

Usability effectiveness of a federated search system for electronic theses and dissertations in Nigerian institutional repositories

Federated
system for
ETDs in
Nigerian IRs

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Abstract

Purpose – The purpose of this study was to evaluate the usability effectiveness of a webware for electronic theses and dissertations (ETDs) in Nigerian repositories. The webware (etdsearch.com.ng) is a web application system that curates ETDs from three sampled Federal government-owned universities. The system also links users to the repositories where the theses and dissertations are hosted.

Design/methodology/approach – The case study research strategy was adopted for the study. Sixty postgraduate students from three universities were randomly selected. A usability evaluation questionnaire based on the ISO 9241-11 framework was used to collect data after performing pre-defined queries/tasks based on the informational and transactional query models. The research questions were analysed using the median of the performance score (f_x) of the three universities for each item evaluated, while the Kruskal–Wallis test by ranks was used to test the null hypothesis at a 5% level of significance.

Findings – The study answered two research questions and tested two null hypotheses on the usability effectiveness of the webware based on the informational and transactional queries. The participants found the ETD search system effectively useable. In addition, there was no significant difference in the opinions of the participants.

Research limitations/implications – The webware used simulated repositories as a feed bed for the ETDs in order to have control over the workability of the repositories. Thus, the results may differ slightly when “live” repositories are used.

Practical implications – The effectiveness of a webware that aggregates ETDs in Nigerian repositories will present libraries in Nigeria with evidence on how these systems work and can be improved upon.

Originality/value – There is a dearth of literature on practical usability studies of digital information systems in Nigerian libraries.

Keywords Electronic theses and dissertations, Institutional repositories, Informational query, Nigerian libraries, Transactional query, Usability effectiveness

Paper type Research Paper

Introduction

Usability evaluation is of paramount importance in the development of information systems. Usability, according to Federici and Borsi (2010) is evaluated by the quality of communication (interaction) between a technological product (system) and a user (the one who uses that technological product). Usability evaluation is a method for identifying specific problems with IT products and specifically focusses on the interaction between the user and task in a defined environment. (Williams *et al.*, 2013) Rubin and Chisnell (2008) mentioned some qualities that makes a product or service useable – efficiency, effectiveness, satisfaction, learnability and accessible. Aliyu (2015) also stated that usability depended on how well the functionality fits users' needs, the flow through the application fits users' tasks and how well the response of the



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application fits users' expectations. A peruse of literature on the usability of repositories or federated search tools (FSTs) for repositories in Nigeria have not been reported in the literature to the best of the researcher's knowledge, although these studies have received significant attention in the field of Library and Information Science (Joo *et al.*, 2011). Madan and Dubey (2012) stated that usability is an essential factor in the development of successful and interactive software applications. Several usability models are reported in the literature, amongst them are Eason usability model, Quality in Use Integrated Measurement (QUIM) model, Neilson usability model to mention but a few. Several methods have also been reported in the literature as approaches, methods and techniques for usability evaluation, prominent amongst them are heuristic evaluation, interviews, log analysis to mention but a few. Randolph *et al.* (2015) mentioned two usability evaluation methods: usability testing that requires observation and recording of behaviours' and activities of users testing the product and inspection method that involves usability professionals viewing the product in order to identify usability defects. According to the authors, the end-user testing is better because systems are user-centred designed and thus feedback from users is imperative. Emphases have been on the awareness, acceptance and availability of repositories without putting into consideration the usability of this technology vis-à-vis its purpose.

Abubakar and Ahmad (2013) asserted that several researchers have pointed to behavioural intention as the most critical determinant of the use of a particular technology. However, behavioural intention or satisfaction is influenced by several usability factors to include but not limited to effectiveness, effort expectancy, efficiency, performance expectancy and ease of use to mention but a few. Informational, transactional and navigational queries are also relevant queries that determine the usability intent of users on search retrieval systems and software. Classifying the three queries based on people's use of web search systems, Jasen *et al.* (2008) stated that users base web search systems services on a variety of purpose that encompasses the three queries. The researchers stated that they are navigational tools that take users to specific Uniform Resource Locators (URLs) or to aid in browsing, conduct e-commerce transactions in addition to finding out information. Search queries, according to Gabbert (2018), are words and phrases that people type into a search box to come up with informational, navigational or transactional results. According to the authors, informational queries are queries used when information is needed, or a question is to be answered. Navigational queries are used when a user intends to complete a transaction like a download or purchasing while the intention of navigational queries are queries made to find a particular website or webpage. The navigational query was expunged because it does not fit into the scope of the web application. The web application a subject-specific (for electronic theses and dissertations (ETDs)), thus it cannot be used to navigate other websites. Evidence from literature also indicated that majority of research studies on usability either yields system design principles, verify its usability vis-a-vis the intended purpose or intends to improve the design of an existing system. In the study by Kathuria *et al.* (2010), web search engines queries were categorised into three and the researchers mentioned that users' intent was more on informational query than navigational or transactional queries.

