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# Towards Unified Criteria for Usability Measurements in the Interface Evaluation Based on Instructional Design.

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## ABSTRACT

Usability evaluation has been implemented to validate any designed interface, in order to see how it performs. When analyzing an interface structure, typical factors to be considered are the way the information is organized and presented, and how to acquired information from the contents presented. On the other hand, the usability of a learning material can usually be verified through the user instructional interface. This paper review existing usability standards and models in determining an appropriate measurement tool for evaluating the usability of instructional interface based on the usability attributes and dimension that must be considered in the interface design. To obtain the appropriate attributes, previous researches are reviewed and compared, and analysis existing usability model in order to identify the usability criteria and characteristics for instructional interface design. From 80 related studies within the year 2018 to 2020, only 22 most relevant ones were selected through literature review. 25 usability dimensions were identified in the studies, while some of these dimensions are inbuilt of other dimensions. Hence, this study proposed an extension of the 10 factors of Quality in Use Integrated Measurement (QUIM) model as a basic dimension for usability measurement tool for an instructional interface design have been suggested.

**Keywords**: Instructional Design, interface, usability, Unified Criteria, Usability Measurements, Interface Evaluation.

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## 1. INTRODUCTION

Usability study has gained an increase attention in present-day interface design. It has been amalgamated in the design and development procedure of many recently published instructional design applications (Sieber, & Slonosky, 2019; Eltahir,2019, Briggs,2018). It is important to provide bases and further improving the quality of the instructional interface. Several factors associated with the challenged of usability evaluation (Shneiderman & Plaisant, 2005), such as evaluation plan and the life cycle design phases; nature of the application; originality of the project; estimate the

particular users; required developers and evaluators with experience in usability evaluation strategies; significant role of the interface in interactive processes; allocated budget for evaluation; and time constraints. Accordingly, the usability of any developed application can be verified through the user instruction interface (Abdulrauf, Ariffin & Sobihatun, 2019). Many usability methods have been introduced, such as Metrics for Usability Standards in Computing (MUSIC), Automated Interface Designer and Evaluator (AIDE) and Evaluation of program impact, output or Product Evaluation. Moreover, in model such as the Diagnostic Recorder for Usability Measurement (DRUM), and the Skill Acquisition Network (SANe), nevertheless all these models and methods still have some limitations and not focusing on courseware instructional interface.

As a rest to that, usability evaluation is often ignored as part of the activities within the design procedures of courseware. The evaluation activities performed uncommonly by experts than the users (Sharp et al., 2007; Semugabi & De Villiers, 2007). Consequently, the major benefits that are associated with evaluation are not actualized. More so, usability evaluation should be performed iteratively not at once-off activity, by applying different suitable measurement tools throughout the stages of a product's development life cycle (Teka, Dittrich, Kifle, Ardito & Lanzilotti, 2017). This study aims to design a measurement tool that is able to evaluate the usability of instructional interface of a courseware based on the Quality in Use Integrated Measurement (QUIM) as well as the usability attributes and dimensions that must be considered in the instructional interface designing.

Usability is the basic factor to consider when developing any courseware interface. How usable the product is the main objective of interface developers. Researchers have considered usability as a fundamental part to determine the quality of application software and it has become an important process to enhance the product utility (Tosho, 2019). In designing of instructional interface, usability is required to ensure the effectiveness for the intended users. On the other hand, researchers have described usability as a measurable quality of a product (Huang & Chen, 2019). For any application developed, we cannot say it is "96.3% usable" due to the neglected elements in it interface design. Subsequently, its report value such as completion time, metrics task, and error rate, and environmental satisfaction of user on the interface are actualized (Sirisuriya et al., 2013). Therefore, usability is about the use of an effective application to achieve goals and the process of achieving the goals with efficiency. An essential feature of courseware interface design is usability (Davids et al., 2013). Therefore, usability refers as the efficiency, effectiveness and pleasure that specified users attained to actualize the specified tasks within particular environments (Abdulrauf, Ariffin, AbdulSalam, 2019).

As described above, usability helps users to accomplish specific tasks with more efficiency, effectiveness, and motivate within specified context of use. Also, it is described as efficiency with which resources are disburses in relation to the correctness, and completeness with which users applied to achieve specified tasks (Neal & Miller, 2005; Somers, 2005). On top of that, this study defines usability as the use of appropriate elements in interface design courseware to ensure maximum performance and it should be effectiveness for everyone, regardless of specific users. Usability is generally connected with five parameters challenges (Nielsen, 1990):

i. Easy to learn: Users can rapidly accomplish some work with the system,
ii. Efficient to utilize: Once the user has learnt the system, a high level of productivity is possible,
iii. Easy to remember: The casual user can come back to utilizing the system after some period without having to learn everything all over,
iv. Few errors: Users do not make numerous errors while utilizing the system or it can easily be recover, and
v. Pleasant to use: Users are subjectively fulfilled by utilizing the system.

