The effect of responsive web design on the user experience with laptop and smartphone devices

Article · November 2015

DOI: 10.11113/jt.v77.6041

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Jurnal
Teknologi

Full Paper

THE EFFECT OF RESPONSIVE WEB DESIGN ON THE USER EXPERIENCE WITH LAPTOP AND SMARTPHONE DEVICES

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Article history
Received
02 June 2015
Received in revised form
09 August 2015
Accepted
1 September 2015

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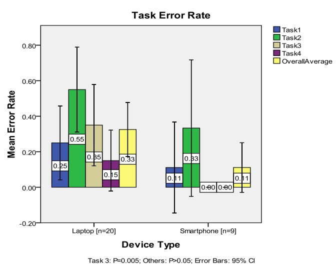
Graphical abstract



Abstract

The introduction of smartphones with their accompanying capacity to access the Internet, changed the way the Internet is used. Many people now use mobile devices to browse the Web. However, the varying screen sizes of these devices portend some impact on their users' experience, as the Web content on the devices vary in size and the navigation of pages are also different in the various devices. The advent of the responsive web design (RWD) philosophy, revolutionized the way Web pages are designed and the way they appear to the users in the various devices. RWD makes Web pages to adjust to the size of any devices' screen irrespective of the device type. In this study, the effect of responsive web design of the user experience witha laptop and smartphone devices while using the e-Ebola Awareness System, (a Web based health awareness portal for Ebola virus disease), was measured and evaluated. The results revealed that users had a better user experience with Smartphones than with laptops while using the system, however, for most of the metrics collected, users' experiences with the two device types were not significantly different at 95% level of confidence, implying that for those metrics, the responsive web design had a similar effect on the users' experiences and attitudes

Keywords: Responsive web design, user experience, laptops, smartphones

1.0 INTRODUCTION

The emergence of smartphones and their capability of accessing the Web have revolutionized the use of the Internet. So many devices are now connected to or can now be used to access the Web: desktops, laptops, phones, tablets, televisions, home appliances, game consoles, car displays, digital photo frames, and wearable computers among others [13]. Also, nowadays, users operate multiple devices: personal computers (desktops/laptops), tablets, smartphones, netbooks and other computing devices that are embedded in home appliance or cars, etc. There are new devices connected to the Internet every day [13]. There are an increasing number of users using small devices to surf the Web [4] [14]. Interestingly, these devices have different screen sizes and resolutions. There viewports are not the same. While desktops and laptops have large viewports, mobile devices like the smartphones have smaller viewports [14]. These characteristics have an impact on users' viewership and experience, as well as the browsing behavior of these devices as the size of their various contents varies. It also impacts page navigation [14].

Before the advent of smartphones and other small devices, Web applications and websites were built with a fixed width screen. Then, it provided a fairly consistent Web experience to users [4]. But with the introduction of smartphones and with the growing number of small devices coupled with the rising trend of their use, there was the need to fix the challenge of users not being able to have a consistent experience with these devices. There was great difference between small and large screen browsing experience [4]. Studies show that far more users browse the Internet on mobile phones than on PCs [4] and yet, even, mobile phones/devices themselves come in different sizes with different viewports [15]. This makes the Web content on these devices to vary in size. In addition,it also introduces navigation challenges. To fix these challenges, a design philosophy was introduced called the responsive web de-sign [4] [14] [15] [13].

The responsive web design was introduced to solve the user experience problems associated with the static web design paradigm. With responsive web design, web applications were designed to robustly fit into the screen sizes and resolutions of every device dynamically [15]. Recently, a Web portal was developed (an e-Ebola Awareness System) using the responsive web design [17]. Till date, the impact of this design has not been tested on the user experience of this Web portal. This study seeks to evaluate the effect of the responsive web design on the user experience of e-Ebola Aware-ness System on laptop and smartphone devices.

The rest of this paper is divided into the following parts: part two is the related works, part three is the methods, and part four is the results while part five is the discussion and conclusion.

2.0 RELATED WORKS

The responsive web design (RWD) is a method introduced to assist in the realization of the dreamof a "One Web" (Gardner (2011) as cited in Groth&Haslwanter [5]). The RWD combines the capabilities of HTML5 and CSS3 which enables it to flexibly adapt to different screen sizes [5]. Marcotte [12] stressed this need as a solution to the increasing number of diverse mobile devices as well as a shifting user behavior towards their use. Websites that are not optimized for mobile devices only shrink to fit the viewable area of the websites. Such technique requires the user to constantly zoom into the website via touch so as to be able to read its content well. However, with the RWD approach, the layout of the website is altered based on the viewport of the device, thus transforming a static website into a dynamic, responsive, fluid and adjustable layout [5]. These layouts are more flexible in the handling of elements in the websites and in automatically rearranging them accordingly [5].