Etdsearch.com.ng

The need for a centralised database or system for students and researchers to access research outputs from Nigeria universities necessitated the design of the webware (*etdsearch.com.ng*). The system curates and also links users to theses and dissertations in the discipline from three sampled universities. The developed web application addressed the issue of a unified interface for ETDs from government-owned universities repositories. It was imperative in order to curb plagiarism and repetitive research studies with postgraduate students claiming oblivion of research studies carried out in other universities. This research study evaluated the usability of the webware vis-à-vis the intended purpose (informational and transactional purposes) (see Figure 1).

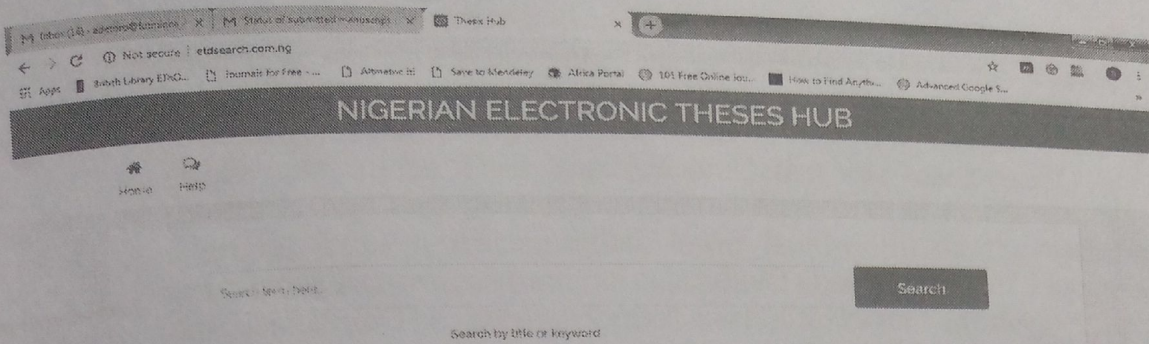


Figure 1.
ETD Hub homepage

The study evaluated the usability effectiveness of Nigerian Electronic Theses Hub with the following objectives and hypotheses:

- (1) Determine the usability effectiveness of Nigerian Electronic Theses Hub based on informational Query;
- (2) Determine the usability effectiveness of Nigerian Electronic Theses Hub based on Transactional Query.

H1. There is no significant difference in the usability effectiveness of Nigerian Electronic Theses Hub based on Informational Query.

H2. There is a significant difference in the usability effectiveness of Nigerian Electronic Theses Hub based on Transactional Query.

Review of related studies

Xin *et al.* (2012) developed a method for testing the usability of geoportals based on the ISO 9241-11 framework, which splits the usability evaluation into three-effectiveness, efficiency and satisfaction. Users provided feedbacks in an organised way which gave geoportal developers tools to validate the functions and the layout and to find possible problematic parts to be able to make better applications to meet both the organisation and the end-users needs.

Mustafa (2014) adapted usability factors and criteria in the QUIM to come up with a framework that would find out whether there is a correlation between accessibility and usability of websites. Similarly, Aziz *et al.* (2013) proposed a usability model for websites based on QUIM model. Also, the researchers compared and analysed existing usability models and identified the evaluation criteria and characteristics for websites. They, however, did not come up with tools for the empirical assessment for the model.

Pant (2015) evaluated the usability of the central science library of the University of Delhi using six usability attributes – efficiency, effectiveness, usefulness, accessibility, learnability and satisfaction. The findings from their study revealed that respondents found information resources provided on the website useful. They, however, reported inadequate

help provision for resources available through the website. They, therefore, recommended sustainable usability improvement for the website in terms of efficiency, effectiveness and learnability.

Moumane *et al.* (2016) used the experimental design of the usability evaluation for mobile applications. Their empirical evaluation was based on ISO 25062 and ISO 9241 standards, and they primarily evaluated the effects of mobile limitations (limited user interface, frequent disconnection, lower bandwidth) on the usability of apps. The experiment was designed and ran using direct observation of 32 users, video recording and questionnaires. The users performed a set of tasks on their devices that allowed them to think aloud while using both Google Maps and Google Apps to identify and highlight the usability issues when using apps. The researchers collected objective measures using a set of measures and video recordings, as well as subjective measures through the QUIS 7.0 questionnaire.