According to Dubey and Rana (2010) explored attribute elements for usability which the studies affirmed that satisfaction, efficiency, effectiveness, learnability, and memorability are the common frequency of the usability measurement factors. Therefore, usability models are conceptual reported and not only state the characteristics but also indicate how those characteristics are fitted together. From the definition of the usability, it can be deducted that four features that strongly influence the usability of learning (courseware) instructional interface are users, technologies, tasks, and environmental elements (Liposinovic, 2020). The first feature is the variety of user capabilities (The novice users, knowledgeable intermittent users and expert users, and the abled and disabled users) (Charoenporn, 2020).

The differences in the users' skill and capability could strongly affect the product usability. This indicated that user with previous experience with the product or similar product will affect the usability of the product. In other words, a product that is usable for the abled will not be best use for the disabled (Saplacan, Herstad & Schulz, 2020; Abdulrauf & Ariffin, 2019). The second feature is technology, which refers to the device's specifications and features, and software and hardware. For example the mobile technology and android application have direct effects over usability. The third usability feature is task, which refers to assignment performed in achieving a goal. In different cases, objectives require a sequence of steps to follow. Developers give the users the possibility instructions to adhere while performing the task that require using more than a single way; they cuddle all the possible ways to perform the task in order to be helpful to the users.

But unfortunately, this causes chaos and overcrowding in the application interface (Briggs, (2018) Three different levels of task have been categorized: frequent tasks, less frequent tasks and infrequent tasks. The complexity of a task is indicated by the number of instructions to successfully complete the task. Frequent tasks can be performed in an action by tapping a button or key, but less frequent tasks require two actions only, whereas infrequent tasks involve more than two actions. Finally the last usability feature is environment, which refers to the situation that the product uses in performing the user's task. Also, it refers to the interface and the application efficiency (Adnan, Prasetyo & Nuriman, 2017)]. It can be features such as user's social conditions, noise, temperature, bandwidth, and connectivity between the connected devices.

## 2. PREVIOUS RELATED STUDY

Many studies have been conducted to develop models or frameworks assess the usability of designed applications and determine it is contextual factors [1, 27-30]. One of those studies has adapted a framework which can be used to evaluate the usability of the interface design context. This study was conducted by Coursaris and Kim [28], where they reviewed about 100 empirical studies in the field of usability in a qualitative analytical review. The results show the usability contextual factors and it is dimensions have effectively contribution towards users. Another study conducted by Treeratanapon in the sudy of Lacerda (2018 ), he try to develop a framework to evaluate the usability of interface of an applications which designed by the free developers in the various platforms. This study was adopted from Technology Acceptance Model (TAM) model and the ISO 9241 standard. This study relied on three dependent variables and two independent variables to measure usability. The dependent variables of the study were efficiency, effectiveness and satisfaction while the group of users and the mobile operating system were the independent variables. According to Lacerda (2018 ), he use the time required to finish the tasks to measure the efficiency and the correctness to measure the effectiveness while the satisfaction was assessed by asking the respondents about their satisfaction immediately after using the application and finishing the tasks.

IOS and Android were the platforms conducting this study, whereas the participants in this study divided in to three groups: novice, experience, and expert. Moreover, in 2013 three researchers from the Universiti Kebangsaan Malaysia had conducted a study aimed to propose a set of usability dimensions that should be considered during the interface designing and evaluation processes (Quiñones, Rusu & Rusu, 2018). Several usability measures that relate to this study are described in the next sub-section.

**Eason Model (1984)**

Eason Model is proposed by Kenneth Eason (1984) and published his model in an early issue of Behaviour and Information Technology. Eason Model has 3 aspect, task, user and system. For task it has 2 sub attribute that is frequency and openness. User has 3 sub attributes that is knowledge, motivation and discretion. System has ease of learning, ease of use and task match. Eason Model cannot measure usability without considering users and their target task. Based on Eason's model, it has two parts that is input and outcome.

The input for Eason's model is user, system, task characteristic and can define as independent variables. The outcome is user reaction and it dependent variable. Eason model is causal type of model because it has input that is independent variable and outcome or result that is dependent variable. A causal model is one that makes prediction about causality. Eason model sees usability as the result of several interacting variables or "multi - variate" (Eltahir, 2019)

**Shackel Model (1986)**

Shackel Model was developed by Brian Shackel. In this model, it has 4 attributes that is effectiveness, learnability, flexibility and attitude. Shackel Model does not weight the dimension, recognizing that the importance of each of these may different from project to project. Shackel model emphasizes measurement of a number of human factors, relating to human performance and attitude (Ardan, Garcia, Tenio & Kurata, 2018). ) Modified Shackel model and adapted the model into usefulness, effectiveness, learnability (or ease of use) and attitude (or likeability).

