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Assessing the Relative Importance of an E-learning system's Usability Design Characteristics Based on Students' Preferences

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Abstract: This study considers the interaction between an e-learning system, the Blackboard system, and the students who use it in Saudi Arabia. While previous work exists, there is limited consideration of the assessment of the preferences of e-learning system usability variables based on students' perspectives, especially in developing countries such as Saudi Arabia. This paper attempts to fill the gap by investigating the relative importance of the design criteria developed for e-learning system usability evaluation from the students' perspective in Saudi tertiary education. Based on reviewed literature, a set of usability principles was developed that have had an influence in the students' learning process and use of the e-learning system. The list includes system navigation, system learnability, visual design, information quality, instructional assessment and system interactivity. An exploratory study was carried out to identify the most important usability design characteristics from a student's perspective and then evaluate the overall usability of the current e-learning system, based on this subset. A quantitative approach was adopted to weigh usability design characteristics, based on 181 learners' perceptions. The sample consists of undergraduates who are users of a web-based e-learning system in a university in Saudi Arabia. The research instrument was tested for construct validity and reliability. The analysed results have shown that information quality is the most important dimension followed by the navigation of the e-learning system. The study has also revealed that the system learnability and visual design came third and fourth in order of importance of e-learning system usability assessment. Finally, the least important design categories that influenced the e-learning system usability assessment were instructional assessment and system interactivity. The empirical results of this study may help to provide insights for designers and evaluators leading to a more effective approach to improve the usability and uptake of the e-learning system.

Keywords: *E-learning system, higher education, usability evaluation, usability principles preference, Saudi Arabia.*

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Introduction

Usability is a quality attribute of users' experiences when interacting with interactive technologies, that assesses the easiness of the user interface (Preece, Rogers, & Sharp, 2015). The usability assessment task is concerned with system usability problem identification with a view to interface improvement and enhancements for its potential users (Ssemugabi & De Villiers, 2007). In an educational context, learners regarded the usability of the e-learning system interface as being the most significant attribute for utilization where high level interactions occur (Shee & Wang, 2008). In line with that, usability is considered one of the most important quality factors for evaluating the quality of the e-learning system user interface (Dix, Finlay, Abowd, & Beale, 2003).

Many studies have assessed the usability of e-learning systems to determine the relative importance of usability of design features that are needed in the evaluation of educational portals (Hasan, 2014; Mustafa & Al-Zoua'bi, 2009). The emphasis on the characteristics for assessing website usability stems from the fact that the design principles offer a specific insight into areas of weakness and strength in a given environment (Agarwal & Venkatesh, 2002). In fact, not all usability principles are equally important for users using the e-learning system (Agarwal & Venkatesh, 2002). In Saudi Arabia, the Blackboard system has been widely and recently adopted across higher education institutes (Ministry of Education Saudi Arabia, 2019). Nonetheless, in the Saudi universities, the majority of students are still unwilling to use

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e-learning systems (Alenezi, Abdul Karim, & Veloo, 2011). The usability factors appeared to significantly influence the e-learning system usefulness, functionality, interactivity and ease of use (Alenezi, Abdul Karim, & Veloo, 2011). Salloum and Shaalan (2019) reported that developing countries have failed, fully or partially, to implement e-learning systems effectively. Thus, it is essential to examine the most influential design principles that affect Saudi students when they use an e-learning system for learning. The goal is for designers and evaluators to draw upon specific design metrics to improve the usability of the website design (Agarwal & Venkatesh, 2002).

While data from several sources have been used to measure the usability of e-learning systems, few have been used to evaluate the usability design characteristics in the Saudi context. Studies into the relative importance of usability design characteristics have been conducted across various domains, such as commercial portals and financial services (Tarafdar & Zhang, 2005); online auction and shopping websites (Calisir, Elvan Bayraktaroğlu, Altin Gumussoy, İlker Topcu, & Mutlu, 2010); e-commerce websites (Pearson, Pearson, & Green, 2007); educational portals (Hasan, 2014); social networking sites (Ellahi & Bokhari, 2013); e-commerce and medical websites (Cebi, 2013; Zhang, von Dran, Blake, & Pipithsuksunt, 2001). However, there is a dearth of research conducted to investigate the relative importance of e-learning systems especially in the context of an expanding Saudi higher education. As Agarwal & Venkatesh (2002) argued, not all design criteria are equally important to diverse groups of users. Thus, this paper will address the gap in prior studies and examine students' preferences of the e-learning usability variables in Saudi Arabian higher education. The e-learning design criteria that will be tested with Saudi students were adapted from several sources (Dringus & Cohen, 2005; Oztekin, Kong, & Uysal, 2010; Reeves et al., 2002; Zaharias, 2009). It is worth mentioning that these developed variables have been extensively validated in prior studies with regard to different e-learning systems. The goal here, however, is to study and examine the preference of the most important variables that have an influence on the students' use of e-learning system. Based on the study findings, an e-learning system designers can draw upon specific design characteristics to improve the system.

Literature Review:

This section reviews prior research that examined the usability design characteristics, emphasising the relative importance of the key design characteristics for different web-based applications from a user's perspective. Agarwal & Venkatesh (2002) investigated the relative importance of design guidelines with 1,475 users across four different industry sectors: airlines, online bookstores, automobile manufacturers, and car rental agencies. The set of heuristics was employed from the Microsoft Usability Guidelines (MUG), emphasising five website features: content, ease of use, promotion, made-for-the-medium and emotion. The results indicated that content was the most important category of all other sectors. The second most important variable was ease of use followed by promotion, made-for-the-medium and emotion.