The study by Mohammed and Yousef (2015) explored a framework for evaluating and comparing two FSTs using two different retrieval protocols, the XML gateway and Z39.50. The researchers proposed framework consisted of three phases, the usability testing, retrievability performance assessment and overall comparison; and used the think-aloud protocol with 20 real user queries for the usability testing. Results indicated that there was no significant difference between the two FSTs, while minor differences were found regarding retrieval consistency and precision at 11-point cut-off recall. The overall evaluation showed that the FST based on the XML gateway rated slightly higher than the FST based on the Z39.50 protocol. The researchers implied that the results of their study and the proposed framework could be utilised by FST developers to enhance their product's performance and by librarians to evaluate FSTs performance and capabilities.

Omame *et al.* (2019) evaluated the usability of web search engines using a navigational query model. The study adapted the experimental design and used 21 master degree students from the Department of Library and Information Technology, Federal University of Technology Minna, Nigeria. The respondents were asked to evaluate the usability of five web search engines, namely: Ask.com, Bing, Excite, Google and Yahoo! web search engines. The respondents submitted queries drawn from library and information services to the various web search engines and assessed their performances based on the relevance of the output results. The study revealed no significant difference in usability effectiveness between web search engines using a navigational query model, i.e. overall, the web search engines performed well, but at different levels of performances. Specifically, Google has the highest performance on usability effectiveness, while Excite had the least performance. The study provided more in-depth understanding to search engine developers on the significance of usability performances of web search engines using navigational query models so that they can put these into considerations when designing a web search engine.

Lewandowski (2015) compared the retrieval effectiveness of Google and Bing using a random representative sample of 1,000 informational and 1,000 navigational queries from a major German search engine. The data were collected using specialised software, the Relevance Assessment Tool and jurors were found through crowdsourcing. The study found that although Google outperformed Bing in both query types, the difference in the performance for informational queries was low. For navigational queries, Google found the correct answer in 95.3% of cases whereas Bing only found the correct answer 76.6% of the time. The study concluded that search engine performance on navigational queries is of great importance and may contribute to explaining user satisfaction with search engines. The navigational query was expunged in this study because they cannot work effectively with the FST, which is the aim of this study.

Abifarin *et al.* (2019) used a case study methodology to evaluate the design effectiveness of three academic library websites in Nigeria. The purpose of the study was to determine whether users can derive useful experiences while visiting them to perform tasks. The researchers found critical issues pertaining to design effectiveness and recommended a review of the design of academic library web sites in Nigeria so that users can find these sites easier to use.

A peruse of the usability evaluation literature revealed a lot of usability evaluation literature for websites. Little or no work has been done to find out the usability effectiveness of search retrieval tools for repositories.

Research methodology

The case study research strategy was adopted for the study. Sixty postgraduate students (2018/2019) from Federal University of Technology Minna (FUT, Minna), Ahmadu Bello University Zaria (ABU, Zaria) and University of Nigeria, Nsukka, (UNN) Nigeria were randomly selected using simple random sampling with replacement. Twenty students were selected from each faculty in each university in order to have equal representation of the usability of the system. This number was used based on Nielsen (2012) explanation that for quantitative usability evaluation, at least 10 respondents are required to get the opinion/perception about how effective and efficient a system is. However, to make up for non-response error or attrition or the likes, the sample size was rounded up to 20 respondents for each sampled university. The researcher retrieved the list of postgraduate students from the postgraduate coordinators and numbered the names 1 to n. The first 20 numbers were randomly generated using an online random number generator. The students were also selected based on their informed consent and willingness to take part in the experiment. The students that were not available or willing to take part were replaced with another random number generated. The questionnaire used (see Appendix 1) for the data collection was a usability evaluation questionnaire based on the ISO 9241-11 framework that split usability evaluation into effectiveness, efficiency and satisfaction. The questionnaire was based on an adapted 4-point Likert scale. The four Likert scales were used in order to extract a specific response on the usability of the system and avoid central tendency bias. This approach was necessary because an indifference option can affect the outcome of the usability evaluation; thus, the suggestion of Simms *et al.* (2019) that odd-numbered Likert scales would show no advantage psychometrically speaking over matched even-numbered scales was adopted. Some of the questions used in the usability evaluation instrument were adapted from Assila *et al.* (2016), Joo *et al.* (2011) and Bringula (2016).

