

Usability Evaluation of the Top 10 Universities in Iraq Using Heuristic Methods

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Article Info

Received
02/10/2022

Accepted
31/01/2023

Published
30/06/2023

ABSTRACT

A heuristic evaluation model is proposed for assessing the usability of the Top 10 Iraq university websites. This model is based on 3 hierarchies of website usability criteria levels. The top hierarchy level consists of five website categories: design and layout, learnability, content, performance, and errors. In the middle hierarchy level 18 subcategories, and in the bottom hierarchy level 44 elements were described. The evaluation model utilized both automated tools and observation methods. To validate the results obtained by the proposed model, the selected universities were evaluated and scored according to the usability criteria of their websites. Besides the observation elements, the four automated tools (thinkwithgoogle, gtmatrix, tools. Pingdom, and webpagetest) were also used to assess the error and performance of the websites. The study showed that except for the University of Kufa and Baghdad University websites, the rest of the university websites failed to meet the applied website usability criteria levels of the proposed evaluation model.

KEYWORDS: Heuristic Evaluation, Website Usability, Website University, Criteria Levels, Usability Model, Automated Tools

الخلاصة

تم اعداد موديل لتقييم مواقع الجامعات وفق عدة مبادئ تقيم استخدام مواقع الجامعة التي تم اختيار موقع أفضل 10 للجامعات العراقية من حيث قابليتها للاستخدام. يعتمد هذه الموديل على ثلاثة مستويات هرمية؛ المستوى الأعلى يتكون من خمس فئات (الواجهة - التصميم، قابلية التعلم، المحتوى، الأداء، الأخطاء). يتكون المنتصف من 18 فئة فرعية، ثم في المستوى الأخير مقسم إلى 44 عنصرًا. ومع ذلك، تم استخدام العديد من الأدوات الآلية وطرق المراقبة في هذا التقييم. للتحقق من صحة الموديل المقترح، تم تقييم الجامعات المختارة وتصنيفها وفقًا لمعايير قابلية الاستخدام. بالإضافة إلى ذلك، تم استخدام أربع أدوات آلية (Thinkwithgoogle، gtmatrix، pingdom، webpagetest) لاختبار الأخطاء وأداء مواقع الويب. وبحسب نتائج بحثنا، فإن معظم مواقع الجامعات لم تصل إلى المستوى المطلوب من حيث معايير الاستخدام، باستثناء جامعة الكوفة وجامعة بغداد، اللتين وصلتا إلى المستوى المطلوب.

INTRODUCTION

Higher educational institutions are usually expected to show a striving tendency towards embellishing their related websites with the most appealing designs and up-to-date academic information aiming at satisfying their users, whether they are students, researchers, administrative staff, schools, parents, teachers, professors, etc. It is therefore an indispensable necessitation to apply an assessment action of the academic websites to characterize any usability problems available [1]. Comprehending the users'

objectives and living up to their necessities and expectations is a key factor in determining, creating, enhancing and presenting a user-friendly, efficient, effective and an appealing academic website design [1]; that is to boost the accessibility and visibility of all associated website content. In addition, this assessment criteria help universities to meet the criterion specified by the International Organization for Standardization (ISO). Moreover, assessing the usability of websites, provides three main factors: 1) effectiveness, 2) efficiency, and 3) satisfaction. Educational websites enhance promoting

education to diverse users, and these websites enable Higher Educational Institutes (HEI) to offer digital academic services to users in order to save time and resources” [2,3]. Therefore, an assessment of an academic website must be aimed at distinguishing the ease-of-use issues, and thus refining and upgrading those websites. University websites provide a variety of purposes according to Mebrate, for example, this could include promoting academic and research activities, as well as providing e-learning resources and information distribution [4]. According to this assumption, a university website serves some primary purposes: advertising, promotion, communication, and providing online services. A website's usability is a key determinant of how easily users can engage with the website's interface [5]. As a key objective, keeping information and services on the university website up-to-date for students and other users is a priority. Websites for universities have dual purposes: they serve as cost-effective communication tools for academics and students while also serving as a tool for a university to project a positive public image [6]. Websites are an effective tool for enhancing the public perception of a university. As a result, university website design must meet specific user requirements while also ensuring that users are satisfied so that they may effectively complete tasks on the website without encountering any complications [7, 8].