Research done by Pearson, Pearson, & Green (2007) investigated the relative importance of five key usability criteria for the assessment of web usability in e-commerce websites from the point of view of undergraduate students. The design dimensions were personalization, accessibility, navigation, download speed and ease of use. The most striking observation emerging from the data analysis was that navigation and ease of use were the most significant design criteria in the explained variance of web usability. Personalization was the least important in determining the website's usability. Pearson et al. (2007) underline the importance of understanding the target audience preferences about the design characteristics. The understanding of the preferences will in turn will increase the usage of the web-based application.

Likewise, Calisir et al. (2010) investigated the relative importance of the usability and functionality factors for online auction and shopping web sites. The usability sets examined in this study were learnability, navigation, interaction, memorability, response time, ease-of-use, efficiency and satisfaction. The functionalities were security, user guidance, search options, information provision, services/facilities and customisability. Usability factors were more influential than functionality factors from the consumers' perspectives. In particular, navigation and interaction features were classified as being of utmost importance in the website evaluation.

In an educational setting, Hasan (2014) examined the relative importance of the design characteristics of educational portals. The author carried out a usability investigation of nine universities' websites from a student's perspective, in which the user-based inquiry method was adopted. Results found that usability metrics such as content, navigation and support of the Arabic language were the priority of students' preferences in this evaluation. Organizational architecture

and communication had received the least attention and students expressed dissatisfaction with these aspects of the design.

For e-learning systems, Zaharias & Koutsabasis (2011) conducted a comparative study of two sets of e-learning usability heuristics proposed by Mehlenbacher et al. (2005) and Reeves et al. (2002). In the Reeves et al. (2002) set, the important heuristics were visibility of system status, interactivity and learning design. Conversely, error prevention, help and documentation were less important to participants in the Reeves et al. (2002) model. In the Mehlenbacher et al. (2005) study, the most significant variables were accessibility, navigability, user control, error tolerance and flexibility as well as readability and quality of writing. Error support and feedback and communication protocols were less important in the Mehlenbacher et al. (2005) study. As can be seen, some variables can be regarded as more significant in one setting and less important in another.

A seminal study in this area is the work of Oztekin, Kong, & Uysa (2010) who draw on a Dringus & Cohen (2005) idea to produce a novel usability model (UseLearn) for e-learning systems. The study provided a categorisation of items that were found to be important and to yield the most critical and problematic usability issues in e-learning evaluation, so a usability analyst could start dealing with the classification based on their order of importance. Error prevention items stood out as being the most critical items whereas consistency and functionality were regarded as the least important questions. Overall, the checklists not only picked up significant usability problems in the e-learning system but also provided a priority ranking of them based on their importance.

Overall, the discussed literature highlights the importance of identifying appropriate design principles of user interfaces that correspond to various systems and contexts. The central key in this research is the identification and prioritisation of design features that are closely tied with actual users of the e-learning system. This study, therefore, attempts to elicit students' perceptions of the most important design characteristics of an e-learning system recently introduced to the Saudi Arabian university sector and prioritise them according to their influence on usability evaluation.

Categories and Subcategories:

There are in total six usability and instructional criteria used in the study described in this communication. The identified usability parameters stem from an extensive review of prior studies that investigate the usability of e-learning systems and instructional design guidelines (Dringus & Cohen, 2005; Oztekin et al., 2010; Pituch & Lee, 2006; Reeves et al., 2002; Squires & Preece, 1996; Zaharias & Poylymenakou, 2009). The following describes the usability criteria and their subcategories:

System Navigation (SN): navigation quality concerns the visible navigational structure such as menus and links that grant learners many options over the system elements. The navigation attribute will be measured by five subcategories including, *ease of use*: the students' perceptions of the easiness of using e-learning system navigation; *navigation support*: navigation options are visible in each page so that learner does not have to remember information when navigating from one part of the system to another; *reliable links*: the correctness and reliability of the e-learning system hyperlinks; *clear sequence*: the clarity of the sequence of the screens so students know where they have come from and where they are going to; *leave and access easily*: the ability of students to leave whenever desired and return easily to the closest logical point in the course. The measurement scales were adapted from several studies that were conducted on e-learning systems (Horton, 2000; Reeves et al., 2002; Zaharias & Poylymenakou, 2009).

System Learnability (SL): learnability is related to the ease and speed with which the users learn how to use an e-learning system. It is important to mention that there is a lack of a set of well-accepted measurement items for evaluating learnability (Grossman, Fitzmaurice, & Attar, 2009). However, various measurement items have been developed across many domains. Since the e-learning system is the focus of this research, the presented measurements have been collected from the e-learning systems domain. In this research, the learnability factor consists of five subcategories. The measurements include, *ease of learning*: the ease of learning performing tasks using the e-learning system; *links predictability*: the results of clicking buttons or links is predictable; *using without long introduction* the use of the system without a long introduction; *wording clarity* the capability of the e-learning system to provide clarity of wording; *sufficient online assistance* the sufficiency of the e-learning system online help to support the learning process. These instruments were adapted from various papers (Holden & Rada, 2011; Horton, 2000; Lin, Choong, & Salvendy, 1997; Scholtz, Mahmud, Mahmud, & Ramayah, 2016; Zaharias & Poylymenakou, 2009).

Visual Design (VD) : this attribute focuses on the aesthetic aspects of the system through considering the effects of images, colours, fonts and general layouts (Usability.gov, 2013). It also measures consistency; the extent to which structure, graphic themes and design are used and distributed consistently across the e-learning system. This factor comprises six subcategories that relate to the visual structure and design of the e-learning system. The subcategories are *readability*: the texts, fonts, colours are easy to read; *aesthetic design*: the e-learning system visual design is attractive and appealing to the learner*; informative layout*: the most important information on the screen is placed in the areas most likely to attract attention; *terminology, fonts, colour and consistency*: terminology, symbols and icons are used consistently throughout; *overall consistency*: the capability of the e-learning system to operate consistently throughout the e-learning system courses; *layout structure*: the e-learning system layout follows a good layout structure. The items were adapted from several questionnaires (Cho, Cheng, & Lai, 2009; Dringus & Cohen, 2005; Reeves et al., 2002; Zaharias & Poylymenakou, 2009).