For the usability evaluation data collection, a task-oriented approach was used to collect data on the usability of the search system. Tasks were given to the selected students to be completed using informational and transactional queries (See Figures 2 and 3). These query models were used as reference points because quantitative metrics in usability studies are challenging to interpret in the absence of a reference point (Budiu, 2017). The task started with a practice task intended to familiarise the respondents with the research study set-up and to iron out individual differences amongst respondents. The selected students performed the queries using the web search application and based on their perceived experience during the task, their responses on the effectiveness of the usability of the webware were recorded by them on the usability evaluation questionnaire. The research questions are presented in tables and were analysed using median of the performance score (f_x) of the three universities for each item evaluated. The decision criterion was $f_x \geq \text{median}$ (Agreed), and $f_x < \text{median}$ (Disagreed). The Kruskal-Wallis test by ranks was used to test the null hypothesis at a 5% level of significance.

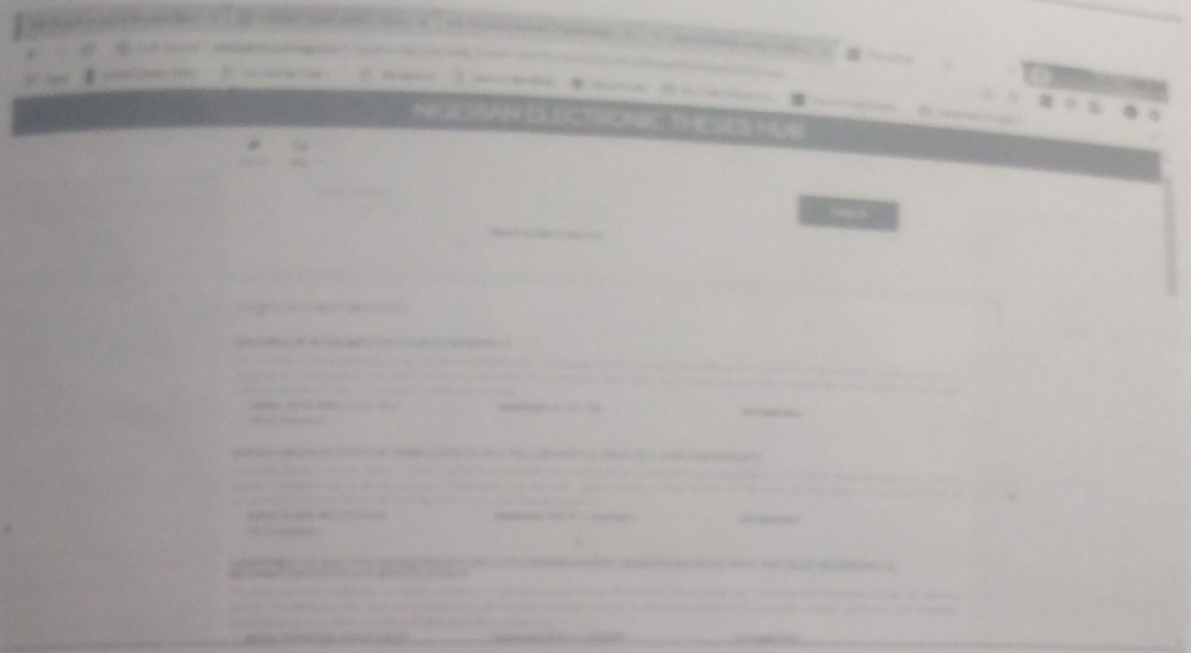


Figure 2.
Displayed webpage for
informational query
effectiveness

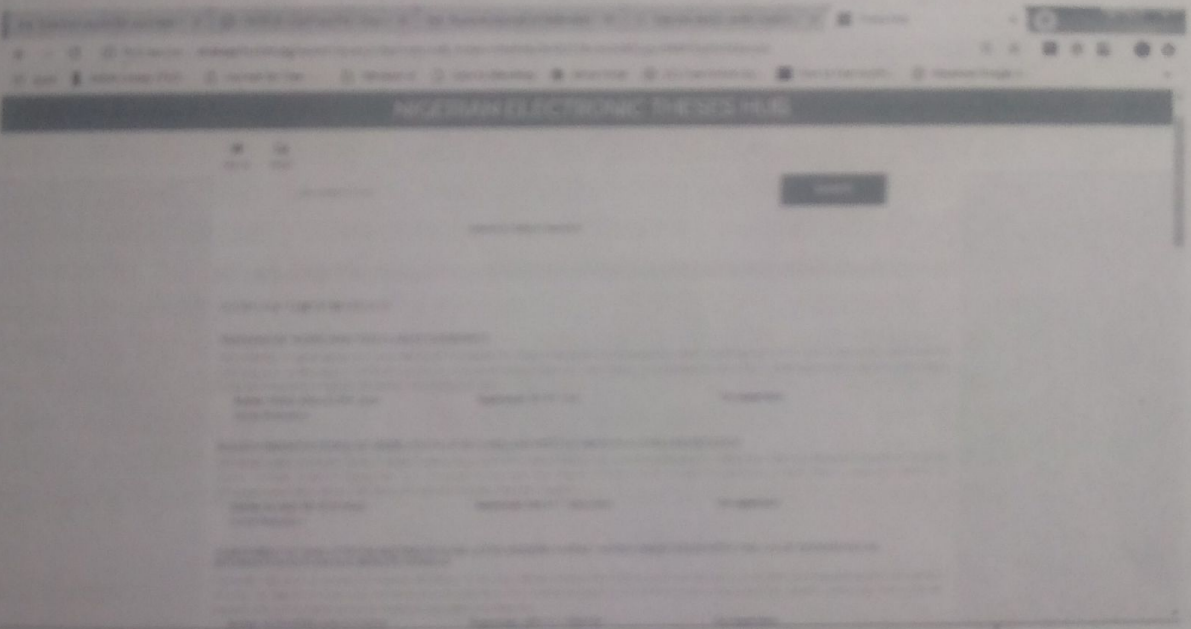


Figure 3.
Displayed webpage for
transactional query
effectiveness

Results and discussions

The data presented in Table 1 were analysed for informational query effectiveness using the median (β) of the total performance score (f_s) for each item of the three universities evaluated. The decision criterion for each statement is agreed if $f_s \geq T$ of 212 (greater than or equal to 212) and disagreed if $f_s < T$ of 212 (less than 212). The results showed that the respondents agreed to four statements out of the seven items listed on the information query effectiveness of the federated search application. These items had a median score higher or equal to 212. These statements are 1: I can accurately complete the search using the system ($\bar{x} = 213 \geq 212$), statement 2: The system was not complicated to use to find the information needed ($\bar{x} = 212 \geq 212$), statement 3: Overall, the system was useful in helping me locate the information requested ($\bar{x} = 219 \geq 212$) and statement 7: Overall, I can perform the search effectively using the system ($\bar{x} = 222 \geq 212$). The other three statements 4: I could not find the information (supervisor) requested ($\bar{x} = 88 < 212$), 5: I could not find the information (author) requested ($\bar{x} = 82 < 212$) and 6: I could not find the information (year) requested ($\bar{x} = 77 < 212$) had lower scores than the median score. These results indicated that the respondents

