A Review on User Experience Models for the Hearing-Impaired Mobile Applications

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Abstract. User experience (UX) is an important element that need exclusive attention. It is to ensure a successful mobile application enjoyable which can affect user perceptions. Currently mobile applications for the hearing-impaired has increased tremendously with the increase of the usage of mobile phones. However, UX evaluation model that best suits the evaluation for mobile application for the hearing-impaired is rather very general. User experience of the mobile application for the hearing-impaired is very limited that makes the evaluation more challenging and difficult. This study reviews the current UX models provide evaluation guidelines for hearing impaired and UX dimensions used by researchers and discuss the trend for future evaluation of mobile applications for hearing-impaired. This review help researcher to identify the dimensions to construct a new model for UX evaluation among hearing-impaired children. Result shows that user experience for mobile application for the hearing-impaired are limited. This study helps mobile developers and evaluators in evaluating mobile application for the hearing-impaired.

INTRODUCTION

According to World Health Organization [1], hearing-impaired is a condition of lacking the power of hearing or having impaired hearing. Hearing-impaired is loss of the ability to hear from one or both ears which can be inherited or caused conditions during birth, infectious diseases and medications. Throughout this paper, the term hearing-impaired is used to define people suffering from deafness and muteness. They face significant constraints in communication between hearing people as they are less skilful in communicating verbally with the others [2][3][4]. Sign language is a medium of communication for hearing-impaired which using a movement of hands, eyes and communicate with iconic narration [5]. It is estimated that by 2050 over 900 million people will have disabling hearing loss [1]. It shows that the hearing-impaired community has increased tremendously.

In Malaysia itself, hearing-impaired people are estimated to be 32,000 [3] and this number is increasing every year. According to the Malaysia Welfare Department [6] statistic, as of the year 2018 the total number of disabled people registered under hearing-impaired disability is 36,139 as shown in Table 1 below. According to the Malaysia Statistic Department [7], anyone who ages below 18 years old are considered as children. Based on the Table 1, the total number of hearing-impaired children is 5872.

Statistics show that almost 26.7 million smartphones in Malaysia are connected to the internet and the number increasing time to time [8]. The usage of mobile phones is not restricted to only normal people, but as well as among disabled people.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Total People Registered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Age Group</td>
<td>Number</td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Less than 6 years old</td>
<td>773</td>
</tr>
<tr>
<td>7 – 12 years old</td>
<td>2226</td>
</tr>
<tr>
<td>13 – 18 years old</td>
<td>2873</td>
</tr>
<tr>
<td>19 – 21 years old</td>
<td>1514</td>
</tr>
<tr>
<td>22 – 35 years old</td>
<td>8153</td>
</tr>
<tr>
<td>36 – 45 years old</td>
<td>5293</td>
</tr>
<tr>
<td>46 – 59 years old</td>
<td>7520</td>
</tr>
<tr>
<td>Above 60 years old</td>
<td>7787</td>
</tr>
</tbody>
</table>

Compatibility of mobile phones for easy communication is being studied continuously to enhance the UX for all groups of people [9]. There are less studies conducted about the hearing-impaired children’s application. Most of the studies reflect about the mobile application for hearing-impaired in general. Besides that, the applications are developed to fulfil hearing-impaired children requirements but how about their experience whilst using the applications. Increasing numbers of hearing-impaired children show the need to increase more valuable application that give the great UX for this community. Thus, a UX evaluation needs to be conducted to ensure the application developed for the hearing-impaired children is enjoyable.

Hearing-impaired children are proven have low achievement [10] in academic which four times slower than normal children [11]. Thus, applications that address to cater this community should take this issue into consideration rather than evaluating mobile applications in general. Therefore, the hearing-impaired children requirement needs to be identified in generating an enjoyable application developed for them. Research to evaluate UX for hearing-impaired mobile application is very limited and even isolated [12]. Current research in this domain is basically conducted generally to collect subjective data instead of having a proper guideline and model in assisting the evaluation.

Demand for applications are increasing as well as the rate of the rejection, even though applications are developed with great expense and expectations. Reason for the wide rejection of applications is due to the lack of positive UX and failure of the application to fulfill user needs. [13] define UX as a person’s perceptions and responses that result from the use and/or anticipated use of a product, system or service. It also can be defined as user perception, feelings and review when they had been using any system or product. It may give positive or negative experience to the users after interacting with the system / product. However, UX is a subjective response when it comes from users’ perception before using an application, during using an application and after using an application in achieving a specific goal [14][15]. As stated by [16], the concept of UX focuses rather on positive emotions and emotional outcomes such as joy, fun and pride.

