The final publication is available at Springer via https://doi.org/10.1007/978-3-319-58515-4_26

A Guidance and Evaluation Approach for mHealth Education Applications

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Abstract. Growing number of mobile applications for health education are beings utilized to support different stakeholders such as health professionals, software developers and patients/general users. There is a lack of a critical evaluation framework to ensure the usability and reliability of mobile health education applications which would facilitate the saving of effort and time for the several user groups. This paper describes a framework for evaluating mobile applications for health education, including a guidance tool to help different stakeholders select the most suitable mobile health education apps. The outcome of this framework is intended to meet the needs besides requirements of the different user categories in addition to improving the development of mobile health education applications with software engineering approaches. A description of the evaluation framework is provided with: an efficient hybrid of selected heuristic evaluation (HE) and usability evaluation (UE) factors. Lastly, an explanation of the quantitative and qualitative results for the framework was obtained using a Medscape mobile app and some other mobile apps. This proposed framework - An Evaluation Framework for Mobile Health Education Apps – consists of a hybrid of five metrics selected from a larger set in heuristic and usability evaluation, filtered based on interviews from patients, software developers and health professionals.

Keywords: Heuristic Evaluation, Usability Evaluation, Evaluation Framework, Stakeholders, Metrics.

1 Introduction

Developing a wide range of application have been allowed as a consequence of the enhancements in mobile technology, which can be utilized in a numerous aspects of people's lives [1]. One example from these applications is the Mobile Health Education Applications. These applications have been utilized to improve knowledge of different stakeholders, such as patients and health professionals in addition improving their health in several aspects of their life [2] [3]. Patients need to develop their health education to ensure corresponding improvement in their health condition via supporting their well-being by the usage of mobile health education applications. Thus, the accumulative effect of mobile technology has headed to significant growth in the number of

mobile health (mHealth) applications and stakeholders. Concern from both the software development and health field communities has been shown as an outcome of this technology revolution. In 2009, 800 people were involved in the inaugural mHealth Summit, a partnership between the National Institutes of Health, the Foundation for the National Institutes of Health, and the mHealth Alliance. One year later, the number of people joining the conference was extended to triple of the number in 2009 [4], which is indicates a significant growth in interest over a short period.

Training and Learning on health matters are increasingly significant issues, mainly as more people are living longer in addition since the scale and complexity of maintenance for health and well-being [5]. Health education reflect several areas, for instance learning how to manage health requirements without barriers, how to manage life in an acceptable way and how to receive appropriate treatment [6]. From the patients side these are the requirements which parallel those of the health professionals who search for to update their medical knowledge and are looking for particular information. According to [7], "M-health was defined as wireless telemedicine involving the use of mobile telecommunications and multimedia technologies and their integration with mobile healthcare delivery systems". The size of mobile phone devices are small which consequent to have various restrictions, for instance the resource storage limitations and battery life, thus bring a lack of the user experience and quality to the service [8].

Recent research mentioned that Mobile Health Apps can make risks of failure equivalent to those of supplementary medical devices, due to mechanical failure, poor manufacturing quality, faulty design, and user error, among other safety issues [9]. The main consequence of these faults is that many software developers of Mobile Health Education Apps do not utilized an appropriately particular framework/model in the evaluation of the usability for their apps to ensure that these apps meet certain requirements, for instance health education for health professionals and patients. This bring the lack of evaluation framework to evaluate these apps in addition to make sure they meet the requirements of several stakeholders [2] [3]. Also many research has been depended on using (HE) for different aspects which is showing the valuable of utilizing (HE) in different aspects [10] [11].

2 Why Mobile Health Education Apps Importance

Mobile phone devices is one of the central development areas in computing [12]. According to Hernandez Munoz and Woolley [13], now a day mobile phones are common and essential devices for the common population, which suggests that mobile phone devices are depended by people in many aspects of their daily lives, such as in commerce, health education and transportation. People are intense utilizing mobile phones for resolves other than the predictable aspects of using them as flexible substitutes for desktop computers [14]. Anybody now can accesses a wide range types of information from anywhere at any time with a mobile phone using wireless technology [15].

There are two types of mobile phone devices. One of them is the classic type, which contains two parts: a keyboard and a display screen above; the other type is the touch

screen type, it is split into either half touch screen controller and a half keyboard under the controller or a full touch screen controller. Simon Personal Communicator developed the first touch screen mobile phone ,by IBM in 1992, however the first smart mobile phone on the market was the Ericsson R380 released in 2000 [16]. Moreover seven years later, Apple released the iPhone in addition it was the first smartphone controlled by its touch screen mostly [16]. Android operating system released to the market for touch screen mobile phones only one year later [16].