Booth did not include flexibility because he thought difficult to specify and measure the flexibility of a system and include useful to be consider as fundamental to usability (Mohammed & Mohammed, 2017). Dawood, el at. (2021) said that definition with one or more of four criteria in Booth model are generally accepted by usability community. Likeability also important to usability which constitutes user's perception, feelings and opinion of product Ardan, el at., 2018)

**Nielson Model (1993)**

Nielson Model was developed by Jakob Nielson. The main model is system acceptability and usability is part of usefulness. Other attribute that contribute to the main model are utility, usefulness, practical acceptability and social acceptability. Under usability it has 5 attributes such as easy to learn (learnability), efficient to use (efficiency), easy to remember (memorability), few error and subjectively pleasing (satisfaction). Nielson Model focus on acceptability that mean if the system is not useful such as did not meet the user requirement, it will not accept it either it usable or not.

The model is based on user interface usability in the context of a software engineering project. Nielsen emphasizes usability as part of a larger set of system characteristics. Same with Shackel Model, Nielson Model also does not weight the dimension, recognizing that the importance of each of these may different from project to project. Nielson model is additive model (Dawood, 2021).

**ISO 9241 – 11 (1998)**
ISO 9241 is an international standard for usability based on process oriented. Nielson and Shneiderman are among the committee members in the development of ISO guideline principles to measure usability of application. ISO 9241 has three attributes which has described as effectiveness, efficiency and satisfaction. ISO 9241 put together all forms of different usability viewpoint. Effectiveness describes the interaction from the process viewpoint, efficiency which focus on results and resources involved and satisfaction which is a user viewpoint (Matraf, Hashim, & Hussain, 2020).

**ISO 9126 (2001)**
ISO 9126 is an international standard for the evolution of software quality model from the product perspective. The approach was quality model of the product and initially published in 1991 and refined over the next ten years by ISO's group of software engineering experts. ISO 9126 is an extension of previous work done by McCall (1977), Boehm (1978), FURPS and others in defining a set of software quality characteristics [36]. ISO 9126 divided into 4 parts which address respectively to the quality model, external metrics, internal metrics and quality in use metric. The internal and external metrics are functionalities, reliability, usability, effectiveness, maintainability and portability (Matraf, Hashim, & Hussain, 2020).

Under usability it has 5 attributes such as understandability, learnability, operability, attractiveness and usability compliance (Bevan & Earthy, 2018) The advantage of ISO 9126 model is it provide a framework for making trade-offs between software product capabilities and the attribute are applicable to any kind of software including computer programs and provide consistent terminology for software product quality. The disadvantage of ISO 9126 was unclear architecture at the detail level of the measures, overlapping concepts, lack of a quality requirement standard, lack of guidance in assessing the results of measurement and ambiguous choice of measures (Moradian el at., 2018)

**Quality in Use Integrated Measurement (QUIM) (2006)**
QUIM or Quality in Use Integrated Measurement developed by Ahmed Seffah et al in 2006 QUIM is a consolidated model for usability measurement and metrics. It combines various standard and model such as ISO 9241 and ISO 9126 and unified into a single consolidated, hierarchical model. It outlines methods for establishing quality requirements as well as identifying, implementing, analyzing, and validating both process and product quality metrics. This model appropriate for novice users that have little knowledge of usability and can be applied by usability experts and non-experts QUIM model consists of 10 factors and subdivided into 26 criteria or measurable criteria, and finally into specific metrics consists 127 specific metrics.

The 10 factors consists Efficiency, Effectiveness, Satisfaction, Learnability, Productivity, Safety, Trustfulness Accessibility, Usefulness and Universality. The model is used to measure the actual use of working software and identifying the problem. In QUIM model associates factors with criteria and metrics in a clear and consistent way. It also usable generally and can adapt in specific context of use. The limitation of this model, it is not optimal yet and needs to be validated (Djordjević, Rančić & Simić, 2014; Okunakol, 2020).

In this study, the relevant previous studies were reviewed then analyzed using the content analysis approach. The analysis process found that there are twenty-five dimensions directly affect the usability of the instructional interface. Based on their importance, these dimensions have been prioritized and re-synthesized to select the most important to be considered that can be used as guideline to develop a usable instructional interface application.