2.1 Responsive Web Design

The phrase "responsive web design" (RWD) was first coined and explained by Ethan Marcotte in 2010 [11]. He later wrote a book on the subject [12]. This new paradigm opens the way for designs to respond to users' behavior and environment irrespective of screen size, resolution, platform or orientation [14]. RWD is a collection of techniques applied at the level of the layout to allow a website adapt itself to any device or screen width [6]. Its objectives are: i) to adapt the layout to suit or fit various screen sizes: from wide screen desktops to tiny phones, ii) to resize images to suit the resolution of the screen, iii) to serve up lower bandwidth images to mobile devices, iv) to simplify the elements of a page for mobile use, v) to hide non-essential elements on smaller screens, vii) to provide larger, finger-friendly links and buttons for mobile users, and vii) to detect and respond to mobile features like geo-location and device orientation (Doyle (2011) as cited in Harb et al. [6]). The key features of the RWD are: i) a flexible (fluid) grid layout, ii) flexible images and iii) CSS3 media and media queries [4] [14]. These features make RWD to be device agnostic and to respond to and suit all device screen sizes. RWD was used in the design and development of the e-Ebola Awareness System (E-Easy).

2.2 Usability and User Experience

There has been a debate on the scope of user experience along with how it should be defined [2]. ISO 9241-210 defines user experience as: "a person's perceptions and responses that result from the use and/or anticipated use of a product, system or service" [9]. This definition is in contrast to the revised usability definition in ISO 9241-210, which defines usability as the: "extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" [9]. These two definitions tend to show that both usability and user experience can be measured during or after the use of a product, system or service [2] [7]. "A person's perceptions and responses" as in the user experience definition looks similar to the construct of satisfaction in the usability definition [2]. So, judging from this perspective, the measures of user experience can be encompassed within the three sub-elements of the usability model, especially, for task oriented experiences. The definition of user experience in ISO 9241-210 shows some ambivalence with regard to usability being part of user experience [2]. However, in the same way that the ISO 9241-11 [8] said nothing concerning learnability, this ISO 9241-210 definition portrays some weakness in the sense that it says nothing about how user experience evolve from users' expectation through their actual interaction to a total experience which includes reflection on the experience [16] [2].

Law et al., [10] argued that there are several reasons why it is difficult to obtain a global definition of user experience (UX). One of such reasons is that UX consists of a broad range of dynamic and fuzzy concepts with emotional, experiential, affective, aesthetic and hedonic variables inclusive [10]. Essentially, however, user experience has the following characteristics: i) users are involved, ii) those users interact with the product, system or anything with an interface, iii) the experience of the users are of interest and should be observable or measurable [1].

3.0 METHODS

In this study, the researchers assess the level of impact that the responsive web de-sign (used in developing the Web based e-Ebola Awareness System) has on the user experience of laptop and smartphone devices. The e-Ebola Awareness System is an Internet based portal devoted to creating awareness about the Ebola Virus Disease. A usability testing was conducted to enable users use the web portal. The study was a within subject design with 20 laptops and 9 smartphone users. The smartphones used are of Android and Blackberry types. The study participants were students of the Universiti Utara Malaysia. The within subject design was chosen to measure the shift in the user experience of the same users as they move from using laptop to using a smartphone. The reason for the unbalanced sample size is because, not all users who were tested with laptop had smartphones. The task scenarios include: task 1: Open three news contents on Ebola in new tab and write out the name of the news media; task 2: Find three tweets on Ebola and write down the name of the source of the tweets; task 3: Search for information on Ebola symptom and Ebola prevention and write out one symptom and prevention each; task 4: View the content on Ebola causes and Ebola treatment in any language of your choice other than English.