According to Leonardi et al. [17], a touch screen set-up is supplementary flexible and easy to utilized for beginner users than the mouse set-up and the keyboard, thus supports the probability of accumulative reliability on mobile phones.

Moreover, a recent research showed that one in every five persons in the world is using a smartphone [18]. Recent estimates specify that about 497 million mobile phone devices were supplementary to the circulation in 2014 and that, of these devices, smart devices represented 26% [19]. This reflect a wide growing in mobile phone devices, which showing a vast intensifications of the potential for having more applications installed and utilized in our mobile phone devices. Which is bringing the lack of a technique for ranking and distinguishing useful apps from the not so useful.

3 Selected Usability Metrics for the Framework

A hybrid selection of metrics taken from heuristic evaluation (HE) and usability evaluation (UE) metrics initially have been proposed and critical filtered by conducting 15 hybrid selected interviews with health professionals, software developer and patients. After analysing the data from the 15 hybrid selected interviews the outcome demonstrated that we need to modify some of the metrics which had selected, as some of the proposed and selected metrics did not meet to the accurate requirements of the interviewees. The 15 hybrid selected interviews with health professionals, software developer and patients reflected that some of the proposed hybrid metrics selected from HE and UE were not essential to their requirements, although some of the metrics needed to be complementary to our proposed hybrid selection of metrics taken from (HE) and (UE). Furthermore, we systematized and categorized our hybrid selection metrics from (HE) and (UE) as: A) Memorability, B) Features, C) Attractiveness, D) Simplicity (containing learnability) and E) Accuracy. The definitions of these metrics are illustrated in figure 1 [**Error! Reference source not found.**].

4 Motivation for Constructing a Framework

There are numerous reasons demonstrate the lack of constructing a framework for mobile health education apps. In the beginning in recent decades, several researchers have created UE for systems in general, although the principal part was for web applications by and large, not for mobile applications or mobile health education applications [20] [21]. Secondly, now a day usability turn into an important area for smartphones, as it is vital to avoid issues from practicing mobile applications [22]. Thirdly Constantinos and Kim [23], mentions that there are a lack of empirical research into the impact of the

environment on mobile usability and the importance of user characteristics is a central point. As well as, they specify in their paper that there has been no subjective research on the usability possibilities considered in such mobile studies [23]. This illustrates the lack of structuralize of a subjective study to rank, enhance and measure the usability of mobile applications in general, and mHealth education applications specifically. Fourthly, and most significantly, according to Constantinos and Kim [23], there is no usability evaluation framework that has yet been developed in the context of a mobile computing environment. This proof the needs of our research, which contains building an evaluation framework for Mobile Health Education Applications. Moreover, according to Smith [24], smart mobile device proprietorships notice a progress of 10% between the year of 2012 and 2013. Utilizing mHealth applications began to rise markedly from 2013: over 36% of all mHealth applications in 2014 had been released in the previous year [25]. According to Dubey et al. [26], usability
Investigations need the used of different methods, such as interviews, logging, or surveys. Furthermore, one of the top approaches in terms of usability to evaluate different aspects are (UE) methods, such as systems, applications and prototypes [27]. Finally the increasing number of the mobile health apps is growing in a huge angle as it's more than double in a year between 2015 and 2016 in a percentage 57% to 259,000 apps [28].

5 Framework Designing Stages

The framework has submission updates in three stages during research phases which has been illustrated in the flowing sub titles.

5.1 First Design for the Framework

In the beginning of our research we designed our framework from two parts which were the questionnaire part and the prototype part in addition we considered the questionnaire questions depending on metrics has been obtained from the literature from a hybrid selected metric from Heuristic Evaluation (HE) and Usability Evaluation (UE) metrics. In addition, figure 1 illustrate the first design for the framework. [2].
Unfortunately, moving forward in research we found that this design was not a sufficient design to be consider for the research, as we need to meet the accurate hybrid selected metrics for using it in the questionnaire to measure the usability in mobile health education apps. These mobile health education apps are already exist and utilized regularly by different stakeholders such as (Health Professionals (HP), Patients (P) and Other Stakeholders (OS)). Moreover these different stakeholders using these mobile health education apps for numerous aspects of these life under the umbrella of health education. This bring up the lack of finding out what do these different stakeholders require to measure from these mobile health education apps. Moreover, to meet this condition we had to plug in some qualitative unstructured interviews, to obtain different stakeholders requirement measurement from these apps, so we can design and finalized the hybrid selected metrics depending on their requirements. Which has brought the second design for our evaluation framework.

