation and sequential evaluation and also differentiate Virtual environments usability evaluation from evaluation of traditional user interfaces such as a Graphical User Interface(GUIs)

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II. LITERATURE REVIEW

Most users of computer software are familiar with navigating through different types of menus such as linear menu, pie menu, tree menu, fisheye menu, mega menu, hierarchical menu and so on, as used to represent the files and directories on their computers [10]

In a study by [11], an evaluation was carried out for the development of the Audi Cars web site. They tested linear menus on the left and right sides of the web pages of the Audi web site. They found that there was no significant difference in terms of task times between the two menu types. However they did not test out any other metrics, which could have led to some interesting information.

In contrast, a study by [12] indicates that measuring other metrics can give other interesting and useful information. In the study, four linear menu positions (top, bottom, left and right of a page) were evaluated in the context of an online store. The results showed in agreement with [11] that tasks times did not seem to be affected.

However, in the [12] study, errors and mouse clicks were recorded along with final participant subjective opinions. The results showed that the top horizontal and left vertical positioned menus incurred fewer errors and fewer mouse clicks. Further, participants' levels of satisfaction were in line with the efficiency aspects observed in the study. Some researchers have also looked at the aspect of satisfaction whilst navigating and using web sites. Empirical approach were also adopted to reach a conclusion that essentially suggests that if a web site is designed to give the users some pleasure the web site will tend to be more successful than if it does not give any pleasure. It was suggested that features of a web site, such as the 'content, organization and technology' can have an impact on the users' pleasure. They also found that pleasure or lack of pleasure can affect 'success variables'. By the authors' own discussion, they do suggest that their study has some limitations in their methodological approach to carrying out the study and data collection, e.g. participants supplied their own data etc.

III. METHODOLOGY

For the purpose of this study, four web based interfaces containing two each of the mega menu and the tree menus were developed. A participant based experiment was conducted in which certain tasks were assigned to participants in a within users experimental design which were mainly undergraduate students who are familiar with using the computer system and internet to navigate through WebPages.

The main reasons for this requirement is to remove potential problems of lack of basic knowledge with computers and the internet in novices and to see the effects of the experimental conditions on experienced users. The same task was performed using both the fisheye menu and the tree menu. All of the web site versions had the same content and on them irrespective of the condition under consideration. The website keeps the records of all the participants and the amount of time it takes them to perform this task in a database, to be used for comparison, analysis and evaluation.

IV. EXPERIMENTATION

The purpose of the experiment was to get feedback on the efficiency, fastness and user preference of the two types of menus for selecting an item from a list. In order to conduct the experiment the procedure described below was followed. Before beginning the tasks, the participants were given orientation and demonstration on how to carry out the experiment using a projector and also asked to carefully read the information on the home screen. This contained information about confidentiality and use of the data collected. Finally, participants were asked to click the "start" button at the bottom of the welcome screen to begin with the experiment.

There were four items on the home screen and seven tasks for each of the items stated for the experiment. Each of these was designed to simulate a typical registration procedure where a user may be asked to fill in a bio data and some other information. The tasks were further designed to ensure that the participants had to use the navigation bar to select options peculiar to them on the sample web site. They were to also record the time they start and finish each item

The four items were as follows:

- Tree menu
- Fisheye Tree menu
- Linear menu
- Fisheye linear menu

The tasks were as follows:

- Task 1: select your gender
- Task 2: select your age range
- Task 3: select your employment status

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- Task 4: select your marital status
- Task 5: select your nationality
- Task 6: select your state of origin
- Task 7: select your local government

Then, the participants were instructed to select or click the items applicable to them from each menu to fill the sample form which contains mainly their bio data and other personal information. Immediately after the experiment, the participants were thanked for participating in the experiment and were requested to answer a post-experiment questionnaire (a 10 point Likert scale with five (5) characteristics taken from the system usability scale (SUS)) [13]

The five characteristics are:

- Strongly disagree = 1
- Disagree = 2
- Neutral = 3
- Agree = 4
- Strongly agree = 5

Also, the participants were asked to rank the four menus in order of preference. They were also offered the option of typing any comment about the menu. Then finally, the participants were once again thanked for their time and participation.