This paper aims to review previous studies on UX of mobile applications in identifying potential dimensions that could be applied especially for hearing-impaired mobile application UX evaluation. This is because till to date, there no UX model that has been developed to cater UX evaluation for mobile application for the hearing-impaired children. Thus, this paper will contribute a comprehensive review of the last decade, studies on UX model in general and specifically for mobile. This paper starts by presenting the background of the study followed by methods used of the study in identifying dimensions for UX evaluation for hearing-impaired mobile application
and come out with the result. Conclusion of this paper was also discussed.

BACKGROUND

This section discusses about past studies related to user experience (UX) which evaluates the web and mobile application. Existing dimension or factors for UX evaluation are also discussed widely in this section. Finally, this section makes extensive ground for proposing a UX dimensions for hearing-impaired mobile application.

UX has been identified as the emotion or bonding between the application and users [14][15][17]. If UX is great, then the more user will use that application. In addition, UX is a different part compared to usability [18], UX is external judgments of users on the quality of a product/service, which is influenced by their expectations, satisfaction, and experience while usability ensures that the user interfaces are easy to use and support users in performing their tasks efficiently and effectively. In order to make the web access on mobile phones a success, overall about user experience had been notified, not just usability of a web site [19]. Acceptability or acceptance is close to user experience in the sense that it addresses more aspects than usability. According to [20], it covers also usefulness, practical acceptability, and social acceptability.

UX is a result of a motivated action in a certain context [21]. The user’s previous experiences and expectations influence the present experience, and the present experience leads to more experiences and modified expectations. This research has the merit of showing how important user’s changing expectations are in user experience. However, in another study by [16], they discuss the different approaches to user experience definitions where they identified three elements in UX: a consequence of a user’s internal state, the characteristics of the designed system, and the context within which the interaction occurs.

[22] used emotion, stimulation, identification, value & meaning, social connectedness, security & trust and challenges in UX evaluation to evaluate needs, affect, and product itself. For [22], the identification dimension addresses the human need to express one’s self through objects.

According to [23][24] seven dimensions were used in UX evaluation which are needs, functionality, interface, device, operating system, task and environment. Need is to evaluate how much the users need the application, if the application meets its functionality, whether it has an intuitive and interface, if the settings of the mobiles are sufficient for using the application, if the speed meets the application requirements, if the user can perform other tasks while using the application and finally whether the place where the user is in might interfere with the use of the application.

However, [25] only stated usable, functionality and enjoyment as the dimensions for UX among children compared to [26] who stated six dimensions on UX evaluation; attractiveness, perspicuity, efficiency, dependability, stimulation and novelty. Attractiveness measures the general impression towards the products, or specifically whether the user likes or dislikes the product. Efficiency measures users’ interface of the product. User interface look organized or otherwise for user. Perspicuity measures users’ understandability or difficulty to use the product either easy to get familiar with the product or not. Stimulation and novelty are two dimensions which supported in [27] study beside another two are aesthetics and emotion. [27] stated four major elements on UX evaluation in games. The aesthetics dimension describes about the beauty or attractiveness of the interface something is perceived. Emotion is the main factor in UX [16] which describe about users’ feelings. The stimulation dimension describes measures users’ excitement and interest when using the product like user feel
motivate with the novelty of application. The identification dimension indicates to what extent a certain product allows the user to identify with it.

UX in Mobile Augmented Reality (MAR) was studied by [28] and four dimensions had been evaluated through the study were emotion/affect, challenges, identification and best practices. Emotion/affect is covered all emotions that the participants during the experiment such as relaxing, inspiring, encouraging, exciting, unpleasant, depressing, and boring. Challenges is about physical, mental, prototyping, user interface and technical. Identification is to indicate extent the mobile application allows the user to identify with it.