The following metrics were collected from the testing session: Task success, task error, task time, perceived task difficulty, perceived satisfaction (perceived usability and learnability), perceived task confidence, and perceived loyalty (with Net Promoter Score). Also, problem frequency and severity were collected. The System Usability Scale was used in capturing user satisfaction experience (perceived usability and learnability) [3], while a single 7-point Likert-scaled questionnaires were used to collect the task confidence, and task difficulty metrics respectively. The task confidence questionnaire ("Overall, how confident are you that you completed this task successfully"), ranged from 1 (not at all confident) to 7 (extremely confident). The task difficulty questionnaire ("Overall, how difficult or easy did you find this task"), ranged from 1 (very difficult) to 7 (very easy). The perceived loyalty metric was obtained using an 11-point likelihood to recommend and revisit questionnaires ("How likely is it that you would recommend this website to a friend or colleague" & "How likely is it that you would revisit this website again in the future"), ranging from 0 (not at all likely) to 10 (extremely likely). Also, the Net Promotion Score (NPS) metric was derived from the likelihood to recommend questionnaire. The NPS consists of promoters, passivesand detractors sub-scales. The Net Promoter Score is computed using the 11-point (0-10) likelihood-to-recommend question. It is calculated by subtracting the percent of detractors (0-6) from the percent of promoters (9-10). 7 to 8 in the scale are passives.

4.0 RESULTS

4.1 Problem Frequency

Table 1 Problem frequency for laptop

Device	Laptop							
Problem	P1	P2	P3	P4	P5	P6	P7	P8
Frequency	1	1	1	1	7	12	4	1
Total Users	20	20	20	20	20	20	20	20
Proportion	.05	.05	.05	.05	.35	.60	.20	.05
Ave. Prob. Freq.	0.18 (18%)							
Adj. Ave. Prob. Freq	0.12 (12%)							

The table 1 and 2 reveals the problem frequency for laptops and smartphones. On the average, both the problem frequency and the adjusted problem frequency for laptops are higher than those smartphones. An average adjusted problem frequency of 0.12 and 0.08 indicates that on the average, users of laptops and smartphones will encounter at least 0.12 (12%) and 0.08 (8%) problems with laptop and smartphone respectively.

Table 2 Problem frequency for smartphone

Device	Smartphone						
Problem	P1	P2	P3	P4	P5	P6	P7
Frequency	1	1	1	2	4	1	1
Total Users	9	9	9	9	9	9	9
Proportion	.11	.11	.11	.22	.44	.11	.11
Ave. Prob. Freq.	0.13 (13%)						
Adj. Ave. Prob. Freq	0.08 (8%)						

This shows Smartphone users have a better user experience with the e-Ebola Awareness System website than laptop users. There is no significant difference between the average problem frequency of laptop and Smartphone, difference: (5%); P>0.05; $X^2(1)$ =0.042; 95% CI: -35 to 32. The same goes for the average adjusted problem frequency: difference: (4%), P>0.05; $X^2(1)=0.106$; 95% CI: -34 to 28. This result implies that users will experience similar problems in both laptop and Smartphone at the 95 % level of confidence. The average problem frequency is a bit inflated because of the smallness of the sample. The adjusted average problem frequency was computed to correct the bias.

4.2 Problem Severity

Table 3 Criticality rate for laptop and smartphone

Device	Laptop				Smartphone		
Problem	P1	P4	P5	P8	P1	P4	P7
Frequency	1	1	7	1	1	2	1
Total Users	20	20	20	20	9	9	9
Proportion	0.05	0.05	0.35	0.05	0.11	0.22	0.11
Criticality Rate	0.50 (50%)				0.44 (44%)		

Critical problems are those problems encountered by users that lead to task failure and cause users extreme irritation as shows in Table 3 above. An independent evaluator identified these critical problems among the problems encountered by users. From the analysis provided, users of laptop encountered more critical problems than Smartphone users. However, the observed difference of 6% between laptop and Smartphone was not significantly different from zero (P>0.05; X2(1)=0.011; CI: -34 to 44). This implies that the criticality rate of the two device types is statistically the same.

4.3 Task Success

Figure 1 shows the task completion rate. In all tasks, except task 4, where all users failed the task, there appears to be an improvement in user experience as the users move from laptop use to the Smartphone. On the average, there is a 29% increase in the average task completion rate from laptop to the Smartphone. However, this observed increase is not significant for all tasks, indicating that the user experience for both laptops and Smartphones are similar, though there are observed differences.

