Studies on Deaf Mobile Application: Need for Functionalities and Requirements

Shelena Soosay Nathan, Azham Hussain, Nor Laily Hashim
1,2,3 School of Computing, Universiti Utara Malaysia.
sn.shelena@gmail.com

Abstract—**Deaf people are normally considered to be people that do not need any mobile technology due to the inabilities of hearing and talking. However, many deaf are using mobile phone in their daily life for various purposes such as communication and learning. Many studies have attempted to identify the need of deaf people in mobile application and level of usage of the applications. Requirement for deaf mobile applications need to be analysed to ensure the disabilities need are instilled into the mobile applications developed for them. Universal design is understandable to comply every user needs, however specific disability is argued by the authors to have different need and requirements. These differences are among the reasons for these applications being developed to target for a specific group of people, however they are less usable and later abandoned. This paper focuses on studying the requirements needed by the deaf for mobile applications. Previous literature was conducted it can be concluded that graphic, text, multimedia and sign language interpreter are among mostly required features to be included in their mobile application to ensure the applications are usable for this community.**

Index Terms—**Deaf; Mobile Application; Requirements.**

I. INTRODUCTION

According to WHO deafness consists 5% of world total population which is 360 million people. Deafness can be classified in dB (Decibel) (Gennari & Mich, 2008). The deaf communities are increasing enormously. In Malaysia itself, deaf communities are estimated to be 32,000 in 10 years (Mohid & Zin, 2010). According to the Malaysia Welfare Department statistics, as of the year 2014 the total number of disabled people registered under deafness disability is 5,499 and will increase every year. Increasing number of deaf people leads towards the awareness of making things useful for these special communities. The importance of the deaf people is as equal as normal people. Technology is an important assistant for them to better engage into the community and they should not be isolated due to their impairment (Abascal, Barbosa, Nicolle & Zaphiris, 2015). People who are suffering from deafness commonly use sign language for communication purpose which is gestures using hands and finger.

Identifying user requirements problem especially for disable user need to be done in early phase to ensure usefulness of an application being developed. However, applications being developed for deaf people are argued to be more towards universal design which do not highlight specific disabilities problem Abascal et al., (2015). The purpose of this paper is to highlight the requirements for the deaf mobile application meant by conducting a literature survey. Literature that focuses on deaf mobile applications evaluation are selected and studied thoroughly to identify requirements in mobile applications needed by the deaf. Section two of this paper focuses on discussion on deaf and mobile applications being developed specifically for them. While section three highlights the identified requirements of deaf mobile application and discussion on the identified requirements is presented. Finally, section four concludes the paper.

II. MOBILE APPLICATION FOR DEAF

Mobile application nowadays available for common usage. Many applications such as messaging, video conferencing, social media applications are developed with general usage in mind despite some difficulties that could be faced by disabled people. A survey by National Association of the Deaf (2002) found that 75% of the hearing-impaired are using instant messaging and 97% are using emails daily. It shows that even though there are challenges and limitations in these applications, hearing-impaired are trying to adopt the technology especially telecommunication technology faster alongside with normal hearing people (Power & Power, 2004). This supports on enhancement and enrichment that could be taken into consideration on the hearing-impaired when developing general applications. Many hearing-impaired would want to communicate and use mobile phones as normal hearing people. They tend to use the mobile applications to assist them in learning and communicating with others since both learning and communication are daunting processes for them.

Most of the mobile applications still have features which are difficult for hearing-impaired to handle, such as language usage and navigation (Power & Power, 2004). As such, though applications are available, yet the number of hearing-impaired using them are still in doubtful manner especially in Malaysia. This is because many applications are developed to cater other countries users such as usage of sign language in the application. One of the highest downloaded in Google Playstore is 100,000 downloads (Refer Table 2.1) of an application named Pro Deaf Libras. Unfortunately, this application is meant for hearing-impaired that use Brazilian Sign Language and evidently none of the Malaysians or even other sign languages users unable to utilize it. As for the applications from Apple store, the total number of downloads could not be retrieved thus, tendency of application usage was determined by reviews from users (Refer Table 2). Table 1 and Table 2 indicate the ten

highest downloaded mobile applications from Google Play Store and iOS Apple store.