| SN | Statements | SD 1 | D 2 | A 3 | SA 4 | Total f_x | Median $\bar{x} = 212$ | Decision |
|----|---|---------|--------|--------|---------|----------------|---------------------------|-----------|
| 1 | I can accurately complete the search using the system | - | - | 27 | 33 | 213 | $f_x \geq \bar{x}$ | Agreed |
| 2 | The system was not complicated to use to find the information needed | 1 | 2 | 20 | 37 | 212 | $f_x \geq \bar{x}$ | Agreed |
| 3 | Overall, the system was useful in helping me locate the information requested | - | - | 21 | 39 | 219 | $f_x \geq \bar{x}$ | Agreed |
| 4 | I could not find the information (supervisor) requested | 34 | 24 | 2 | - | 88 | $f_x < \bar{x}$ | Disagreed |
| 5 | I could not find the information (author) requested | 40 | 18 | 2 | - | 82 | $f_x < \bar{x}$ | Disagreed |
| 6 | I could not find the information (year) requested | 46 | 11 | 3 | - | 77 | $f_x < \bar{x}$ | Disagreed |
| 7 | Overall, I can perform the search effectively using the system | 1 | - | 15 | 44 | 222 | $f_x \geq \bar{x}$ | Agreed |

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Table 1.
Informational query effectiveness

Note(s): $f_x = \sum(SD*statement + D*statement + A*statement + SA*statement)$

disagreed to the statements that they could not find information on these using the search application.

The data presented in Table 2 were analysed for transactional query effectiveness using the median (\bar{x}) of the total performance score (f_x) for each item of the three universities evaluated. The decision criterion for each statement is Agreed if $f_x \geq \bar{x}$ of 207 and Disagreed if $f_x < \bar{x}$ of 207. The results on Table 2 showed that the respondents agreed to three statements out of the five items listed on the transactional query effectiveness of the federated search application. These items had a median score higher or equal to 207. These statements are statement 1: I can effectively complete the search task using the system. ($\bar{x} = 209 \geq 207$), statement 2: I can effectively complete the log-in task of the thesis I selected ($\bar{x} = 209$) and statement 3: I can effectively download the thesis using the search system ($\bar{x} = 207 \geq 207$). The respondents disagreed with two statements, statement 4: The system was complicated to use for the transactional tasks ($\bar{x} = 100 < 207$) and statement 5: Overall, I was not able to achieve the transactional tasks using the system ($\bar{x} = 90 < 207$) had lower scores than the median score.