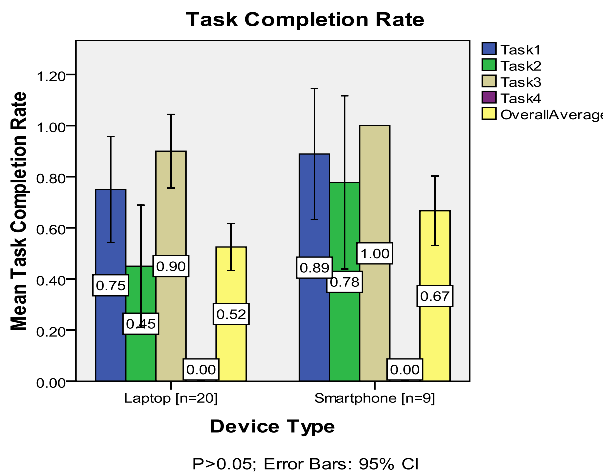


Figure 1 Task completion rate

4.4 Task Error

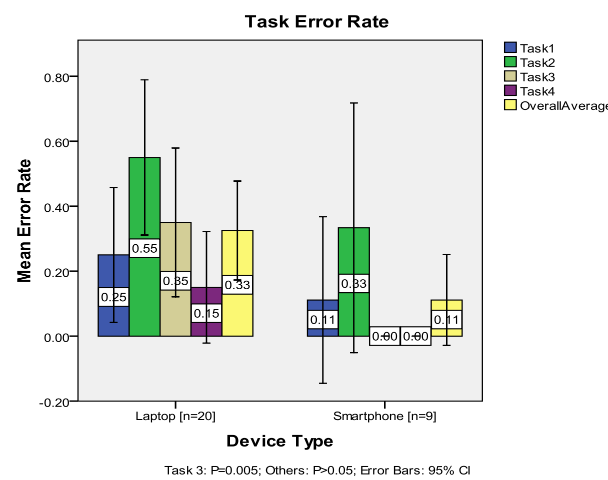


Figure 2 Task error rate

In the tasks error data (Figure 2), only task 3 indicates a significant difference in the average difference (diff: 0.35; CI: 0.12 to 0.58; Std Error: 0.11) in error rates between laptops and smartphones ($p<0.05$; $t(19)=3.20$). The error rates for all other tasks are the same on laptops and smartphones. The difference in overall average error rate also does not show any significant difference between laptops and Smartphones. However, the error rates for Smartphones is lower than that of laptops across the tasks, though these observed differences are not statistically significant except for task 3. This also shows that users of smartphones had a better user experience than laptop users in terms of task error rate.

4.5 Tasktime

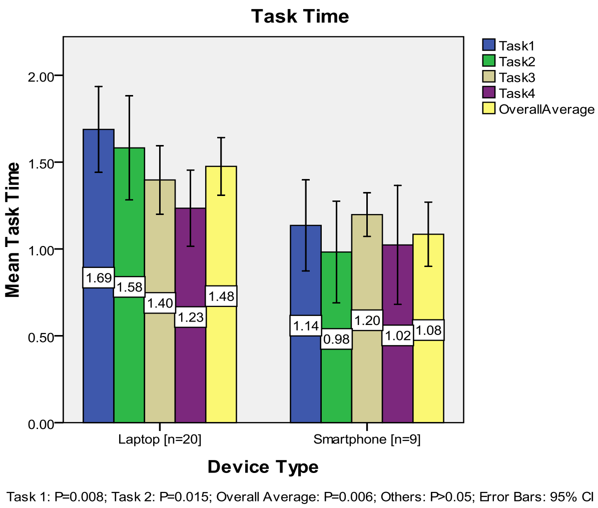


Figure 3 Task time

The task times for smartphone users were generally lower than those of laptop users as shown in Figure 3 above. On the average, time difference (diff: 0.56 mins; CI: 0.16 to 0.95; Std Error: 0.19) for laptop and smartphone users for tasks 1 is significant at $p<0.05$; ($t(27)=0.008$)), also, the average time difference for task 2 for a laptop and Smartphone (diff: 0.60 mins; CI: 0.13 to 1.07; Std Error: 0.23) is significant at $p<0.05$ ($t(27)=0.2.594$). The overall average time difference for all tasks (0.39mins; CI: 0.12 to 0.66; Std Error: 0.13) was also significant ($p<0.05$; ($t(27)=0.006$). This indicates that for these tasks, and on the average, the user experience for laptops and smartphones are not the same. Smartphone users had a better experience. But, the average time for tasks 3 and 4 are the same for laptops and smartphone users. Further analysis indicated that average task completion time for laptops is 1.36 mins, while that of Smartphone is 1.01 mins representing a reduction of 0.35 mins (26%) in Smartphone in comparison to a laptop.