Table 1
Five Highest Download of Hearing-impaired Application in Google Play Store

Application	Total Downloads
Pro Deaf Libras	100,000
Deaf Bible	50,000
LearnASL	50,000
Belajar Bahasa Isyarat	10,000
SSMS	10,000

Table 2
Five Highest Download of Hearing-impaired Application in iOS Apple Store

Application	Category
Marlee Sign	Education
Sign Language!	Education
Note Listen for Deaf	Communication
Smart Deaf	Communication
Transcence	Communication

Independency of using the application in terms of flexibility and mobility has been the highest reason of people from all norms of life choose mobile applications to assist them in daily tasks. Moreover, the easy downloadable and installed to be used anywhere at any time engaged people towards the mobile applications. However, many applications still do not gain much popularity among hearing-impaired might be due to failure of the applications to meet their expectations. Studies agreed that many advantages can be gained by the specified applications but user's satisfaction for the interface usability might be an effect for the less popularity (Harrison et al., 2013; Yeratziotis, & Greunen, 2013). Studies also stated that usability enacted did not fully sufficient for user need because the usability is depicted for general and disregards special needs people (Yeratziotis, & Greunen, 2013).

As such, technology and mobile applications are used by more technical savvy people rather than slow learners like hearing-impaired people. This supports a statement that when the technology is unreliable, it will be abandoned (Abascal1, Barbosa, Nicolle and Zaphiris, 2013). Therefore, hearing-impaired rely more on close relations such as family and friends rather than technology for communication and learning (Yeratziotis & Greunen, 2013). Thus, it leads to the usage of hearing-impaired mobile application lesser. Such things need to be addressed to bridge gaps in justifying that advantages of mobile applications are not only for normal users but as well as for hearing-impaired users. There are also drawbacks for the mobile application, whereas the user has to update the versions frequently that might be baffling for some hearing-impaired users. Despite all that, mobile applications are viewed as one of the interesting and most used by all the people across the globe and this figure of users will increase in the close future (Coursaris & Kim, 2011).

III. FUNCTIONALITIES OF DEAF MOBILE APPLICATIONS

Mobile applications apply to much functionality for the users. Different mobile applications are meant for different purposes such as SMS used for text messaging, while applications such as Video Messaging and Skype are focused on video calls and communication. Other than that, there are applications that were developed for entertainment purposes such as video streaming applications and games. Mobile applications basically assist hearing-impaired in many ways such as for learning, communication, teaching, religious and gaming. But two most prominent and widely used applications are meant for learning and communication (Refer to Table 2.1 and Table 2.2).

Learning: As the Kanter (2006) states every disabled person should have equal access for learning and education. It is clearly stated that disabled people must be included in education as any other normal people and accommodation for the education must be fulfilled with the disabled requirement. Alternative format of knowledge information transfer should be provided and must be ensured that an effective learning process can be adapted.

Communication: This is the most important functionality of mobile application and mobile technology towards the hearing-impaired. Aware of the usage of sign language as the hearing-impaired communication language, technology should be an aid for interpreting the language into easier understandable manner for people who could not understand sign language (Bragg et al., 2015). Moreover, many hearing-impaired are also not a trained signer, thus to enable them to be able to communicate with others will be made easier if proper communication medium is available through mobile phones. This will also help in overcoming barriers aced by hearing-impaired communicating with hearing people (Al-Osaimi & Alsumait, 2009).

Learning and communication are the most important functionalities that mobile applications have for hearing-impaired though there are some others such as games and information provider functionality. Therefore, the functionalities are very significant and will be used as guides in this study for metrics development and user testing purpose for the usability model to be proposed.

Johnson et al. (2010) also conducted a study on mobile alerting for hearing-impaired people whereas the objective of the study was to ensure the access of the application is equal to all especially for the disabled people. The approach is used considered on the distension vibration that notifies the hearing-impaired of incoming messages or calls in their mobile. This could alert them easily since the hearing-impaired could not hear the sound that comes from their mobiles. The vibration mode was also used in different ways such as lesser, higher and pattern mode. This vibration mode is able to be adjusted according to the level of hearing loss problem faced by the hearing-impaired. Field testing was conducted to test the application and was used to refine the application. They suggested that future plans for mobile alerting system could use video and graphic to alert the hearing-impaired people and this will increase the interest in using mobile by the disabled.