5.2 Second Design for the Framework

The second design of our framework is an update version of the first design of the framework, which contains as the first design from two parts, which were the questionnaire part and the prototype part in addition we considered the questionnaire questions depending on mapping between metrics, which been obtained from the literature from a hybrid selected metric from heuristic evaluation and usability evaluation metrics.
However, after we enhance the qualitative 15 unstructured interviews with (HP, P and SD) we obtained the most accurate hybrid selected metrics. Which were [A) Memorability, B) Features, C) Attractiveness, D) Simplicity (containing learnability) and E) Accuracy]; obtaining these accurate hybrid selected metrics supported us to do our mapping between the accurate hybrids selected metrics and the questionnaire questions, which is had helped us to measure the accurate usability issues in mobile health education apps (MHEA). Moreover, these questions were designed to use for doing two aims which are firstly, ranking exist mobile health education apps which is one of the most important things to do in our research, and secondly, for designing our prototype which was apart from the firs and the second framework design. In addition figure 2 presenting the second design for the evaluating framework. [3].
This design been modified to the third design as we consider in our research to swap the prototype into a Tool of Guidelines. Which has replaced the third part of our framework, which explained more in the next subtitle.

5.3 Third Design for the Framework

This design of our framework is the most critical design as it is going to help us to answer all of our research questions. This design contains as the first design and the second design apart from changing the last part of it into a Tool of Guidelines. In other word this design reflect the first two experiments we did in our framework which are firstly, the unstructured interviews with different stakeholders (HP, P and SD) led to obtained the accurate hybrid selected metrics to meet there requirements. Secondly, the questionnaire which has been obtained depending on mapping between the outcomes from the unstructured interviews and the questionnaire questions. This questionnaire in the beginning of our framework designed supposed to support us to achieve to aims, which are ranking the mobile health educations apps then enhance us to develop prototype to reflect some of features of mobile health education apps.
So for the third design of the evaluation framework the aims from the questionnaire has been slightly modifies into ranking exist mobile health education apps plus enhance and guide to develop a select tool for helping different stakeholders to find different mobile health education apps which is meeting there accurate requiring. The Tool of Guidelines going to be designed depending on the outcomes from analysing the feedback of the questionnaire. This is reflecting the flowing of the research, which is developing the tool depending the two experiments, which are the unstructured interviews and the questionnaire.
Moreover, this design which is the third design going to be consider for the rest of the research to obtain the rest of the contribution for our research. In addition, answering

the research questions. Moreover, the third design of the evaluation framework reflected in figure 1.