Research hypotheses

The research hypotheses were tested using the Kruskal-Wallis test by ranks. It is the non-parametric alternative to the one way ANOVA. Kruskal-Wallis makes use of ranks of the data rather than the actual data points and determines whether the medians of two or more

| SN | Statements | SD 1 | D 2 | A 3 | SA 4 | Total f_x | Median $\bar{x} = 207$ | Decision |
|----|---|---------|--------|--------|---------|----------------|---------------------------|-----------|
| 1 | I can effectively complete the search task using the system | - | 1 | 29 | 30 | 209 | $f_x \geq \bar{x}$ | Agreed |
| 2 | I can effectively complete the log-in task of the thesis I selected | - | 1 | 29 | 30 | 209 | $f_x \geq \bar{x}$ | Agreed |
| 3 | I can effectively download the thesis using the search system | 2 | 3 | 21 | 34 | 207 | $f_x \geq \bar{x}$ | Agreed |
| 4 | The system was complicated to use for the transactional tasks | 27 | 26 | 7 | - | 100 | $f_x < \bar{x}$ | Disagreed |
| 5 | Overall, I was not able to achieve the transactional tasks using the system | 32 | 26 | 2 | - | 90 | $f_x < \bar{x}$ | Disagreed |

Table 2.
Transactional query usability effectiveness

groups are different. The test statistic used in this test is called the H statistic, and the score is compared to the chi-square critical value (Stephanie, 2016).

H1. There is no significant difference in the informational query usability effectiveness of the web search application amongst the three universities (Groups)

The f_x data points for the three groups (see Appendix 2) are presented (see Tables 3-6): To calculate the Kruskal-Wallis H test, the H statistics equation was used

$$H = \left[\frac{12}{n(n+1)} \sum_{j=1}^c \frac{T_j^2}{n_j} \right] - 3(n+1)$$

Where

n = sum of answered responses for all samples (21);

Table 3.
 f_x data points for information query effectiveness

| Groups | Data points |
|-----------------------------------|----------------------------|
| Ahmadu Bello Uni. Zaria | 25, 28, 31, 71, 73, 73, 76 |
| Federal University of Tech. Minna | 25, 26, 26, 71, 71, 74, 77 |
| University of Nigeria, Nsukka | 26, 29, 31, 69, 71, 72, 75 |

Table 4.
Assigned ranks to data points (ascending order)

| S/N | Data points | Assigned ranks | S/N | Data points | Assigned ranks | S/N | Data points | Assigned ranks |
|-----|-------------|----------------|-----|-------------|----------------|-----|-------------|----------------|
| 1 | 25 | 1.5 | 8 | 31 | 8.5 | 15 | 72 | 15 |
| 2 | 25 | 1.5 | 9 | 31 | 8.5 | 16 | 73 | 16.5 |
| 3 | 26 | 4 | 10 | 69 | 10 | 17 | 73 | 16.5 |
| 4 | 26 | 4 | 11 | 71 | 12.5 | 18 | 74 | 18 |
| 5 | 26 | 4 | 12 | 71 | 12.5 | 19 | 75 | 19 |
| 6 | 28 | 6 | 13 | 71 | 12.5 | 20 | 76 | 20 |
| 7 | 29 | 7 | 14 | 71 | 12.5 | 21 | 77 | 21 |

Table 5.
Assigned ranks to data points of each group

| S/N | ABU data points | Assigned ranks | FUT data points | Assigned ranks | UNN data points | Assigned ranks |
|-------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| 1 | 25 | 1.5 | 25 | 1.5 | 26 | 4 |
| 2 | 28 | 6 | 26 | 4 | 29 | 7 |
| 3 | 31 | 8.5 | 26 | 4 | 31 | 8.5 |
| 4 | 71 | 12.5 | 71 | 12.5 | 69 | 10 |
| 5 | 73 | 16.5 | 71 | 12.5 | 71 | 12.5 |
| 6 | 73 | 16.5 | 74 | 18 | 72 | 15 |
| 7 | 76 | 20 | 77 | 21 | 75 | 19 |
| Total | | 81.5 | | 73.5 | | 76 |