The ease with which a website may be used by its visitors is determined in part by its usability. It's the most important aspect of a product's total user experience, and skipping over it could prove to be extremely costly [9]. It is impossible to assess a website's impact without considering its usability, as incorporating it into society can be challenging without a satisfactory usability [10]. Jakob Nielsen describes heuristic evaluation as “a usability engineering method for finding the usability problems in a user interface design so that they can be attended to as part of an iterative design process. Heuristic evaluation involves having a small set of evaluators, examine the interface, and judge their compliance with the recognized usability principles” [11]. There are many works studying websites usability among scientific institutions, however in this study a new model has been customized to evaluate the usability of university websites. The structure of

this paper is organized as follows: Section 2 presents background literature for this study. Section 3 discusses the methodology. Section 4 explains finding and discussion the results. Finally, section 5 provides conclusion.

Background literature

University websites can be considered as backbone of delivering services and contents to the clients; it is a window to interact and manipulate with its stakeholders. During COVID-19 pandemic, the role of the websites has been doubled, so it is important to utilize the maximum functionality of the websites according to the website usability. Therefore, various standards and models have been used to design benchmarks and guidelines in order to enhance website usability.

Usability Models

A number of models have been designed and developed to evaluate the websites. Website Analysis and Measurement Inventory (WAMMI) focuses on five essential components: attractiveness, controllability, helpfulness, efficiency and learnability [12]. On the other hand, ISO has designed other models which provide several standards, such as, ISO 9241-11, ISO 9241-220 and ISO/IEC 25066. In addition, the ISO provided three main factors: effectiveness, efficiency, and satisfaction which offer valuable sources for usability experts and academics [13]. Another model for usability is SIMARECH model that has been conducted in usability evaluation. The evaluation was based on Jakob Nielsen's platform, which contains of five elements: learning, efficiency, memorization, errors, and satisfaction [14]. Along with this method the study conducted a survey also.

Generally, there are three approaches which are used to evaluate websites usability: User-based usability approach, which is a group of pre-defined functions that are performed by users to detect usability issues. The second one is, evaluation approach, which is utilized by a group of experts or developers to evaluate the websites, and the third one is, software approach, which includes automated tools to identify usability problems. However, there are a number of similarities and differences between the mentioned methods and the proposed model of this paper, can be found. More information is demonstrated in Table 1.

Table 1. Differences between the usability models.

	WAMMI	ISO 9241-11	Jakob Nielsen	Our model
Categories	attractiveness, controllability, helpfulness, efficiency and learnability	effectiveness, efficiency, and satisfaction	learning, efficiency, memorization, errors, and satisfaction	Design and layout, content, performance, errors, learnability
Automated tools for evaluation	NA	NA	NA	thinkwithgoogle, gtmatrix, tools. Pingdom and webpagetest
Specialized model	Websites and intranet	All platforms	All platforms	Higher Education website, fully customized
Evaluation methods	User-based usability evaluation methods	User-based usability evaluation methods and Evaluator based usability	User-based usability evaluation methods and Evaluator based usability	Evaluator based usability and automated software tools to metric errors & performance

Automated Tools

Automated tools have been used to evaluate the factors which are difficult to human to specify the levels, such as load-time and errors. An automated web-based technique used to assess usability of Bangladesh's websites. The method was based on three principles which were: content of information, loading time and overall performance [15]. Both internal and external factors have been used to tour websites via three automated software's such as; Gtmatrix, Website grader, and Pingdom. However, html toolbox and web page analyze have been used to evaluate the external website components [16]. Moreover, HTML Toolbox and web page analyzer dedicated to assess the usability [17]. In addition, four components were conducted for analyzing the usability of twelve different African university websites, such as color contract check, web accessibility [18]. However, the automated software was used to evaluate internal factors, for instance, performance, page size, load time, and page requests, while data organization and navigation measured as internal factors [19]. Along with the automated tools for collecting data, questioner forms have been conducted to collect data.

Automated usability tests are vital to acknowledge how best to optimize the website. in this paper, four automated tools have been used to metric load-time and error in order to obtain a much more accurate score rather than using one or two automated tools. The automated tools are:

- 1) GTmetrix is a website optimization tool that can analyze and track the speed and performance of the website. In addition, it provides recommendations to improve it,
- 2) Pingdom utilize monitor the websites' uptime, performance, and interactions for a better end-user-experience,
- 3) webpagetest tool test the speed, usability, and resilience of the website, and
- 4) thinkwithgoogle it is Google's tool that used to check page speed.