A. Area Of Study Description

The experiment was conducted at the HND laboratory of computer science department, federal polytechnic Bida, faculty of ICT, Bida Niger State. The lab contains 60 working computer systems all of which were networked and connected to a server. The laboratory was equipped with four (4) network printers and a wireless router

B. Participants

73 participants were selected. The participants chosen for this experiment were selected from a class of undergraduate students by means of politely asking for the participants to show interest in the experiment after explaining the aim of the experiment. We decided not to select users with certain characteristics because we believe they have undergone several practical and assignments on high computer usage experience, high confidence in using computers and experience of using the internet. Linked to these, we specifically asked and confirm from the participants if there is anyone without internet browsing and computer usage experience of which no one affirmed to that. These choices were made because we wanted the data collected from participants to not be affected in any way with bias in relation to someone not having adequate IT skills. Also the sample recruited had a mixture of male and female participants across the 16-30 age range.

C. Variables

The independent variables were the four navigational webpage menus positioned at the two different locations each on the web pages and the type of tasks which involved selecting items that has to do with bio data and other personal information. The dependent variables were the performance and the participants' subjective opinions. The dependent measures were the task time, efficiency and participant's subjective opinions regarding various features of the web site and the navigation used. A Likert type scale [13] ranging from 1 to 5 was used for all the questions, where for all the ranking scores, a 5 score was the highest possible positive scores that could be allocated.

D. Tools And Materials

The following materials were used in the research:

- 20 desktop PC running Windows 8, 4GB RAM, 500GB HDD, a dual core 2.4330GHz processor, a 64 bit operating system and a 24 inch monitor,
- Firefox internet browser.
- A wireless router
- Wireless card
- The four sample web pages which were identical in content and style with the exception of the actual aspect being investigated, i.e. the navigation bar positioning (see Experimental Design section above for the actual positions used in the experiment).

E. Data Collection

The Standard Usability Scale (SUS) model was used to develop the Research questionnaire administered to all the participants at the end of each section of the experiment to state their view, opinion and experience on the interfaces.

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Participants also ranked the menus according to their preference, the result of which was stored in the database for further analyses.

F. **Statistical Analysis**

The data was compiled using Microsoft excel 2016 and analyzed by analysis of variance (ANOVA) with SPSS (statistical package for social sciences) version 15.0. Descriptive statistics such as percentages and frequency distributions was used to present the characteristics of the result.

V. EVALUATION

From the frequency distribution table above (table 5), linear menu has the mean value of 3.22 and 4 as the mode. Also tree menu has the mean value of 3.06 and 4 as the mode while fisheye linear menu has 2.39 And 2 as the mode. Also fisheye tree menu has the mean value as 2.69 and 2 as the mode these implies that menus that have no fisheye effect have the highest ranking values.

Table: 1. Frequency table describing the percentage of the rank values selected for linear menu

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	9	12.3	12.5	12.5
	2	17	23.3	23.6	36.1
	3	10	13.7	13.9	50.0
	4	21	28.8	29.2	79.2
	5	15	20.5	20.8	100.0
	Total	72	98.6	100.0	
Missing	System	1	1.4		
Total		73	100.0		

The frequency table for rank values of the linear menu (Table 1) indicates the percentage of the values selected for all ranks. The first column contains the rank values from 1-5 with total number of valid inputs, missing value and overall total. The second column captioned the frequency of the rank values selected with 1 (strongly disagree) been the least selected with frequency of nine and 4 (agree) been the highest selected with frequency of 21. Second third and fifth ranks have the frequency of 17, 10 and 15 respectively. The third column display the percentage of the value of frequency while fourth and the last columns shows the valid percent and cumulative percent respectively.

Table: 2. Frequency table describing the percentage of the rank values selected for fisheye linear menu

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	17	23.3	23.6	23.6
	2	27	37.0	37.5	61.1
	3	14	19.2	19.4	80.6
	4	11	15.1	15.3	95.8
	5	3	4.1	4.2	100.0
	Total	72	98.6	100.0	
Missing	System	1	1.4		
Total		73	100.0		

Frequency table for rank values of the fisheye linear menu (Table 2) indicates the percentage of the values selected for all ranks. The first column contains the rank values from 1-5 with total number of valid inputs, missing value and overall total. The second column captioned the frequency of the rank values selected with 5 (strongly agree) been the least selected with frequency of three and 2 (disagree) been the highest selected rank with frequency of 27. First third and fourth ranks have the frequency of 17, 14 and 11 respectively. The third column display the percentage of the value of frequency while fourth and the last columns shows the valid percent and cumulative percent respectively.