Information Quality (IQ): this construct assesses whether the e-learning system includes the information that learners require i.e. the quality of information that is displayed by the e-learning system. In this context, five items were evaluated in relation to the e-learning system information quality including: correctness, relevancy, coverage, appropriateness and timeliness (Orehovački, Granic, & Kermek, 2013). *Information correctness* refers the extent to which e-learning system content is correct, and free from semantic or syntactic errors. *Information relevancy* signifies that the content of e-learning system is adequate and relevant for students' learning and is not overwhelming. *Information coverage* dimension is concerned with the completeness and clarity of the e-learning system content. *Easy to understand* information is concerned with the students' perceptions of the easiness to understand e-learning system content. The final subcategory is *information timeliness* which refers to the extent to which information is current, and up-to-date for students' learning. All the measurements have been validated in previous studies and adapted from (Gable, Sedera, & Taizan, 2008; Orehovački et al., 2013; Zaharias & Poylymenakou, 2009).

Instructional Assessment (IA): this is concerned with e-learning system instructional assessment that facilitates the students' learning activities through the use of various useful tools including: test, quizzes, surveys, electronic submission of assignments and the grade book. The construct also includes the e-learning system feedback facility to the online assessment. Instructional assessment comprised six subcategories. *Assessment tools effectiveness*: the e-learning system contains self-assessment tools (i.e. exams, quizzes, case studies… etc.) that advance achievement; *Assessment tools ease of use*: it is easy for me to use the e-learning system self-assessment tools; *achievements of learning objectives:* the e-learning system self-assessment tools adequately measure my achievements of learning objectives; *understanding the materials*: e-learning system assessment features are effective to help me understand the materials; *instructional feedback*: the e-learning system provides learners with opportunities to access extended feedback from instructors, experts, peers, or others; *Informative feedback*: the e-learning system provides informative feedback to online assessments. All the measurements were validated in previous studies and adapted from (Oztekin, Nikov, & Zaim, 2009; Reeves et al., 2002; Zaharias & Poylymenakou, 2009).

System Interactivity (SI): Interactivity concerns the e-learning system collaborative tools that facilitate the interaction among students and between students and instructors. Interactivity has four subcategories including: *effectiveness of communicational tools*: the students' perceptions of the effectiveness of the functionalities such as announcements, mail, chat and discussion that are used as a convenience to communicate course matters and support instructional tasks; *instructor-student communication*, the extent to which the e-learning system enables interactive communication between instructor and students; *student-student communication*: the extent to which the e-learning system enables interactive communication among students; *engaging interaction*: the e-learning system makes the learning process more engaging and motivating. The measurement items were adapted from (Moreno, Cavazotte, & Alves, 2017; Oztekin et al., 2010; Pituch & Lee, 2006; Zaharias & Poylymenakou, 2009).

Methodology

Research Instruments

The final list consists of six usability parameters which have been carefully selected based on the literature review on e-learning system usability evaluation. These variables have been used and validated extensively in prior studies of e-learning system evaluation (Dringus & Cohen, 2005; Oztekin et al., 2010; Reeves et al., 2002; Zaharias & Koutsabasis, 2011; Zaharias & Poylymenakou, 2009). A single research instrument employing all dimensions with all sub-item questions for the e-learning system usability evaluation is problematic in terms of the numbers of questions involved (Oztekin et al., 2010). Thus, it was attempted to decrease the number of dimensions by deselecting variables that

measure similar concepts as suggested by Oztekin et al. (2010). The measurement items were then adapted to relate to an e-learning system. All survey items were translated from the English version of the original survey into Arabic. The process of translation was done by bilingual professors to ensure linguistic equivalence and that the items of the survey remained accurate.

In the literature, it is claimed that most usability studies contain many overlapping items. As a result, methods and checklists could be merged to generate a customised method in the specific e-learning context (Oztekin et al., 2010). Although the terms of usability dimensions can be different across studies, they refer to the same or related concepts that address the same or similar e-learning issues (Oztekin et al., 2010). It is worth mentioning, however, that in the literature, some of the usability principles have subcategories in which there are items that represent various aspects of the major categories. It is important to highlight also that the draft checklist used in this research is not all inclusive, and new or revised factors could be enhanced. Nevertheless, the developed list is considered important in e-learning system usability evaluation, so it will be further assessed regarding content and item validity.

To realize the study aim, two surveys were conducted. The first survey (relative importance survey) is concerned with weight allocation for the developed usability categories and subcategories as suggested by Agarwal and Venkatesh (2002). The second survey (the e-learning system ratings survey) is designed to obtain students' perceptions about the rating of the e-learning system against its compliance with various categories and subcategories of the developed model.

The questionnaire was divided into four main sections. The first section included information about the respondents' characteristics, such as gender, age, educational level and academic discipline. Demographic data was collected to obtain descriptive statistics about the study sample. The second section asked students to report the frequency with which they use an e-learning system. It garners data about students' previous experience of an e-learning system, training and development courses received and the current students' usage experience. The third section of the questionnaire served to identify the relative importance (weight) to them of the usability category identified and subcategory. The fourth section was about the rating of each categories and subcategories. This section comprises 31 items divided into six subscales using a five-point Likert scale. Acquiring a higher score in self-reported rating of usability characteristics indicates a perceived higher importance among students when using the e-learning system.