This is a good approach since many tend to ignore vibration as an accessibility requirement for disabled person but it is generally available in all mobile phones in term of universal accessibility. Thus an application is beginning to be considered as user friendly for disabled person. But each disabled people have different needs. For example, physical disability people who does not able to have detect touch sensor in their body due to some ailment could definitely unable to detect vibration. While camera phone with image capturing and object

recognition would work reasonably well but when it is to be used by a blind person, the accuracy might decrease since not compatible with the disabilities (Bigham et al., 2011). This is the reason why universal design adopted for all application might be useful for many but not some specific disability people. Therefore, application for specific disabilities should consider specific requirements features to be inhabited in the development.

Requirements that can be appended in the assistive courseware for the hearing-impaired were also discussed in the study conducted by Shaffiei and Aziz (2012). Through the study, the researcher finds that audio, video, animation and text are some of the important requirements should be considered for hearing-impaired mobile applications. Audio is considered to be a less significance aspect of hearing-impaired since they are likely to hear, but using audio could be added advantage when the application is focused for communication between the hearing-impaired and normal people (Motlhabi, Tucker, Parker & Glaser, 2013). Hearing-impaired might needs an application that could attract them and one of the criteria is animation. Animation is an important aspect to be considered for hearing-impaired application (Adamo-Villani, 2007; Zhou et al., 2012). It will help the mind to relate graphic and it could enable the curiosity among these slow learners to utilize the application. While usage of text (captioning) on the other hand is important for creating a relationship between the animation and video would enable the learner to enjoy the learning process and make them engaged towards the application (Gennari & Mich, 2008). This study also shows different type of users have different needs in the content of the course and hearing-impaired people in this context requires the guidelines as discussed above before they could enjoy their learning process.

The requirements guidelines proposed for hearing-impaired applications are useful as reference for the development process of an application and end product is reliable for special community to lead an easier life. However, evaluation to validate the guideline is still in the beginning phase. To sustain an established guideline would require more time and endeavor in developing quality of hearing-impaired application. Next section discusses briefly on the need of requirements for deaf mobile application.

IV. REQUIREMENTS OF DEAF MOBILE APPLICATION

Deaf people mostly depend on the interpreter for sign language so that they could communicate with normal people (Al-Osaimi et al., 2009; Weaver & Starner, 2011; Ng'ethe et al., 2015). This is because as discussed previously, deaf people main language is sign language which differ much from normal spoken language. However, not all deaf people are prone to have knowledge in using sign languages or literate (Fen & Cheng, 2010; Shaffiei & Aziz, 2012; Boulares & Jemni, 2012). Many deaf people prefer to communicate with sign languages (Wheatly and Pabsch, 2010) which lead to communication barrier when signing is used with normal hearing people. Researchers do focus on developing sign language interpreter applications that aid both literate and illiterate deaf people which could help in a way or another to reduce this barrier and make deaf people as one in the society.

Mobile applications for deaf people can be regarded as a diligence that allows them regardless of age to utilize for any need of learning, communication or even playing games at anytime and anywhere. Mobile applications developed especially for the deaf people are really a must have in enabling them to mingle around with the society regardless of the disabilities. In terms of requirements, most of the applications that are meant for the deaf were developed with the general requirement of a desktop application (Ariffin & Faizah, 2010; Aziz, Roseli, & Mutalib, 2010; Mazlina, Ananthi & Herawan, 2010; Masitry et al. 2013). Mobile applications developed must be able to ensure prospect of a user, along with the limitation in mobile technology (Hussain, Mutalib & Zaino, 2014). Thus, the application developed should identify some general requirements of the deliverables to be made for the deaf users. However, Adamo-Villani (2007) conducted studies in developing 3D avatar on virtual learning environment for deaf people children to learn sign language for mathematical terminology. The research focuses on a virtual environment where technology lags are identified in terms of usability and specific need of the user which makes the application non-engaging as user shows difficulty in usage during testing.