4.6 Task Difficulty

Task difficulty as perceived by users indicate a significant difference in the experience of laptop and smartphone users in task 2 (diff: -1.66; CI: -3.29 to -.02; Std Error: 0.78) ($p<0.05$; $t(27)=-2.08$) and task 3 (diff: -1.09; CI: -2.08 to -0.11; Std Error: 0.48) ($p<0.05$; $t(24)=-2.30$) . These two tasks are statistically significant at 95 % confidence level with regards to task difficulty/ease.In other tasks as well as in the overall average perceived difficulty, there is no significant difference.However, there is an observed lift in attitude (increase in task ease) as the users used the smartphone in comparison to laptops: Task 1(6%), task 2(43%), task 3(20%), task 4 (3%), the overall average (16%) with improvements in tasks 2 and 3 statistically significant respectively.

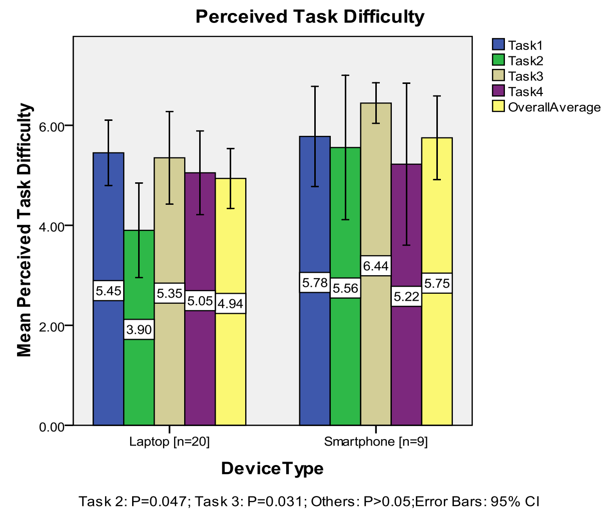


Figure 4 Perceived task difficulty

This result shows that users had a better experience with smartphones when compared to laptops. Users on smartphones found theirs tasks easier than users of laptops. Further analysis revealed that some of the users that indicated that their tasks were easy actually failed the tasks, implying they exaggerated their task ease: Laptop: Task 1 (10%), task 4 (65%); Smartphone: Task 1 (11%), task 2 (11%), task 4 (78%). This result shows that Smartphone users exaggerated their task ease more than laptop users.

4.7 PerceivedSatisfaction

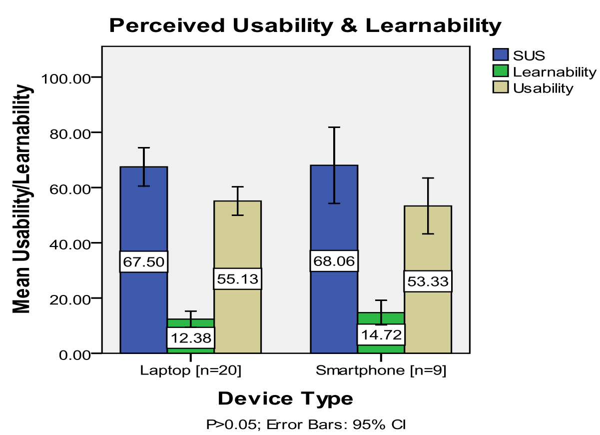


Figure 5 Perceived satisfaction

The SUS scores measure the perceived usability (overall system satisfaction) of the users. This score shows upward shift in perceived usability from laptop to Smartphone (1%). However, the learnability score is higher for Smartphone than in the laptop, representing a negative lift of (19%). When this effect is removed from the SUS score, the perceived usability drops to an average of 55.13 for a laptop and 53.33% for Smartphone. This effect represents a negative lift of 3%. This result reveals that perceived learnability had a negative impact on users as they moved from using a laptop to Smartphone even though there was an upward lift in satisfaction (usability) prior to the removal of learnability effect. However, both the usability and learnability scores are statistically the same for the laptop and Smartphone at 95% confidence level, implying the users had similar experience with respect to perceived satisfaction.