Procedure

The approach for assessing the relative importance (weights) of usability measurement items was adopted from the Agarwal & Venkatesh (2002) paper. University students were invited to participate in the study. A check was made to ensure that all students were frequent users of the e-learning system. Four sessions were organised to welcome students to explain the aim and objectives of the study. Due the requirement of female segregated colleges in Saudi education, a female lecturer facilitated the study in the female colleges. The participants were prompted to fill out the questionnaire. The relative importance (weight) of usability variables of 6 categories was assessed (Table 1).

The procedure is to divide 100 points between the individual usability variables. Within each variable, the variables points are then divided across the various subcategories (Agarwal & Venkatesh, 2002). Thus, two surveys were developed based on weights and rating: the first survey requested the learners to provide the importance (weights) of the different usability criteria for which he/she distributes 100 points across the six categories (Table 1) and then the student further subdivides category allocation points into the corresponding subcategories (Table 4). The more important a particular category is for a student, the more points they should assign to it. In order to explore the relative importance value (weights) assigned to each usability category and their subcategories, the average weight was estimated.

A second survey (e-learning system rating survey) was developed to elicit students' perceptions about the ratings of each criterion based on the conformance of the e-learning system to usability subcategories. Following the allocation of weights, the ratings were obtained for those usability variables and their sub-items. Respondents rated different usability variables. The rating of the e-learning system was assessed against compliance with each usability category and subcategory (Table 5). All items in the rating questionnaire were measured on a five-Point Likert scale and respondents were requested to indicate their extent of agreement with the statements from 1 to 5 (1= strongly disagree to 5= strongly agree).

In order to calculate the usability score for the e-learning system, the given weight (average of the subcategories) was multiplied by the rating of the site (the Likert score of each subcategory). Then the computed usability scores stemming

from the previous step were added up to form the overall usability value for the system. The total usability value was evaluated considering the six major usability categories against students use of the e-learning system.

The process of data collection was carried out over two weeks. The data were gathered in the first academic semester of 2018-19 from King Khalid University "KKU" which is the largest university in the Southern Province of Saudi Arabia. Participation in this investigation was voluntary and undergraduates did not gain course credit or extra grades for participating. Financial incentives were not offered in this research. Using this approach, researchers have been able to quantitatively evaluate the usability characteristics and rate them according to various subcategories (Agarwal & Venkatesh, 2002; Hasan, 2014). The combination of weights and ratings is employed to evaluate the overall usability criteria. The final calculated number constitutes the usability metric of the e-learning system (Table 5).

Table 1. The instruction regarding the weight of the relative importance survey

Instructions for allocating weights to the six usability principles			
The table illustrates the explanation of each usability category. Please allocate 100 points, which represent weights, across the six major categories based on their importance in the evaluation of the usability of an e-learning system. The more important the category, the more points you allocate to it. For example, if interactivity is the most important category then give it a higher weight.			
No.	**Criteria**	**Explanation**	**Weight**
1	***System Navigation (SN)***	The extent to which the navigational tools (e.g. menus and links) facilitate the learner to navigate through a site and enable them to locate specific content items and instructional elements quickly	
2	***System Learnability (SL)***	This construct is related to the ease and speed with which the users learn how to use an e-learning system.	
3	***Visual Design (VD)***	This attribute focuses on the aesthetic aspects of the system through considering the effects of images, colours, fonts and general layouts as well as the system overall consistency.	
4	***Information Quality (IQ)***	This assesses whether the e-learning system contains the information that learners require.	
5	***Instructional Assessment (IA)***	This is related to the ease and efficiency of the e-learning system assessment tools including, test, quizzes, surveys, electronic submission of assignments and the grade book.	
6	***System Interactivity (SI)***	This is related to the collaborative tools that facilitate the interaction between students and the e-learning system.	

Construct validity

The list consists of six major usability categories. The measures have been carefully selected based on the discussed literature review and theories on the e-learning systems usability evaluation. However, the refinement of the items and the final selection of usability constructs and their items were accomplished in two phases. The first phase was conducted with experts in the field and the other with targeted participants. As Kline (2016) advised, the opinion of experts is the basis for establishing the construct validity, not the statistical analysis. The assistance of four usability experts from the UK and Saudi Arabia was sought to obtain construct validity. The academics involved in the questionnaire evaluation were 4 professors: 2 in a Computing School in the UK, a scholar from a university in Saudi Arabia and an expert from a Usability Lab in industry. The received insights and suggestions substantiated that the items labelled were consistent with the construct and indicators label. In the second phase, the researcher also considered how students might interpret the questionnaire items. 45 students were gathered to evaluate the questionnaire and ensured that the meaning is consistent with the conceptual value of the construct. Feedback and comments about the survey layout and question ambiguity were taken into consideration. Overall, there was high

degree of consistency among students about the constructs and their measurements. Therefore, based on the examination conducted in the previous two phases, the domain was adequately measured, and the researcher believed that the content validity was established.

Participants/ Sample

The target sample for this study was taken from students in Saudi higher education. Most of the students' sample have used the e-learning system in their studies. The questionnaires of the study were distributed to undergraduates in multiple campuses at one of the largest academic institutions in the Southern province of Saudi Arabia. The researcher used the convenience sampling technique. Convenience sampling relies on data collection from members who are accessible to the researcher (Bryman & Bell, 2015). In convenience sampling, the subjects are selected based on easiness and participant availability, so the first available primary data source will be recruited. Several faculties were involved in this study including Computer Science, Art and Humanities, Applied Medical Science, Medicine, Natural Science. By the end of the study period, a total number of 250 questionnaires were collected. However, there were 69 questionnaires either incomplete or invalid or presented with a data pattern, such as giving one answer to all items. Those instances had to be discarded before the process of data analysis. There were 181 final usable questionnaires used for further analysis, indicating an overall response rate of approximately 72%. A consent form was filled in by all participants and personal data protection and anonymity were guaranteed.