Usability Factors

There are no certain factors to conduct usability levels. Various factors have been selected together in order to design a model, and here in this part we will discuss some of them. First, seven factors have been used to evaluate top three rated Arabic educational websites. The elements were: effectiveness, efficiency, learnability, memorability, errors, satisfaction, and content [20]. University of Putra Malaysia (UPM) website was, for this purpose, assessed using a questionnaire based on five usability criteria: efficiency, learnability, attractiveness, controllability, and helpfulness, in which each of these elements is a subset of the others [21]. Second, three components, such as usability, navigation and content have been conducted as a model for assessing website usability, in which each of them contained three sub-components [2]. Third, a bunch of criteria such as navigation, organization of website, ease of use, design, communication and content have been put together to develop the usability metrics, and then

assessed 86 university websites across Canada, United States of America and Europe. At this time across, learnability, efficiency, memorability, error, and satisfaction became factors to evaluate usability of Muhammadiyah Magelang university website [22]. In addition, five factors, for instance, attractiveness, controllability, helpfulness, efficiency and learnability have become criteria to measure the Namik Kemal university usability level. The key usability characteristics described by [2] are: ease of navigation, ease of use, learnability, response time, informativeness, accessibility, aesthetics, efficiency, user satisfaction, content, design, user friendliness, accuracy, interactivity, and load speed [2]. Furthermore, criteria including attractiveness, controllability, helpfulness, efficiency and learnability have been used to design a guideline [1]. Moreover, the system, usability and scaling components were dedicated to reveal usability weaknesses of Saudi universities in comparison with the UK's universities, in which the study conducted a model to show the satisfaction level. Last but not least, criteria such as visual design and consistency, links and navigation, data entry forms, information truth and precision, privacy and security, search functionality, as well as, help, feedback and error tolerance have been used to develop a model for assessing university websites [23].

Usability Evaluation

According to the researches, various factors have affected the websites' evaluations. Most of the African university websites do not totally conform to the Web Content Accessibility Guidelines 2.0 (WCAG 2.0) [18]. Also, the Arabic websites deteriorate from slow loading speed and the websites' usability elements expressed poorly [20]. The evaluation of King Abdul-Aziz university reveals that its website's weakness is that it does not meet the satisfaction usability level [24, 25]. There are a variety of website evaluation models that take into account the principles of usability, graphic design, and navigability, but no model has examined the relationship between these concepts and the usability of a website as a whole [26]. These parameters were selected based on the findings of Martinez-Sala *et al.* [27]. Additionally, university websites in Bangladesh cannot meet users' satisfaction, therefore there is massive space to enhance the quality of the university websites [15]. However,

there were some weaknesses in designing the websites such as design, interface, and performance, but generally, the websites were met with usability requirement levels [16]. In addition, the websites satisfy with the usability levels, however there were some vulnerabilities related to interface and performance [17]. The overall usability level was acceptable, meanwhile there were some weaknesses required to be corrected, such as error and website speed [22]. The quality of a website was evaluated using automated software testing GTMetrix to determine the YSlow and PageSpeed of the website [28]. According to GTMetrix's automatic software testing, various recommendations are generated to better management of the website quality [28, 29]. According to the ISO 9241-151:2008 discipline, 12 universities have been assessed in the provinces, Khyber Pakhtunkhwa, Pakistan in which the websites displayed poorly and they did not meet ISO standards [24]. On the other hand, the government universities were found to offer 5% higher usability levels than private Universities [23].

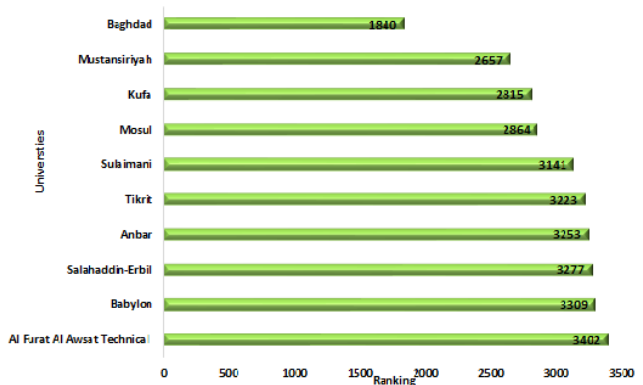
Generally, there were various models and frameworks designed to evaluate university websites; the model require customization and updating the criteria. In this research customized heuristic evaluation has been proposed to evaluate top 10 university at Iraq. The model has based on adapted categories and sub-categories to the universities' websites usability, some categories have been added to the model. In addition, in order to enhance the quality of the website usability evaluation, interim of both error determinations and performance measuring, this model utilized 4 automated tools.