4.8 Task Confidence

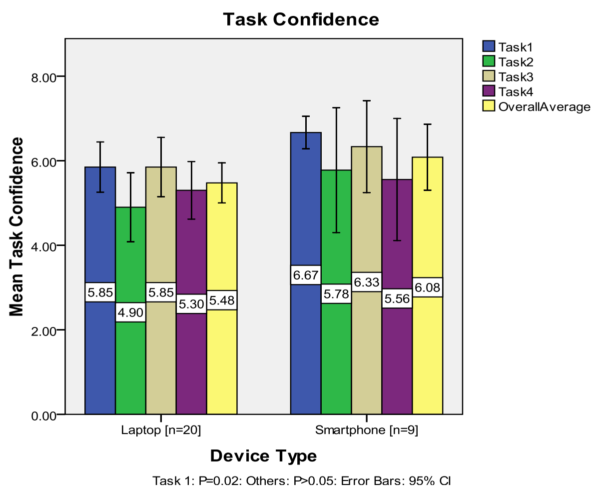


Figure 6 Perceived task confidence

Tasks confidence measures users' confidence level after each task as to whether they were confident they completed the task successfully. Based on the Figure 6 above, the result indicates that only in task 1 (-0.82; CI: -1.49 to -0.14; Std Error: 0.44) was there a significant task confidence between laptops and smartphones, ($p<0.05$; $t(27)=-2.48$). However, in all tasks there is an observed lift (increase in confidence) as users shift from using laptops to smartphones: Task 1(14%), task 2 (18%), task 3 (8%), task 4(5%), and overall average (11%). The result indicates that generally, users were more confident that they accomplished the tasks successfully in smartphones more than were on laptops, however, only task 1 shows a statistically significant evident. Further analysis revealed that among users that indicated that they were extremely confident (selected option 7 in the question), that they finished their tasks successfully, a number of them actually failed the tasks. This indicates overconfidence and implies a disaster. The disaster rates are as follows: Laptop: task 1: (5%), task 2 (5%), task 3 (5%), task 4 (25%); Smartphone: task 4 (33%).

4.9 Perceived Loyalty

Loyalty can be measured by how many users indicate their willingness to recommend the Website to a friend or a colleague through 'word of mouth' and by how much willingness they indicate to revisit the Website.

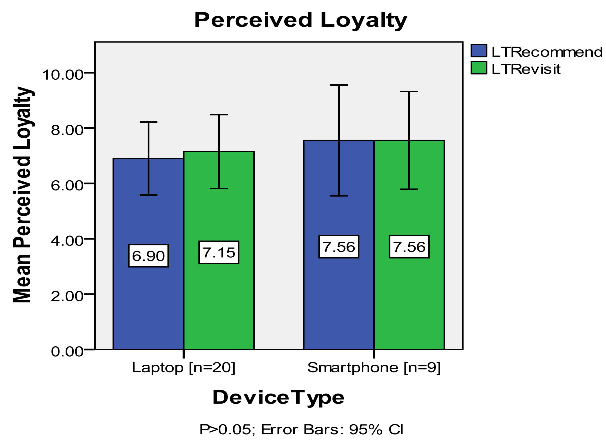


Figure 7 Perceived loyalty

Based on Figure 7 above, the likelihood to recommend score shows that users are more willing to recommend the Website to a friend or colleague in Smartphone than on a laptop. The same goes for the likelihood to revisit. The difference in perceived loyalty between laptop and Smartphone represent a 10% increase for likelihood to recommend and a 6% increase for likelihood to revisit, which implies that users are more willing to recommend them to revisit. However, the loyalty scores are statistically the same at 95% level of confidence. Further analysis reveals the Net Promoter Score (NPS) (NPS derives from the likelihood to recommend score) for laptops as follows: Promoters are 30%, the passives are 45% and detractors are 25%. The Net Promoter Score for a laptop is 5%. For Smartphone: Promoters are 33%, the passives are 56%, detractors are 11%, and the Net Promoter Score for Smartphone is 22%. This indicates that there are more net promoters for Smartphone than a laptop, with a difference of 21.95%. Also, there are more detractors with laptops (25%) than with Smartphones (11%). On the whole, users are likely going to be more loyal to the website on Smartphone than on a laptop.

5.0 DISCUSSION AND CONCLUSION

The impact of responsive web design on the user experience of laptop and smartphone devices was measured and evaluated. The smartphones used for the testing were of Android and Blackberry type. Several user experience metrics were collected, namely: task completion rate, task error rate, task time, task difficulty, perceived usability (system satisfaction), perceived learnability and loyalty.

From the data collected and analyzed, there is evidence that users had a better user experience with Smartphone than witha laptop. This shows that there is observable evidence that in some metrics and tasks, there was a difference in the user experience with laptops and smartphones due to the effect of the responsive web design. However, for most of the metrics examined, the observed differences were not significantly different from zero at a=0.05. This implies that for those metrics, users had similar user experiences on the two types of devices while using the e-Ebola Awareness System Website, it also indicates that for those metrics, the effect of responsive web design was similar for laptop and smartphone devices.

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