E-learning System in Saudi Arabia

Most Saudi universities are equipped with a Blackboard system as the main application for learning and teaching. Recent statistic indicated that Blackboard is by far the most prevalent LMS in Saudi higher education, used by 90% of kingdom public universities (Aldiab, Chowdhury, Kootsookos, Alam, & Allhibi, 2019). The system empowers tutors with the tools they need to administer and track the progress of students' performance throughout the entire educational cycle. It can also be used to set up courses, prepare assignments, report grades and give feedback. The system offers students a means whereby they can access different online materials, communicate with their course coordinator and individually study theoretical and practical courses online regardless of time and geographical constraints. Also, learners can employ the system to track their progress, submit assignments and check their grade and evaluation. Many studies have been conducted to evaluate the use of an e-learning system. Few have been focused on the Saudi Arabian context (Bouznif, 2018).

Results

Demographics Analysis of Respondents

The Table 2 below illustrates the frequency distributions for all profiles of the participants. The IBM Statistical Package for Social Sciences (SPSS) was used for the statistical analysis. SPSS software provides basic to advanced functions including, frequencies, reliability analysis and bivariate statistics. It is a powerful tool for manipulating and deciphering survey data (Pallant, 2016).

The population comprised 43.6% females (79 respondents) and 56.4% males (102 respondents). Around 60% of those who were surveyed indicated that they study natural and medical sciences whereas the remaining 40% are from humanities and applied science.

In the age group, a continuous measure was used. The main age group ranged from 18 to 25 years old, representing 87.3% (158 respondents) of the total study sample. The remaining 12.7% corresponds to the more senior age groups, 26-36 years old.

Regarding the educational level, the undergraduate represents 97.2% % (176 respondents), while the postgraduate only 2.7% (5 respondents). Thus, the results of age and educational level were as anticipated, as undergraduates constitute the majority in Saudi tertiary education (Ministry of Education Saudi Arabia, 2019).

In terms of e-learning system experience, around 70% (126 students) had had previous experience of using the e-learning system ranging between 1 and 7 years of the system use. However, 26% of students reported that they had been using the e-learning system in their course for less than a year whereas the minority of students (3.9%) reported their limited use of the system. The descriptive statistics also showed that the majority of students had had no previous training in the use of the e-learning system (83.4%) while a minority (13.8%) reported some training (1-5 and 5-10 hours). Regarding the usage of the e-learning system, 76.3% acknowledged that they are frequent users, while 23.7%

regarded their use of the system as occasional as shown in Table 2. By the end of the survey period, a total of 181 students had fully completed their responses.

Table 2. The demographic characteristics of the sample

	Frequency	***Percentage***
Gender		
Male	102	56,4
Female	79	43,6
Total	181	100
Major		
Humanities	34	18,8
Applied Science	39	21,5
Natural Science	46	25,4
Medical Science	62	34,3
Total	181	100
Usage Experience		
< 1 year	47	26
1 - 3 years	71	39,2
3 - 7 years	56	30,9
Don't use but I know it	7	3,9
Total	181	100
Training		
None	151	83,4
1 - 5 hours	20	11
6 - 10 hours	5	2,8
> 10 hours	4	2,2
Total	181	100
Frequency of Use		
always	72	39,8
regularly	66	36,5
sometimes	33	18,2
rarely	10	5,5
Total	181	100

Learners Assessment of Usability

The first part of the analysis is the reliability analysis. For the measurement of the internal consistency, a reliability coefficient of Cronbach Alpha was utilised to determine the reliability of the questionnaire. The reliability assessment of the measurement model ranges between 0.859 and 0.920 in which all variables were greater than the recommended benchmark value of 0.70 (Hair, Black, Babin, Anderson, & Tatham, 2010). This indicates that the proposed scale is well-constructed. The overall reliability statistics for all items is 0.971 which suggests that the variables are robust in terms of their internal consistency (see Table 3).

Table 3. Cronbach's Alpha Reliability Results

Construct	**Cronbach's Alpha**	**N of Items**
System Navigation (SN)	0,859	5
System Learnability (SL)	0,9	5
Visual Design (VD)	0,885	6
Information Quality (IQ)	0,92	5
Instructional Assessment (IA)	0,898	6
System Interactivity (SI)	0,885	4
Overall Reliability	0,971	31

The second part of analysis includes the calculation of the relative importance of the e-learning system design characteristics from the students' perspective in Saudi higher education. By utilizing the analytical functions included in Microsoft Excel, the researcher was able to compute the weights of each category. The results obtained from the respondent's allocation points for the most important category and subcategory are shown in Table 4. What stands out in the table is that information quality has the highest weight (19.27). The second most important category was

attributed to the navigation dimension (18.86) followed marginally by learnability category (18.21), next e-learning system visual design (17.88), instructional assessment (16.1) and interactivity came (9.68) fifth respectively in the most significant categories. From this data, we can see that the interactivity parameter resulted in the lowest weighted value indicating that it is the least important category among the participants.

The table also illustrates the subcategories scores. It can be seen that a variety of perspectives were expressed in the subcategories scores. Overall, the maximum value of subcategory was attributed to e-learning system information relevancy (4.08), whereas the minimum value was for student-student communication (2.11) in the interactivity dimension. It is apparent from the data that navigation support, clarity of wording, aesthetic design, information relevancy, assessment tools ease of use and effectiveness of communicational tools merit the most significant properties in their corresponding categories. In contrast, clear sequences, learning without long introduction, informative layout, information timeliness, understanding the materials and student-student communication were the least important subcategories, as illustrated in Table 4.