MATERIALS AND METHODS

The heuristic guidelines model is designed to evaluate the usability of the university websites. The model is customized fully to adapt with the universities' environments.

The Webometrics Ranking of World universities is an ambition of the Cybermetrics Lab, which is a scientific research team that held by the Consejo Superior de Investigaciones Científicas (CSIC) [30]. The scientific body sort the universities across the world according to the certain criteria's such as, web contents impact, top cited researchers and top cited papers [30]. According to their standards the universities re-rank twice

annually, normally it would be by the end of the January or July. In this paper top 10 Iraqi universities' websites have been nominated to investigate usability websites, Figure 1 shows that university of Baghdad is the first university in Iraq with rank 1840 worldwide, while Al-Furat Al-Awasat Technical university is the last 10 universities with rank 3402 worldwide, there are 115 universities ranked in Iraq [30], in accordance with to the second updated university ranking at 2021.



Source of data: Webometrics.

Figure 1. Top 10 Iraqi Universities Ranking.

The model is based on a three levels hierarchy; at the top level there were five categories: Design and Layout, Learnability, content, Performance and Efficiency and Errors categories as illustrate in Figure 2. The second level of the model divided into 18 sub-categories (Table 2), and the third level of the hierarchy contained 44 elements. Evaluating the elements were based on binary and ordinary questions.

Two evaluation methods have been used to collecting the data: Observation and automated tools. The first data source is collected by observation the 44 elements of the websites, and second source have been used to evaluate the factors which were difficult to human to specify the levels, such as load-time and errors. The importance aspect of this model can be counted as: First, it is fully customized to evaluate the university websites. Second, the sub-categories' mode is designed in a way to collect data much more accurately by using metric principles, for example, binary approach. Third, along with the evaluation approach to collect data, automated tools are also used to evaluate errors and performance.

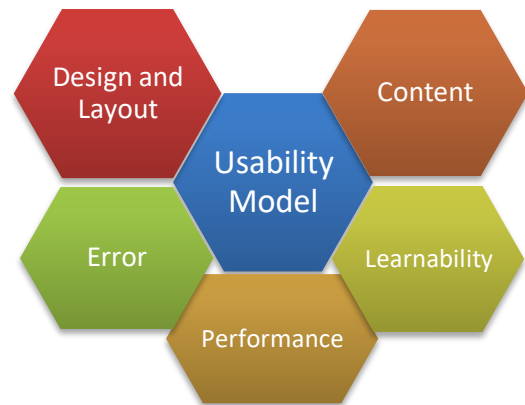


Figure 2. Usability Model.

Table 2. Usability element and related question items.

Category	Sub-categories
Design and layout	Foreign language support. Website's interface design is attractive. Ease of use of navigation menu Internal search facility. Clarity of Contact information. Does the website provide any Online Learning Environment facility? The Website is responsive
Content	Up-to-date information (Academic Activity) About university Academic calendar Emphasis point and Achievement Information about alumni
Performance	Website Load-time
Learnability	Reading content at this website is easy, I can understand the navigation easily I can learn how to use the website without instruction
Errors	Broken link Under construction page

Data collection

The data of the websites collected due to the utilizing two methods: observation and automated tools.

Observation

The data is collected from the 44 elements by observing all the universities websites at the same period of time (Appendix A). Each element represents leaf of the branch of the model.

Automated tools

Four automated tools are used to assess the loading time and the error. Each website is evaluated by all the four tools: thinkwithgoogle [31], gtmetrix [32], tools. Pingdom [33] and webpage test [34], then the scores are calculated by taking the average of all the metric tools.