Table 6.
Result of hypothesis testing

| Calculated H statistics | Critical X^2 value | Df | Alpha level | Decision |
|-------------------------|----------------------|----|-------------|-----------------|
| 0.19 | 5.9915 | 2 | 0.05 | H1 Not Rejected |

T_j = sum of ranks in each group (81.5, 73.5, 76);

n_j = size of answered items of each group (7).

$$H = 12/21(21 + 1)[(81.5)^2/7 + (73.5)^2/7 + (76)^2/7] - 3(21 + 1)$$

$$H = 12/462 \left[\frac{6642.25}{7} + \frac{5402.25}{7} + \frac{5776}{7} \right] - (63 + 3)$$

$$H = 0.026(2545.78) - 66$$

$$H = 66.190 - 66$$

$$H = 0.19$$

The H -statistic of 0.19 is less than the critical X^2 value of 5.9915; therefore, the null hypothesis that there is no significant difference in the informational query usability effectiveness of the search application amongst the three groups (ABU, FUT, UNN) is not rejected.

H2. There is no significant difference in the transactional query usability effectiveness of the web search application amongst the three universities (Groups)

The f_x data points for the three groups (see Appendix 2) are (see Tables 7–10):

| Groups | Data points |
|-----------------------------------|--------------------|
| Ahmadu Bello Uni. Zaria | 29, 30, 67, 70, 71 |
| Federal University of Tech. Minna | 75, 72, 74, 33, 26 |
| University of Nigeria, Nsukka | 67, 66, 63, 37, 35 |

Table 7.
 f_x data points for transactional query effectiveness

| S/ N | Data points | Assigned ranks | S/ N | Data points | Assigned ranks | S/ N | Data points | Assigned ranks |
|------|-------------|----------------|------|-------------|----------------|------|-------------|----------------|
| 1 | 26 | 1 | 6 | 37 | 6 | 11 | 67 | 11 |
| 2 | 29 | 2 | 7 | 63 | 7 | 12 | 70 | 12 |
| 3 | 30 | 3.5 | 8 | 64 | 8 | 13 | 71 | 13 |
| 4 | 33 | 3.5 | 9 | 67 | 9.5 | 14 | 72 | 14 |
| 5 | 35 | 5 | 10 | 67 | 9.5 | 15 | 75 | 15 |

Table 8.
Assigned ranks to data points (ascending order)

| S/ N | ABU data points | Assigned ranks | FUT data points | Assigned ranks | UNN data points | Assigned ranks |
|-------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| 1 | 29 | 2 | 26 | 1 | 35 | 5 |
| 2 | 30 | 3 | 33 | 4 | 37 | 6 |
| 3 | 67 | 10 | 67 | 10 | 63 | 7 |
| 4 | 70 | 12 | 72 | 14 | 64 | 8 |
| 5 | 71 | 13 | 75 | 15 | 67 | 10 |
| Total | | 40 | | 44 | | 36 |

Table 9.
Assigned ranks to data points of each group

| Calculated H statistics | Critical X^2 value | df | Alpha level | Decision |
|---------------------------|----------------------|----|-------------|-----------------|
| 0.32 | 5.9915 | 2 | 0.05 | H2 Not rejected |

Table 10.
Result of hypothesis testing

The result in Table 10 shows a Kruskal–Wallis H value of 0.32 with a χ^2 value of 5.99, thus not rejecting the null hypothesis. The likelihood of obtaining this χ^2 value of 5.99 can occur five times in one hundred (0.05). Since the Kruskal–Wallis value of 0.32 is less than the χ^2 value of 5.99; it is more likely to occur. Thus, this result suggests that the opinion of the postgraduate students about the effectiveness of the search application in downloading information about theses from the repositories was the same in the three universities.

To calculate the Kruskal–Wallis H test, the H statistics equation was used

$$H = \left[\frac{12}{n(n+1)} \sum_{j=1}^c \frac{T_j^2}{n_j} \right] - 3(n+1)$$

Where

n = sum of answered responses for all samples (15);

T_j = sum of ranks in each group (40, 44, 36);

n_j = size of answered items of each group (5).

$$H = 12/15(15+1) \left[\frac{(40)^2}{5} + \frac{(44)^2}{5} + \frac{(36)^2}{5} \right] - 3(15+1)$$

$$H = 12/240 \left[\frac{1600}{5} + \frac{1936}{5} + \frac{1296}{5} \right] - (45+3)$$

$$H = 0.05[966.4] - 48$$

$$H = 0.32$$

The H -statistic of 0.32 is less than the critical X^2 value of 5.9915; therefore, the null hypothesis that there is no significant difference in the transactional query usability effectiveness of the search application amongst the three groups (ABU, FUT, UNN) is not rejected.