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Table: 3. Frequency table describing the percentage of the rank values selected for tree menu

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	13	17.8	18.1	18.1
	2	14	19.2	19.4	37.5
	3	13	17.8	18.1	55.6
	4	20	27.4	27.8	83.3
	5	12	16.4	16.7	100.0
	Total	72	98.6	100.0	
Missing	System	1	1.4		
Total		73	100.0		

Tree menu (Table 3) indicates the percentage of the values selected for all ranks. Missing value is one while total valid value is 72 all in total making 73. The first column contains the rank values from 1-5 with total number of valid inputs, missing value and overall total. The second column captioned the frequency of the rank values selected with 5 (strongly agree) been the least selected rank with frequency of twelve and 4 (agree) been the highest rank selected with frequency of 20. First, Second and third ranks have the frequency of 13, 14 and 13respectively. The third column display the percentage of the value of frequency while fourth and the last columns shows the valid percent and cumulative percent respectively.

Table: 4. Frequency table describing the percentage of the rank values selected for fisheye tree menu

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	15	20.5	21.1	21.1
	2	24	32.9	33.8	54.9
	3	5	6.8	7.0	62.0
	4	22	30.1	31.0	93.0
	5	5	6.8	7.0	100.0
	Total	71	97.3	100.0	
Missing	System	2	2.7		
Total		73	100.0		

Frequency table for rank values of the fisheye tree menu (Table 4) indicates the percentage of the values selected for all ranks. The first column contains the rank values from 1-5 with total number of valid inputs, missing value and overall total. The second column captioned the frequency of the rank values selected with 3 (neutral) and 5 (strongly agree) been the least ranks selected with frequency of five and 4 (agree) been the highest rank selected with frequency of 22. First, Second and fifth ranks have the frequency of 15, 24 and 15 respectively. The third column display the percentage of the value of frequency while fourth and the last columns shows the valid percent and cumulative percent respectively.

Table 5: Descriptive Statistics showing mean, standard deviation, variance and mode of all the four menu types for overall ranking

	N	Mean	Std. Deviation	Variance	mode
LINEAR MENU	72	3.22	1.355	1.837	4
FISHEYE LINEAR MENU	72	2.39	1.133	1.283	2
TREE MENU	72	3.06	1.373	1.884	4
FISHEYE TREE MENU	71	2.69	1.305	1.703	2
Valid N (listwise)	71				

The above table (table 5) is a descriptive statistics showing the mean, mode, variance and standard deviation. The first column contains the list of the four menu type namely linear menu, fisheye linear menu, tree menu and fisheye tree

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menu and valid N. second column contains the number of selections that were valid with linear menu, fisheye linear menu and tree menu having a total of 72 valid values, while fisheye tree menu having total of 71 valid values. Column three have mean as the heading with 3.22 as mean score for linear menu, 2.39 for fisheye linear menu, 3.06 for tree menu and 2.69 for fisheye tree menu. The fourth, fifth and last columns contains standard deviation, variance and mode respectively

VI. DISCUSSION

This study compared the performance of tree menu, fisheye tree menu, linear menu, fisheye linear menu on a web based interfaces. The results show no significant difference in task completion time regardless of navigation type. There was also no significant difference in performance for any individual task. The research carried out and described in this experiment, has helped to gain more understanding about which menu type may be better.

Regarding the hypotheses devised the positive hypothesis for hypotheses 1 is rejected, as there was no significant statistical difference in terms of times for the tasks and menu positions. However, for hypotheses 2, the positive hypothesis is partially accepted. These suggested that the linear and tree menu would incur fewer errors and more user satisfaction. However, while this is shown in the data analyzed, the data also shows that the fisheye tree menu did not perform any worse than the fisheye linear menu for errors and user satisfaction.

Furthermore, we would suggest that irrespective of menu positioning, designers should ensure as far as possible that the cognitive, physical, functional and sensory affordances are not violated in any way, as any violation of these could be more crucial than the actual positioning of the menu itself.