## 3. METHODS AND RESULTS

### Systematic Literature Review

Systematic Literature Review (SLR) defined as a formal literature review of the high quality studies related to a specific research matter in order to identifying, appraising, selecting and synthesizing all the evidence relevant to that matter (Mengist, Soromessa & Legese, (2020). It is considered as a key element of the evidence based studies in instructional, but it is used other fields too such as information systems (Cook, Collins, Cook & Cook, 2020). This study employed SLR in order to acquire the usability dimensions of mobile applications. Aboytes and Barth (2020) outlines that SLR consists of three main steps which are planning, conducting, and reporting the review. Planning: In this study SLR has been conducted to address the usability dimensions of mobile applications. Therefore, the keywords "Usability", "Evaluation", and "Mobile" have been used to retrieve the relevant studies.

Four criteria as the basis of selecting references are:

i. The study has been published in a high impact journal in Human – Computer Interaction (HCI) or Usability Studies, as shown in Table 1
ii. Published not earlier than 2000,
iii. Empirical study, and (4) on mobile technology.

The study identified some selecting studies, and evaluating the primary studies based on the criteria of the review protocol that is developed in the planning phase. However, based on [34] in SLR before identifying primary studies there is a need to make sure that this work has not been done previously in order to avoid repetitions and time wastage.

**Table 1: Articles Reviewed based on the criteria that have been defined in the planning phase**

| Journal Title (Short Title) | Publisher | Candidate | Selected |
|---|---|---|---|
| Computers in Human Behavior (CHB) | Elsevier | 10 | 6 |
| Human-Computer Interaction (HCI) | Taylor & Francis | 14 | 4 |
| Interacting With Computers (IWC) | Elsevier | 19 | 2 |
| International Journal Of Human-Computer Interaction (IJHCI) | Taylor & Francis | 18 | 5 |
| International Journal of Mobile Human Computer Interaction (IJMHCI) | IGI Global | 10 | 1 |
| Journal of Usability Studies (JUS) | Usability Professionals' Association | 12 | 2 |
| Transactions on Computer - Human Interaction (TOCHI) | ACM | 16 | 2 |
| | | 89 | 22 |

Therefore, in this study performed a quick search about the previous meta-analysis and systematic reviews that addressed the "the usability evaluation in instructional design" by using the same protocol. In fact, four studies have been founded in which the same research idea has been addressed by using the same research protocol (Cook, Collins, Cook & Cook, 2020; Aboytes & Barth 2020). Accordingly, the research protocol time limit has been changed to retrieve the studies that have been published from 2017 up to now. In order to minimize any omission of relevant studies, the reviews were performed based on multiple databases. Over 80 journal articles have been downloaded. These articles have been reviewed and 40 articles only were selected based on the criteria that have been defined in the planning phase as showed in Table 1.

In this step the 22 selected studies' have been analyzed carefully and summarized. This study focused on the measures that have been addressed in selected studies to measure and evaluate the usability. The Analysis process identified 25 measures which have been circulated in the previous meta-analysis and systematic reviews that addressed the same research ideas in this study. Based on elicited study, some attributes of usability are considered for evaluating instructional interface, which are motivation, efficiency and effectiveness. They have been proposed to measure the instructional interface elements as part of usability strategies. The proposition of the attributes were elicited from previous studies related to usability evaluation of instructional interface. The total of 22 evaluation works were reviewed particularly on the attributes used in the study.

**Attribute Utilized in the study**

| | |
|---|---|
| A – Reliability | B – Ease of user |
| C – Effectiveness | D – Applicability |
| E – Efficiency | F – Motivation |
| G –Satisfaction | |

Based on the meta-analysis, this study decided to select attributes C, D, E and F to measure the usability of the instructional interface elements as part of usability strategies as they have the highest frequency. This gives a new description label that is related with the constructs meaning; structural element, layout elements, and navigation elements for usability attributes. The selected evaluation attributes are proposed with appropriate constructs in measuring the instructional interface elements as part of usability strategies as discussed in the study of Abdulrauf, Ariffin, and Sobihatun, 2015.

## 4. CONCLUSION

Effective evaluation should be iterated and should involve users in a multi-layered design of evaluation (Taylor, 2006). To realize the effective interface strategies depends on the usability or principles that take cognizance of both learning process and interface design factors (UX Nuggets: Thoughts and advice on usability and user experience, 2011). The usability in the content of instructional does not related only interface design but includes the elements that guide content or information, and functional tools that could be use to perform tasks. The interactive part of clearning systems provides learners with access to vast amount of instructional contents in differed forms, control over the procedure of learning, and the potential for collaboration with the system and other people. Such system enhances the learners' and enforces evaluators on learning how to adopt a broad based set of methods and criteria to accommodate 'self-directed' evaluation learning (Abdulrauf, Ariffin, Sobihatun, 2019). On the other hand, the usability as well as metrics, evaluation factors, and criteria for interface design are inconsistently defined across different standard (Aziz, kamaludin & Sulaiman, 2013).

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