Table 4. The relative importance (weights) for the categories and subcategories

Categories	Subcategories	Weight	Total Weights for Each Category
System Navigation	ease of navigation	3,91	18,86
	navigation support	4,01	
	reliable links	3,74	
	clear sequence	3,4	
	leave and access easily	3,8	
System Learnability	ease of learning	3,93	18,21
	links predictability	3,39	
	learning without long introduction	3,11	
	clarity of wording	3,96	
	sufficient online assistance	3,82	
Visual Design	readability	2,82	17,88
	aesthetic design	3,3	
	informative layout	2,22	
	terminology & fonts consistency	3,11	
	layout structure	3,18	
	overall course consistency	3,25	
Information Quality	Information correctness	3,88	19,27
	Information relevancy	4,08	
	Information Coverage	3,93	
	Ease to understand Information	3,77	
	information timeliness	3,61	
Instructional Assessment	Assessment tools effectiveness	2,88	16,1
	Assessment tools ease of use	3,01	
	achievements of learning objectives	2,46	
	understanding the materials	2,25	
	instructional feedback	2,67	
	Informative feedback	2,83	
System Interactivity	effectiveness of communicational tools	2,81	9,68
	instructor-student communication	2,54	
	student-student communication	2,11	
	engaging interaction	2,22	
Total Weights			100

In this study, the overall usability of the e-learning system is presented in Table 4. The overall usability rating is the total of the products of the subcategory weight and the assigned rating. All students assigned a rating between 1 and 5 to each usability subcategory, indicating whether or not it applied to the e-learning system. The maximum rating is the subcategory weight multiplied by 5. As shown in Table 4, the overall usability score of the e-learning system is 343. This indicates that the majority of Saudi students considered the e-learning system to be a usable system. Still, some issues were raised regarding some problems of the lack of utilization of e-learning system functionalities.

Table 5. Illustration of the use of weights and ratings in determining usability

Categories	Subcategories	Weight	Total Weights for Each Category	Assigned Rating	Weighted Rating	Maximum Rating
System Navigation	ease of navigation	3,81	18,86	3,65	14	19,55
	navigation support	4,01		3,25	13	20,05
	reliable links	3,74		3,29	12	18,7
	clear sequence	3,4		3,52	12	17
	leave and access easily	3,8		3,72	14	19
System Learnability	ease of learning	3,93	18,21	3,51	14	19,65
	links predictability	3,39		3,33	11	16,95
	learning without introduction	3,11		3,25	10	15,55
	clarity of wording	3,96		3,48	14	19,8
	sufficient online assistance	3,82		3,92	15	19,1
Visual Design	readability	2,82	17,88	3,83	11	14,1
	aesthetic design	3,3		3,61	12	16,5
	informative layout	2,22		3,48	8	11,1
	terminology & fonts consistency	3,11		3,35	10	15,55
	layout structure	3,18		3,43	11	15,9
	overall course consistency	3,25		3,3	11	16,25
Information Quality	Information correctness	3,88	19,27	3,51	14	19,4
	Information relevancy	4,08		3,33	14	20,4
	Information Coverage	3,93		3,25	13	19,65
	Ease to understand Information	3,77		3,48	13	18,85
	information timeliness	3,61		3,12	11	18,05
Instructional Assessment	Assessment tools effectiveness	2,88	16,1	3,83	11	14,4
	Assessment tools ease of use	3,01		3,61	11	15,05
	achievements of learning objectives	2,46		3,48	9	12,3
	understanding the materials	2,25		3,35	8	11,25
	instructional feedback	2,67		3,44	9	13,35
	Informative feedback	2,83		3,26	9	14,15
System Interactivity	effectiveness of communicational tools	2,81	9,68	2,9	8	14,05
	instructor-student communication	2,54		3,07	8	12,7
	student-student communication	2,11		2,82	6	10,55
	engaging interaction	2,22		3,24	7	11,1
Overall Rating					343	500

Discussion

The aim of this research is to assess the relative importance of usability design characteristics in the evaluation of an e-learning system from a students' perspective in Saudi higher education. This study proposed a set of usability variables and assessed their importance with regards to the e-learning system. Students allocated weights to each category and then distributed the score across corresponding subcategories. This illustrates the most important as well as the least significant measures that should be taken into account when evaluating the usability of an e-learning system. It is worth mentioning that there is a lack of published research observed in the importance of usability variables in an educational setting. Hence this research attempted to fill this gap. This research contributes to the field of e-learning system

usability evaluation by revealing the most prevalent factors for usability in the e-learning environment in the context of Saudi Arabian higher education.

The study found information quality to be the most important variable that influenced the usability of the e-learning system across all attribute categories. The results match those observed in earlier studies that the information quality dimension plays a significant role in e-learning system usability evaluation (Bringula & Basa, 2011; Hasan, 2014; Noorulhasan, Muhammad, Sanober, Rafik, & Shah, 2017; Zaharias & Poylymenakou, 2009). Hasan (2014) found that content was perceived as the most important quality from a students' perspective. Also the Zaharias & Poylymenakou (2009) analysis found that the content factor explained 36% of the variance, signifying its importance in the assessment of e-learning acceptance and use. Wu et al. (2009) revealed that e-learning system information quality increases a user's behavioural intention to use the system. It was also shown that e-learning system information content significantly affected website usability (Bringula & Basa, 2011). In Saudi higher education, e-learning system information clarity and currency were found to be significant factors for the successful use of an e-learning system in Saudi Arabia (Noorulhasan et al., 2017). Therefore, e-learning system information relevance, completeness, accuracy, coverage and timeliness are all critical characteristics for the successful use of an e-learning system.