According to the study conducted by Ariffin & Faizah (2010), most important requirements in assistive technology for the deaf are navigation, language and flow of the content. They gathered these requirements through three phases which consist of user requirement study, prototype development and observation study. Guidelines for the development are collected from document study and interviews that were conducted with special school children and their teachers with the gathered information (Chittaro et al., 2006; Gennari, R., & Mich, 2008). Requirements that can be appended in the assistive courseware for the deaf such as accessibility were also discussed in the study conducted by (Chittaro, Buttussi & Nadalutti, 2006; Aziz et al., 2010). Through the study, the researcher finds that audio, video, animation and text are some of the important requirements should be considered for deaf mobile applications (Gennari, R., & Mich, 2008; Bragg, Rector & Ladner, 2015). On the other hand, testing usability of an application needs many attributes to be considered to ensure the application is suitable and useable (Coursaris & Kim, 2011; Baharudin et al., 2013). However, this study does not relate the usability testing on the application interface. This could have been neglected due to the unavailability of proper guides for conducting a usability evaluation. The usability evaluation, however seem to be generalized. Similar courseware is given importance in terms of learning attributes and neglected in term of users' satisfaction (Zainuddin et al, 2011; Masitry et al., 2013). However, the similarity between the courseware applications is that those studies focus on user testing and have implemented in ISO 9241-11 (1998) that show the specific model for deaf people usability evaluation is unavailable. This also could be a reason on why needs of deaf people have been neglected which need to be considered as part of the usability of an application.

V. CONCLUSION

According to the finding above, it is clear that mobile applications being developed for the deaf are not fully fulfil the need of deaf according to their disabilities. Thus, the mobile application for the deaf required to be studied explicitly to

guarantee the final product to reach the community is in a useable way. Deaf people requirement such as video output, more images and multimedia content need to be instilled in the application developed for them so that it is easier for them to adapt into the current technology without being left behind. Usability are evaluated in general usually but by identifying specific requirements the application meant for the deaf would be able to be evaluated in detail. Therefore, the requirements of a user is an important thing to be studied especially for deaf mobile applications. As future work, the authors will be focusing on the development of usability metrics for usability evaluation model for deaf mobile application according to the requirement obtained.