Calculating the University website scores

The model based on three levels, five categories, and 18 subcategories which divided across 44 elements. SPSS has been used to descriptive statistics analysis the data. Each subcategory rated between [0 to 15] which comes from the elements, then the universities scores found by the equation:

Usability score = (total score*100)/total score all questions). Summation of sub-categories for each category multiply by 100 then divide by summation of maximum total score of all sub-categories (appendix A).

RESULT AND DISCUSSION

The total scores of the universities' websites come from accumulating the grades of the all 5 categories (Table 2). The grades have been counted form the 44 elements, then subcategories and categories (Appendix A). The universities scored various grades according to the categories.

Design and Layout

Design and Layout category contains 8 sub-categories which illustrated at Tables 2. In this study two sub-categories added to the universities website usability evaluation: 1) foreign language support, it has two options (Yes or No). 2) online learning environment facility, it divided across 5-point Likert scale.

Table 3 presents design and layout usability scores for each university website, where the university of Kufa scored 100% which was the highest, while the university of Sulaimani scored the lowest 25.71%.

Table 3. Usability university website scores by design and layout.

University Name	Percent
University of Baghdad	82.86
Mustansiriyah University	74.29
Kufa University	100
University of Mosul	71.43
University of Sulaimani	25.71
Tikrit University	60
University of Anbar	82.86
Salahaddin University Erbil	60

University of Babylon	57.14
Al Furat Al Awsat Technical University	77.14

Learnability

Learnability consists of 3 sub-categories (Table 2), according to this category university of Kufa recorded the highest of website learnability, accumulated 80% scores, however both universities of Sulaimani and Babylon scored the lowest rate 46.67%. The learnability scores are illustrated in Table 4.

Table 4. Usability university website scores by learnability.

University name	Percent
University of Baghdad	73.33
Mustansiriyah University	73.33
Kufa University	80
University of Mosul	60
University of Sulaimani	46.67
Tikrit University	53.33
University of Anbar	73.33
Salahaddin University Erbil	60
University of Babylon	46.67
Al Furat Al Awsat Technical University	73.33

Content

In order to enhance the content of university usability websites, five sub-categories (Tables 2) were added to the evaluation of the model: 1) up-to-date information about academic activities. It is divided across 5-point likert scale, 2) about university, it has 5 selection elements of likert scale, 3) academic calendar consists of binary selection (Yes or No), 4) academic achievement. It is divided across 5-point likert scale, and 5) information about alumni, also consist of binary selection. According to the content category of usability, the university of Baghdad scored 88%, which was the maximum grade, while the university of Babylon recorded the minimum content usability university website score 20%, as shown in Table 5.

Table 5. Usability university website scores by content.

University name	Percent
University of Baghdad	88
Mustansiriyah University	68
Kufa University	72
University of Mosul	72
University of Sulaimani	30
Tikrit University	44
University of Anbar	68
Salahaddin University Erbil	80
University of Babylon	20

Al Furat Al Awsat Technical University	56
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Performance

In this research the universities websites performance measured due to automated tools. Four automated tools have been used to the universities usability evaluation: 1) thinkwithgoogle, 2) gtmetrix, 3) tools. Pingdom, and 4) Webpagetest. Through using automated tools, the performance of the university websites has been evaluated, as it is shown in Table 6, where the university of Sulaimani scored the highest 100%, whereas Al Furat Al Awsat Technical university recorded 20%, which was lowest performance.

Table 6. Usability university website scores by performance and efficiency.

University name	Percent
University of Baghdad	60
Mustansiriyah University	40
Kufa University	80
University of Mosul	40
University of Sulaimani	100
Tikrit University	60
University of Anbar	60
Salahaddin University Erbil	80
University of Babylon	80
Al Furat Al Awsat Technical University	20

Errors

This research has utilized 4 tools in order to determine higher accurate error evaluation measurement across the university's websites, automated tools such as, thinkwithgoogle, gtmetrix, pingdom and webpagetest. Four automated tools have been used to check the university websites for errors, most of the Iraqi universities have recorded poor scores, although both of universities of Baghdad and Kufa had nil errors. See Table 7.

Table 7. Usability university website scores by error.