System navigation emerged as the students' second most important category in the evaluation of an e-learning system in Saudi tertiary education. Elsewhere, system navigation was found to be the second most important category that influences students' use in educational settings (Hasan, 2014). The findings also corroborate the ideas of Pearson et al.(2007), who suggested that navigation was among the most important design criteria in the explained variance of web usability. In the same vein, Calisir et al. (2010) attempted to investigate the relative importance of the usability and functionality factors and found navigation and interaction features to be the most important in the website evaluation. Asarbakhsh & Sandars (2013) highlighted that navigation should be one of the primary factors to be included in the usability evaluation of e-learning systems. In a dual study that evaluated e-learning systems' usability, this attribute was found to be the major obstacle that distracts students from achieving their goals (Guo, Wang, Moore, Liu, & Chen, 2009; Tee, Wook, & Zainudin, 2013). There is a direct link between the ease of navigation and the success of use of any website (Fang & Holsapple, 2007; Oztekin et al., 2009). Effectively navigating the architecture of an e-learning system is viewed as a vital condition that students encounter when they set out to accomplish learning tasks (Koohang & Du Plessis, 2004; Triacca, Bolchini, Botturi, & Inversini, 2004; Van Nuland, Eagleson, & Rogers, 2017). Furthermore, students perceptions of usability formed the central focus of a study by Selim (2007) in which the author found that navigation in an e-learning system impacted the decision to adopt and use the e-learning system. Overall, the correctness of navigation buttons, menu, site map, movement buttons (forward, backward, and exit) and links are significant elements for the students' effective use of an e-learning system.

The results revealed that e-learning system learnability was the third most important category among students in Saudi tertiary education. A consensus among researchers has been reached regarding the importance of learnability in usability assessment (Dix et al., 2003; Nielsen, 1993; Shneiderman, 1997). In particular, most researchers acknowledge that learnability is particularly important in an e-learning system due to the system complexity, intricate pedagogy and the diversity of users (Kiget, Wanyembi, & Peters, 2014; Scholtz et al., 2016; Thowfeek & Salam, 2014). Kiget et al. (2014) found a positive significant relationship between learnability and usability, signifying that learnability is an important indicator for the usability assessment of an e-learning system. Besides, the value of the learnability parameter was shown to exhibit the highest score in the students' assessment of an e-learning system (Thowfeek & Salam, 2014). These lines of evidence support the importance of learnability in e-learning system evaluation. Learnability problems result in additional training courses, personnel, support and maintenance cost (Lindgaard, 1994). Generally, the ease of learning, the sufficiency of the user manual and the clarity of wording not only improves the learnability of the e-learning system but also decreases users' mental load.

Our findings indicate that the system's visual design was the fourth most important usability category in the evaluation of the e-learning system. This contrasts with studies elsewhere (for example, Zaharias and Poylymenakou (2009) and Reeves et al. (2002)). Simple, flexible and consistent interface design with control tool bars and menus will promote accessibility and add further enhancement to the e-learning system's usefulness (Cho et al., 2009). Lanzilotti et al. (2006) proposed that the right combination of text and graphic features inspires students to stay longer in the e-learning course and explore it further. The choice of colour in the e-learning system not only captures learners' attention but also improves the learnability and ease of use (Zaharias, 2009). It was also revealed that the success of an e-learning system depends largely on the visual presentation of the tools, content and support (Kirsh, 2014). Furthermore, Thuseethan et al. (2014) revealed that visual inconsistencies in an e-learning system design resulted in

chaos and lack of interaction from the students' perspective. Elsewhere, also in contrast to this study, in the Saudi Arabian context, the e-learning system visual design was found to be a critical success factor for implementation and the use of an e-learning system with user-friendly items being the *most* significant factor for the successful use of e-learning (Noorulhasan et al., 2017). Even though students regarded visual design as the fourth most important category, the differences are marginal compared with learnability and navigation dimensions (17.88, 18.21 and 18.68 respectively). Therefore, the e-learning system's aesthetic appeal only *to some extent* affects engagement, ease and motivation and can draw e-learners' attention and improves the learner's retention and success.

Instructional assessment came as the fifth most important design category in the e-learning system usability evaluation. That said, the e-learning assessment tool is an indispensable element in the students' learning process. E-learning system online assessment facilitates the students' learning activities through the use of various useful tools including: test, quizzes, surveys, electronic submission of assignments and grade book (Martin, 2013). In a survey that evaluated the usefulness of Blackboard features, students rated the assignments function as the most important followed by the gradebook function (Martin, 2013). In a usability study of the Moodle platform, teachers valued the grading mechanism as it is more cost-effective compared to the paper test format and were more satisfied with the Moodle assignment quality (Ivanovic et al., 2013). However, the assessment tools of Moodle received several negative remarks, especially regarding the tool's utilization and value from students' point of view. Likewise, Storey et al. (2002) evaluated Blackboard assessment features using a questionnaire based method. Blackboard online quiz and assignment submission facilities were easy to use and effective from the student's perspective. However, there were some remarks about improvements especially in the system feedback. Previously, system characteristics such as instructional assessment in the e-learning system have not been considered in the previous literature and so the current paper explored the role of the e-learning system's assessment tools from the student's viewpoint in Saudi tertiary education. In this research, the presence of instructional assessment as only the fifth important in our proposed model might be explained by the fact that students were not aware of the complete assessment and feedback functionalities in the e-learning system. The e-learning system is used mainly for assignment submission and the other e-learning system features such as test, quizzes, surveys, given feedback are practically unutilised in the students learning process, thus this also might be a plausible explanation for the low rating. This finding is unexpected and suggests that the matter should be explored further in future research.