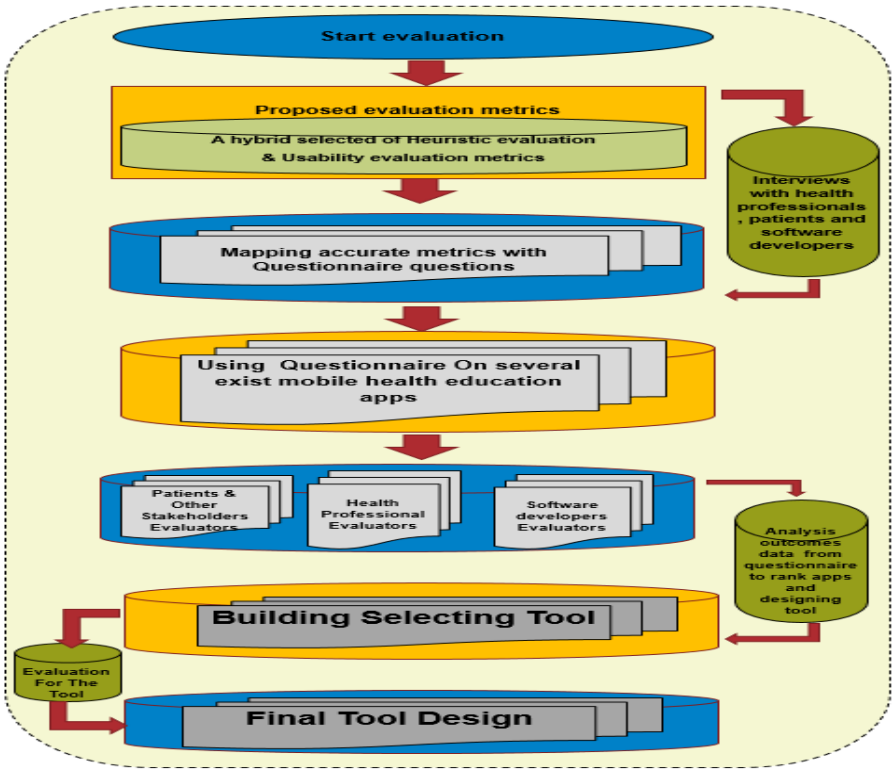

Fig. 1. Third proposed framework design

6 Qualitative Results for the Framework

After analysing the feedback data which has been collected from the 15 interviews (five interviews with health professionals, five with patients and five interviews with software developer), we analysed the feedback from all sets of interviewees to address their most important requirements when using mHealth education applications. Our results are shown in Figure 2 and are detailed below.

The most important metric to be measured in meeting patients, software developer and health professionals' requirements is D) Simplicity, showing the highest score (96) with an average of 6.4. In second place is B) Features, with score (84) and an average of 5.6. Third is E) Accuracy, with score (55) and an average of 3.7. In fourth place is A) Memorability, with score (35) and an average of 2.3. In last place is C) Attractiveness, which has the lowest score (6) and with an average of 0.4. From these results, we can state that the most important metrics for health professionals, software developer

and patients when using mHealth education applications are D) Simplicity and B) Features.

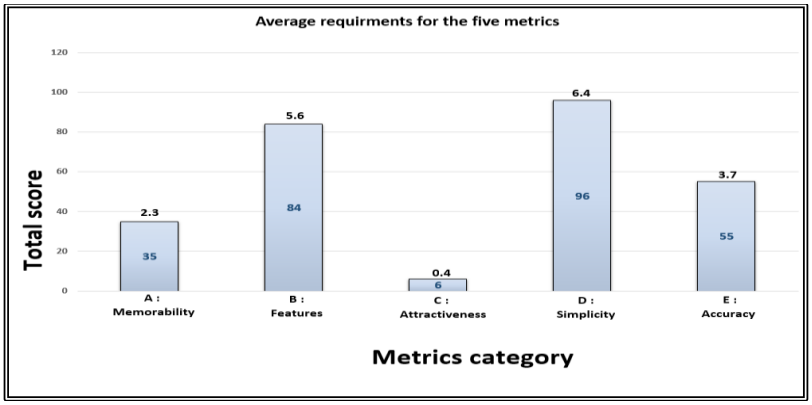

Fig. 2. Results from the interviews measuring patients, health professionals and software developers requirements

7 Quantitative Results for the Framework

After analysing the questionnaire feedback data which has been collected from the 81 participants (27 health professionals, 27 patients and 27 software developer), we analysed the feedback from all of them and find out that different stakeholders prefer different mobile health education apps.

As figure 3 reflecting that health professionals are in the first place prefer using Medscape with average requirements (4.1). And in the second place is patients/ general public with average requirements (4), and in the last place is software developer with average requirements (3.9). Moreover there is no significant difference within the group of professionals with Medscape as the p-value in the statistical analysis showed it's not less than 0.05.

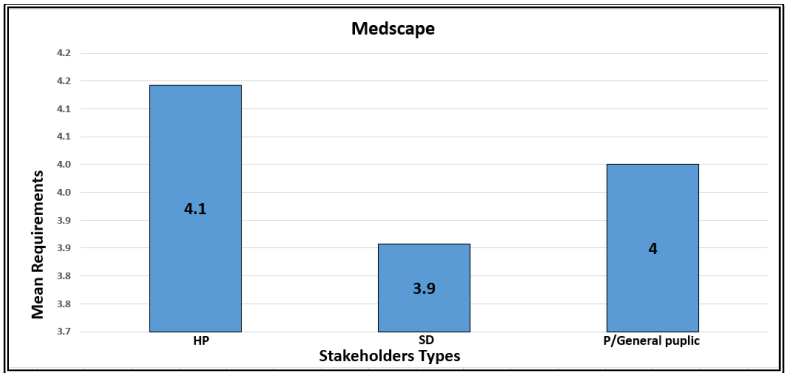

Fig. 3. Questionnaire Results from measuring patients, health professionals and software developers requirements from Medscape

As figure 4 reflecting that patients/ general public are in the first place prefer using Epocrates with average requirements (4.5). And in the second place is health professionals with average requirements (3.3), and in the last place is software developer with average requirements (3). Moreover there is significant difference within the group of professionals between health professionals and patients with Epocrates as the p-value in the statistical analysis showed less than 0.05. And there is significant difference within the group of professionals between software developer and patients with Epocrates as the p-value in the statistical analysis showed less than 0.05.