The questionnaire data show that participants prefer the use of the menus that has fisheye effect i.e. fisheye linear menu and fisheye tree menu than the linear and tree menu, particularly for the selection of items from a list of data sets. In accordance with these findings some participants commented that they appreciated the fisheye effect on both the linear and tree menu. Note, however, that in this study we observed that the actual time taken to complete given tasks in linear and tree menus are faster than the fisheye linear menu and fisheye tree menu.

The usability of fisheye menus rests on their ability to enable users to accomplish the objective of homing on a target items.

VII. CONCLUSION

Fisheye linear menu and fisheye tree menus performed similarly in terms of task time, overall ranking, and preference while linear and tree menu performed similarly too in terms of overall ranking only. Therefore, the results of this experiment suggest that menus that has fisheye effect (tree and linear) seem to elicit better performance in users. This is in terms of time taken to complete the whole task in each menu and errors. No statistical significant differences in terms of task times were found between fisheye linear menu and fisheye tree menu. The authors would also suggest that using menus with fisheye view would also go a long way to helping in having web pages that are universally designed.

Future studies will confirm or refute these findings, but clearly more research is needed.

Furthermore, the significant differences in errors between the different menu types suggest that menus with fisheye effects would incur fewer errors. Although it is felt that this study helps to increase our knowledge regarding menu and navigation design, more work could still be done to make things more clear. Some examples include investigating further other menu design types and other menu configurations. The authors hope to be able to engage in further studies around these contexts.

REFERENCES

[1] Foley, J. D., & Van Dam, A. (1982). Fundamentals of interactive computer graphics. In Addison-Wesley Publishing Company. https://doi.org/10.2307/1574879

[2] Sukinah, A. N., Adzhar, K., Azliza, Y., & Suhana, S. N. (2014). AssessingWebsiteUsability Attributes. Australian Journal of Basic and Applied Sciences, 8(4), 192--198.

[3] Mosier, S. S. (1986). Guidelines For Designing User Interface From these themes , 20 user interface design Mosier Read / Download.

[4] Bigby, G. (2018). How to perform usability evaluation. DYNO Mapper. https://dynomapper.com/blog/19-ux/427-how-to-perform-a-usability- evaluation

[5] Cockton, G. (2013). Usability evaluation- The Encyclopedia of Human-Computer Interaction. In Semi-structured qualitative studies. https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/usability-evaluation

DOI: 10.17148/IJARCCE.2022.115195

[6] Schmettow, M. (2009). Controlling the usability evaluation process under varying defect visibility. People and Computers XXIII Celebrating People and Technology - Proceedings of HCI 2009, 188–197. https://doi.org/10.14236/ewic/hci2009.22

[7] Benbunan-Fich, R. (2001). Using protocol analysis to evaluate the usability of a commercial web site. Information and Management, 39(2), 151–163. https://doi.org/10.1016/S0378-7206(01)00085-4

[8] Zaharias, P., & Poylymenakou, A. (2009). Developing a usability evaluation method for e-learning applications: Beyond functional usability. International Journal of Human-Computer Interaction, 25(1), 75–98. https://doi.org/10.1080/10447310802546716

[9] Bowman, D. A., Tech, V., Gabbard, J. L., & Hix, D. (2002). A Survey of Usability Evaluation in Virtual Environments : Classification and Comparison. The Massachusetts Institute of Technology, 11(4), 404–424. https://doi.org/10.1162/105474602760204309

[10] Tominski, C., Abello, J., Van Ham, F., & Schumann, H. (2006). Fisheye tree views and lenses for graph visualization. Proceedings of the International Conference on Information Visualisation, August, 17–24. https://doi.org/10.1109/IV.2006.54

[11] Kalbach, J., & Bosenick, T. (2003). Web page layout: A comparison between left- and right-justified site navigation menus. Journal of Digital Information, 4(1), 1–17.

[12] Pietro, D., & Tracey, J. (2015). Menu Positioning on Web Pages. Does it Matter? International Journal of Advanced Computer Science and Applications, 6(4), 141–147. https://doi.org/10.14569/ijacsa.2015.060419

[13] Murano, P., & Khan, I. N. (2015). Journal of Emerging Trends in Computing and Information Sciences Pie Menus or Linear Menus, Which Is Better?6(9), 476–481. http://www.cisjournal.org