Information query effectiveness

The study revealed that information query usability evaluation revealed uniform results in the effectiveness of the webware. Majority of the participants reported that the federated search application was effective in meeting their information queries about ETDs (Table 1). These results indicated that the federated search application assisted postgraduate students greatly in retrieving information on theses relevant to their studies conducted in other universities. This is probably because the information query is usually the first intention of any postgraduate student looking for ETDs for their research studies. This result is similar to Coates (2014), which revealed that local users of Auburn University ETD collection had more of informational queries from search engines seeking information about theses from specific Auburn researchers. 70% of participants in the study by Mohammed and Yousef (2015) also stated that FSTs provided an easy way to find their information resources. Questions about availability, location, year of publication are some of the information the search web application in this study takes care of and has been found useable. In a similar finding, Wakeling *et al.* (2017) usability study of worldcat.org, a global online catalogue found that respondents frequently mentioned using the online catalogue to determine which location particular items were. The PhD students used worldcat.org to identify all the literature in their research area of study from a single access point. In this study, postgraduate students will not need to search for individual

repositories or travel to search for theses and dissertations related to their research studies, thus making access to library information resources easier. According to Bracke *et al.* (2008) in the educational context, systems such as the federated search application have been found to help lower the barriers to information resources and increase the use of evidence-based resources for learning. Roy *et al.* (2016) also opined that this type of web-enabled gateway is useful to the researchers because it provides global access to the resources through a unified search interface. Also, Saparova *et al.* (2014) stated that information retrieved by federated search engines from different locations could help physicians address their information needs every day by conducting a single search.

The result in Table 8 shows a Kruskal–Wallis H value of 0.19 with a chi-square value of 5.99. The likelihood of obtaining this chi-square value of 5.99 can occur five times in one hundred (0.05). Since the Kruskal–Wallis value of 0.19 is less than the chi-square value of 5.99; it is more likely to occur. Thus, this result suggests that the opinion of the postgraduate students about the effectiveness of the search application in retrieving information about theses from the repositories was the same in the three universities. In a similar study, Mohammed and Yousef (2015) study found no significant effectiveness difference between two FSTs in terms of searching capabilities. Hanrath and Kothman (2015) equally reported a similar study that showed that over 80% participants rated their impression of “Primo” a new search tool as positive. The implication of these results shows that there is a paradigm shift in the search behaviour of students that libraries have to take cognisance of. Lown *et al.* (2013) and Asher *et al.* (2013) stated that Google has widened and significantly impacted users’ search expectations, thus libraries adoption of these search tools. Collaborating these assertions, Salau and Gama (2015) also opined that users of electronic information would mostly use sources of access that can give them fewer challenges and offer more advantages to them especially for teaching and research; FSTs offer this advantage. Korah and Cassidy (2010), found a high rate of federated search amongst students of Sam Houston State University and stated that federated tools presented information in a simple, user-friendly way that required little formal knowledge of information organisation and searching techniques which made it attractive to many students.

Transactional query effectiveness

Results on Table 2 showed that respondents agreed to statements supporting the effectiveness of the system for transactional queries for ETDs; and disagreed to statements not supporting the effectiveness of the system for transactional queries. Transactional queries are essential to complete the whole cycle of information retrieval. Studies have shown that it is not enough to know where to find information; access to the information is equally important. According to Sankar and Kavitha (2015), modern information and communications technology tools like the designed webware in this study acts as an effective intervener and has become a boon to avoid duplication of research studies as well of the utilisation of theses.

Information discovery is as important as information delivery. In Online Computer Library Centre (2009) study of users’ and librarians’ expectations of the online catalogue, many users indicated that without the delivery of an information need, discovery alone was not sufficient. The uniform results of the hypothesis are expected because the respondents were able to download the theses they searched for, thereby completing the process. Studies have indicated that web users want instant access to information resources (Ballard and Bliane, 2011; Neal, 2009; Wakeling *et al.*, 2017). Although there were varied opinions on the download task, this had little to do with the effectiveness of the system.

Conclusion

The study evaluated the usability effectiveness of an ETD webware that retrieves ETDs from institutional repositories based on informational and transactional queries. The webware

was effective in retrieving and downloading information about theses and dissertations from three universities. Thus, there was no significant difference in the opinion of the three groups about its usability based on information and transactional queries. However, because of the peculiarities of the repositories used in the design of the webware, which makes it laboratory ready, another usability evaluation should be conducted with the webware when designed using "live" repositories. Also, the usability efficiency and satisfaction need to be ascertained in order to have a holistic usability evaluation of the webware.

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Appendix

The appendices are available online for this article.

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