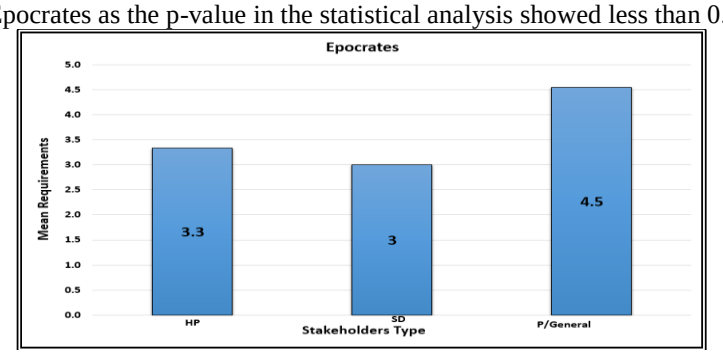

Fig. 4. Questionnaire Results from measuring patients, health professionals and software developers requirements from Epocrates

As figure 5 reflecting that software developer are in the first place to prefer using other apps such as (WebMD, UpToDate) with average requirements (4.5). And in the second place is health professionals with average requirements (3.7), and in the last place is patients/ general public with average requirements (3.1). Moreover there is significant difference within the group of professionals between health professionals and software developer with other apps as the p-value in the statistical analysis showed less than 0.05. And there is significant difference within the group of professionals between software developer and patients with other apps as the p-value in the statistical analysis showed less than 0.05.

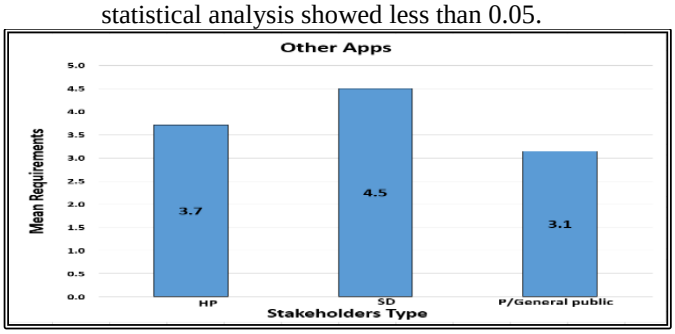

Fig. 5. Questionnaire Results from measuring patients and health professionals software developers requirements from other apps

8 Conclusion

MHealth education applications are utilized by several stakeholders for several critical reasons. These include saving effort and time; and simplifying their understanding of matters associated with health education. When such a mobile health education application does not offer users these components, this app will not be going to be consumed effectively, which is a part of the wider goal of satisfying the fundamentals of, patients, health professionals and different partners.

This paper has demonstrated HE and UE metrics are an effective technique to above these problems. Furthermore, this paper has argued that mHealth education applications can be improved by evaluating them in the early stages of software design. In this case, our hybrid of five selected usability metrics - Memorability, Features, Attractiveness, Simplicity and Accuracy - can be enhanced to increase the possibility of these apps being useful and successful. This kind of framework can be utilized as an evaluation tool for numerous sorts of mobile apps. This paper has focused on highlighting the structure of an evaluation framework for mobile Health education applications that depends on a hybrid selection of metrics (HE & UE) and combined a hybrid of five selected metrics from a larger set of heuristic and usability evaluations, filtered based on interviews with patients, health professionals and software developers. These five metrics correspond to specific aspects of usability acknowledged over a requirements analysis of typical users of mHealth apps. These five metrics were decomposed into 24 specific questionnaire questions. The aims of this project are to construct a set of tools for the evaluation of mHealth apps to facilitate them to be ranked, and to assist numerous of the stakeholders (health professionals, patients and others) in selecting suitable apps. Our Evaluation Framework for Mobile Health Education Apps is proposed to offer guidance on system specifications and different user requirements for software developers of mHealth apps.

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