University name	Percent
University of Baghdad	100
Mustansiriyah University	50
Kufa University	100
University of Mosul	0
University of Sulaimani	0
Tikrit University	50
University of Anbar	0
Salaheddin University Erbil	50
University of Babylon	0
Al Furat Al Awsat Technical University	0

All in all, according to the total score recorded by adding the five categories, university of Kufa scored the highest while it took the third place depending on the web metrics ranking. However, the university of Baghdad placed the second position in usability university scores, yet it placed the first one regarding to the web metrics ranking. The rest of the results are found in the Table 8. There is, however, no relationships between web metrics ranking as presented at Figure 1 and the proposed model of the universities presented in this research. The model consists of five categories: design and layout, content, learnability and errors. The categories divided across 18 sub-categories. The categories modelled to express the usability of the university's websites

Table 8. Overall university usability website scores.

University name	Percent
University of Baghdad	83.33
Mustansiriyah University	67.78
Kufa University	87.78
University of Mosul	60.00
University of Sulaimani	32.22
Tikrit University	53.33
University of Anbar	66.67
Salaheddin University Erbil	65.56
University of Babylon	40.00
Al Furat Al Awsat Technical University	58.89

CONCLUSIONS

Academic websites of educational organizations aim to provide information and services to their stakeholders in most efficient techniques. To achieve this goal, the universities should design their websites in the best usability criteria in order to achieve the stakeholders' satisfaction. The model has been proposed to evaluate the university websites. The model is based on three levels hierarchy at the top level, in which there were five categories: Design and Layout, Learnability, Content, Performance and Errors categories. There were 18 sub-categories at the second level and there were 44 elements at the third level which were based on binary method.

In this research a new model has been designed to evaluate the university websites usability. It includes 5 categories and 18 sub-categories as shown in Table 8 in Appendix A. In order to adapt evaluation to the university website 7 sub-categories added to enhance the model, they are:

1) foreign language support, 2) online learning environment facility, 3) up-to-date information about academic activities, 4) about university, 5) academic calendar, 6) academic achievement and, 7) information about alumni. In addition, the model provides 4 automated tools to evaluate the errors and performance of the university's websites. Based on the measurement results of the categories, universities' websites scored various grades, for example: university of Kufa scored 100% at Design and Layout categories, while the university of Sulaimani scored the lowest, 25.71%. Also, university of Kufa scored the highest, 80%, at learnability criteria, while the university of Sulaimani and Babylon scored the lowest, 46.67%. university of Baghdad rated the highest, 88%, at Content category, but the university of Babylon rated the lowest, 20%. university of Sulaimani scored the highest, 100%, at website performance, while the Al Furat Al Awsat Technical university scored the lowest, 20%. Most of the Iraqi universities have recorded poor scores, although both the university of Baghdad and university of Kufa scored the best. According to the total scores which were recorded by adding the five categories, university of Kufa scored the highest, 87,78%, while it took the third place depending on webmetrics ranking. university of Baghdad placed the second, 83.22%, but the university of Sulaimani scored poorer, 32.22%, than the Babylon university, 39.72%. Based on the findings, our recommendation is to guide the IT directories of the universities' websites to enhance the weaknesses of their websites. For future studies, the model can be enriched by adding more elements to the sub-categories.

Disclosure and Conflict of Interest: The authors declare that they have no conflicts of interest.

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How to Cite

R. Abdulla, H. A. Faraj, K. O. Mohammed, and M. M. Younis, "Usability Evaluation of the Top 10 Universities in Iraq Using Heuristic Methods", Al-Mustansiriyah Journal of Science, vol. 34, no. 2, pp. 50–59, Jun. 2023.



Appendix A

Table 8: Results of questions form

Category	Sub-categories	Elements
Design and layout	Foreign language support	**
	Website's interface design is attractive	*****
	Ease of use of navigation menu	*****
	Internal search facility	**
	Clarity of Contact information	*****
	Does the website provide any Online Learning Environment facility	*****
	The Website is responsive	**
Content	Up-to-date information	*****
	About university	*****
	Academic calendar	**
	Emphasis point and Achievement	*****
	Information about alumni	**
Performance & efficiency	Website Load-time (faster load-time= Maximum)	*****
variability	I can easily find what I want at this website	*****
	Reading content at this website is easy, I can understand the navigation easily	*****
	I can learn how to use the website without instruction	*****
Errors	Broken link	**
	Under construction page	**

Note 1: ****Scores**

Maximum (Yes)	15
Minimum (No)	0

Note 2: *******Scores**

Strongly Agree	15
Agree	12
Fair	9
disagree	6
strongly disagree	3