The results of this analysis show that e-learning system interactivity was the least important design category in the e-learning system evaluation. The e-learning system collaborative tools such as announcements, mail, chat and discussion not only can promote constructive and meaningful interaction among students and between students and instructors but also facilitate the interaction between students and the software (Rubin, Fernandes, Avgerinou, & Moore, 2010). It was well established that the diversified evaluation tools within the e-learning system not only stimulate students to interact with the assessment tools but also boost the students' satisfaction (Sun, Tsai, Finger, Chen, & Yeh, 2008). Prior studies have noted that the interaction that occurs in the online environment is a key not only to student learning and collaboration but also to instructors' understanding of the effectiveness of their communication (Moreno et al., 2017). Contrary to expectations, our finding did not affirm the significant importance of online communication. In this research, communication tools seem to be underutilised among students in Saudi tertiary education. In an online environment, the communication between students and instructors as well as between students appears to be deficient. Students regarded the interactivity dimension in the e-learning system as the least important. One possible explanation is that some students are enrolled in blended learning courses in which the traditional mode of face-to-face communication is dominant. Therefore, some students may take advantage of being more involved in active participation with lecturers in the face-to-face classrooms rather than being anonymous in online communication. Another possible explanation for these results may be the lack of awareness regarding the e-learning system communication functionalities among university teachers and students. This may be caused in part by the lack of training and support, for academics and students to support teaching practices using an e-learning system. In our study, nearly 84 % students have not received any training in the use of an e-learning system. This problem has been reported as a key inhibitor for successful adoption of educational technology in Saudi Arabia (Smith & Abouammoh, 2013). These results are also in accord with the study that revealed that the Blackboard chat and discussion board were underutilised and sometimes never used (Huang & Hsiao, 2012). This also was the case in the Moodle system in which the system communication capabilities were underused (Ivanovic et al., 2013). Besides, instructors tended to be reluctant to use the Blackboard chat service as a form of instant communication in online learning (Hrastinski, 2008). These differences can be explained in part by the lack of students' awareness of the e-learning system communication

tools. Overall, this research demonstrated the lack of students' experience of e-learning system communication features in Saudi higher education.

The findings also demonstrate the design subcategories effectiveness in the e-learning system. The majority of students expressed their satisfaction with the usability of the evaluated e-learning system. However, a few issues were raised regarding the lack of utilization of certain e-learning system features.

Conclusion and Limitations

This study attempted to measure students' views of what were the most important design characteristics influencing their use of the e-learning system. Although extensive research has been carried out on usability design characteristics, few writers have been able to draw on the design characteristics in an educational setting. Key here is the classification of design features that closely connect with actual users of the e-learning system. The most obvious finding to emerge from the analysis is that information quality was the most important dimension in all six categories, followed by the system navigation element. The study has also shown that system learnability and visual design came as third and fourth in importance in the e-learning system usability assessment. Lastly, the least important design categories that influenced the e-learning system usability were instructional assessment and system interactivity. This study has identified the overall usability score for an e-learning system from the student's perspective. The goal was to provide the extent to which the e-learning system complies with the developed design principles.

The present results are useful for both researchers and practitioners in two major respects. The first is to highlight the categories and subcategories that should be considered in the usability evaluation of an e-learning system. The second aspect is the assessment of how these design categories have actually affected the current students' use of the e-learning system. The ultimate aim is to improve the design of the e-learning system, acknowledging aspects that merit the attention of usability evaluators and designers looking for further enhancement. Specifically, careful consideration should be made to the usability variables while designing, evaluating or customising the e-learning system.

There are certain limitations that must be acknowledged. Although this research evaluates the importance of e-learning system usability categories and subcategories, the instrument focuses on the assessment of importance and ratings based on students' views only. The study is limited by a lack of information on other stakeholders such as academics, administrators, system developers; whose perceptions are important for a thorough e-learning system evaluation. This research has thrown up many questions in need of further investigation. The issue of inclusion of other stakeholders is an intriguing one which could be usefully explored in further research. There is also abundant room for further investigation in determining the impact of demographic differences, such as age and gender, on the developed usability variables.

Besides, future investigations could assess the effects of the proposed usability principles on the students' use of an e-learning system. Finally, further studies are needed to conduct an exploratory factor analysis of the developed questionnaire to ensure that the construct validity is adequately accomplished. This would not only help us to establish a greater degree of accuracy of the instrument but also provide empirical evidence with regards to the construct validity. Notwithstanding these limitations, the study prioritises the design categories, from the most to the least important from students' standpoints in Saudi tertiary education. The results also revealed that the overall consistency of the developed instrument is high and the content and face validity has been established. In the light of these results, the proposed questionnaire-based usability evaluation method can be utilised to improve the design of the e-learning system. In particular, the developed usability parameters could be explored further to investigate the design issues that have an impact on the student's learning outcomes. Along with the proposed inquiry-based method, efforts can employ a combination of other usability evaluation techniques, such as heuristic evaluation, with the aim of identifying the usability problems and fixing them. It is suggested that universities enhance the assessment and interactivity functions of the e-learning system. Clearly communication between students and their teachers through the e-learning system can be improved. Educational institutions would be advised to recruit personnel trained in the use of e-learning systems, supply the required applications with online/offline assistance and initiate a proper helpdesk for supporting students' academic activities. In particular, educational authorities are recommended to develop strategies for e-learning system training and tutorials offered to university learners and teachers, with a purpose of creating a more effective learning platform. It is hoped that these steps would boost students' motivation and engagement to utilize learning technologies effectively at universities.

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