On the other hand, seven dimensions decided by [29] in UX evaluation among person with disabilities. There are useful, usable, credible, desirable, findable, accessible and valuable. Useful was evaluated through the content which were fulfil user’s requirement and original. The mute application should be easy to understand for the user would be evaluated for usable dimension. Trustworthiness the content of the application was evaluated under credible dimension. Pictures and other visual elements were used to generate emotion and feelings evaluated through desirable dimension and if the content understandable and easy to navigable, it was to evaluate the findable dimension. Accessible be the most important dimension to evaluate for disabilities. Besides the application at least gave some value to user’s life then user will use the application. Challenging issue for hearing-impaired mobile application is to make them enjoyable and accessible [30]. Based on a review of the hearing-impaired characteristics, some features should be considered important in conducting the UX evaluation. Some guidelines had been introduced by [31] for experience evaluation among hearing impaired children. The evaluation should organize in public area such their school and the test carried out with a group of children, not individual. Beside the evaluation session is not more than 30 minutes while parents are not allowed to present together with the children during the session. The instruction must be provided orally and with sign language. Then, ask them to repeat the instruction because hearing-impaired children often say understand even it is not. Carefully with the language used for written instruction if necessary, to ensure the children were understood. Finally, ask their impressions.

METHODS

Theoretical study has been used as a method for this review. A broad range of study was required in many different aspects of user experience design and evaluation. This includes identifying the dimensions of UX evaluation for general, children and children with disabilities. In order to get good foundation of knowledge and understanding of the requirements, development tools, strengths and weaknesses of the UX evaluation model, this study reviews previous literature ideas, issues and articles related to user experience evaluation. The following search string has been applied for this study:

- C1 (‘user experience”) AND (‘evaluation” OR ‘dimensions”)
- C2 (‘deaf” OR ‘hearing impaired”)
- C3 (‘Mobile” OR ‘Phone”) AND (‘Application”)

Selected papers have been downloaded and sorted according to journal and conference proceeding. Table 2 shows some types of journals/conference proceedings papers that been downloaded for review. Focus on the selected papers is based on UX dimensions or factors related to interactive technology such as mobile application, games and web application. Thus, the total downloaded paper was revised and analysis related to this study is 35 articles as shown on Table 3.
UX models are conceptual view about the dimensions to be focused and should be tested to know the accuracy of [32]. These will help in the UX evaluation to be conducted on an application. Based on the existing UX models,
there are many dimensions that selected by previous researchers. However, some dimensions have similar meaning on each other. Therefore, the dimensions had been concluded using one word which covered to others because a successful evaluation starts with the selection of a set of factors or dimensions that want to evaluate [27].

Table 4 shows the UX model available in general and was adopted by many researchers from year 2010 till to 2018 and the dimensions that were used. The selected dimensions are aesthetic, emotion/affect, stimulation and identification because those items are used regularly by previous study. However, accessibility is selected for this paper although only two previous study which stated the dimension as shown on table 4. It is to ensure that the mobile application is accessible by the hearing-impaired children.

Table 4 UX Models in general

<table>
<thead>
<tr>
<th>Model</th>
<th>UX Dimensions Used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aesthetic</td>
</tr>
<tr>
<td>Hassenzahl et al. (2010)</td>
<td>X</td>
</tr>
<tr>
<td>Read (2012)</td>
<td>X</td>
</tr>
<tr>
<td>Paula et al. (2014)</td>
<td>X</td>
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<tr>
<td>Bernhaupt (2015)</td>
<td>X</td>
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<tr>
<td>Ibrahim et al. (2015)</td>
<td>X</td>
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<tr>
<td>Yazid &amp; Jantan (2017)</td>
<td>X</td>
</tr>
<tr>
<td>Dirin &amp; Laine (2018)</td>
<td>X</td>
</tr>
<tr>
<td>Deshmukh (2018)</td>
<td>X</td>
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</table>

**CONCLUSION**

It is important that deficiency of studies in the hearing-impaired mobile application area should be advanced in the future. This is not only to fulfil the need of an academician, but also for the hearing-impaired community beneficial. Since they are being isolated from the community and difference between them from the normal hearing people the deaf people tend to have lack of self-esteem and they prefer to move out from the community.

Thus, in accordance with the advancement of technology, mobile application, especially for hearing-impaired need more consideration in the development. Difference between mobile and desktop application should be realized and a suitable UX model should be developed for specific evaluation instead of generalizing it since each user and his or her task differs from one another. The key point of UX is to make product enjoyable, thus it must be enjoyable even for the hearing-impaired. According to the above discussion, UX dimension of mobility is very limited and even isolated in case for hearing impaired. Each of these UX dimensions of the available model are influenced by user, device and task to be fulfilled. Developer have to understand this feature to determine the UX dimension to be considered for hearing-impaired mobile application. This paper aims to review on existing UX models in general for desktop and mobile applications. In the future, this study will be extended to study on metrics for UX model mobile application and important features to be considered in development. The paper will be beneficial for UX practitioners in the field of Human Computer Interaction.
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REFERENCES