REFERENCES

[1] J. Abascal, S. D. Barbosa, C. Nicolle, P. Zaphiris, "Rethinking universal accessibility: a broader approach considering the digital gap", Universal Access in the Information Society, 1-4 (2015).
[2] N. Adamo-Villani, "A virtual learning environment for deaf children: design and evaluation", International Journal of Human and Social Sciences, 2(2), 123-128 (2007).
[3] A. Al-Osaimi, H. AlFedaghi & A. Alsumait. User interface requirements for e-learning program designed for deaf children. In Proceedings of the First Kuwait Conference on E-Services and E-Systems (p. 7). ACM, (2009, November).
[4] A. M. Ariffin & M. Faizah, "Guidelines of assistive courseware (AC) for hearing impaired students", In Proceedings of Knowledge Management International Conference. 43, 49-340 (2010).
[5] N. Aziz, N. H. M Roseli, & A. A. Mutalib, "Assistive courseware for visually-impaired", In Visual Informatics: Bridging Research and Practice (pp. 905-915), Springer Berlin Heidelberg (2010).
[6] R. Baharuddin, D. Singh & R. Razali. Usability dimensions for mobile applications- a review. Res. J. Appl. Sci. Eng. Technol, 5, 2225-2231, (2013).
[7] J. P. Bigham, R.E Ladner & Y. Borodin, "The design of human-powered access technology", In The proceedings of the 13th international ACM SIGACCESS conference on Computers and accessibility (pp. 3-10). ACM, (2011, October).
[8] M. Boulares & M. Jemni. Mobile sign language translation system for deaf community. In Proceedings of the International Cross-Disciplinary Conference on Web Accessibility (p. 37). ACM, (2012, April).
[9] D. Bragg, K. Rector, & R. E. Ladner, "A user-powered American Sign Language dictionary", In Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing (pp. 1837-1848). ACM, (2015, February).
[10] C. Coursaris, (S. U. Michigan & D. Kim (University of H. (2011). A Meta-Analytical review of empirical mobile usability studies. Journal of Usability Studies, 6(3), 117–171. doi:10.1038/nrc839, (2011).
[11] L. Chittaro, F. Buttussi, & D. Nadalutti, "MAge-AniM: a system for visual modeling of embodied agent animations and their replay on mobile devices", In Proceedings of the working conference on Advanced visual interfaces (pp. 344-351). ACM, (2006, May).
[12] W. X. Fen & X. J. Cheng. Using mobile learning way to support learning of the deaf. In Education Technology and Computer (ICETC), 2010 2nd International Conference on (Vol. 2, pp. V2-460). IEEE, (2010, June).
[13] R. Gennari, & O. Mich, "Designing and assessing an intelligent e-tool for deaf children", In Proceedings of the 13th International Conference on Intelligent user interfaces (pp. 325-328). ACM, (2008, January).
[14] A. Hussain, N. A. Mutalib, & A. Zaino, "A usability testing on JFakih Learning Games for hearing impairment children", In Information and Communication Technology for the Muslim World (ICT4M), 2014 The 5th International Conference on (pp. 1-4). IEEE, (2014, November).
[15] R. Harrison, D. Flood & D. Duce, "Usability of mobile applications: literature review and rationale for a new usability model", Journal of Interaction Science, 1(1), 1-16, (2013).
[16] ISO. International Standard: ISO 9241-11(Guidance on Usability). Geneva, (1998).
[17] J. Johnson, H. Mitchell, S. LaForce, E. Price & F. Lucia, "Mobile emergency alerting made accessible", International Journal of Emergency Management, 7(1), 88-99, (2010).
[18] A. S. Kanter, "Promise and Challenge of the United Nations Convention on the rights of Persons with Disabilities", Syracuse J. Int'l L. & Com., 34, 287, (2006).
[19] A. K. Masitry, M. A. Majid, M. Z, Toh, & T. Herawan, "An investigation on learning performance among disabled people using educational multimedia software: A case study for deaf people", International Journal of Bio-Science & Bio-Technology, 5(6), (2013).
[20] A. M. Mazlina, K. M. Ananthi, & T. Herawan, "A design of educational multimedia software for disability: A case study for deaf people", In the International Conference on Modelling and Simulation 2012 (MAS 2012) November 28-30, 2012, Jeju, Korea. (pp. 1-8), (2012).
[21] M. B. Motlhabi, W. D. Tucker, M. B Parker & M. Glaser, "Improving usability and correctness of a mobile tool to help a deaf person with pharmaceutical instruction", In Proceedings of the 4th Annual Symposium on Computing for Development (p. 13). ACM, (2013, December).
[22] S. Z. Mohid, & N. A. M. Zin, "Courseware accessibility for hearing-impaired", In Information Technology (ITSim), 2010 International Symposium in (Vol. 1, pp. 1-5). IEEE, (2010, June).
[23] G. G. Ng, E. H. Blake, & M. Glaser, "Mobile aid for deaf people learning computer literacy skills", Journal of Deaf Studies and Deaf Education, (2014).
[24] M. R. Power and D. Power, "Everyone here speaks TXT: Deaf people using SMS in Australia and the rest of the world", Journal of Deaf Studies and Deaf Education, 9(3), 333-343, (2004).
[25] Z.A. Shaffiei & N. Aziz. Assistive courseware for hearing-impaired learners in Malaysia based on theory of multiple intelligences (MI). International Journal of Computer Science & Emerging Technologies, 2(6), (2012).
[26] K. A. Weaver & T. Starner. We need to communicate!: helping hearing parents of deaf children learn American Sign Language. In The proceedings of the 13th international ACM SIGACCESS Conference on Computers and Accessibility (pp. 91-98). ACM, (2011, October).
[27] M. Wheatley & A. Pabsch. Sign language legislation in the European Union. European Union of the Deaf, (2010).
[28] G. Yeratziotis & D. van Greunen. Making ICT accessible for the deaf. In IST-Africa Conference and Exhibition (IST-Africa), (pp. 1-9), IEEE, (2013).
[29] M. M. Zainuddin, H. B. Zaman & A. Ahmad. Developing augmented reality book for deaf in science: the determining factors. In Information Technology (ITSim), 2010 International Symposium in (Vol. 1, pp. 1-4). IEEE, (2010, June).
[30] . Zhou, K.C Sim, P. Tan & Y. Wang. MOGAT mobile games with auditory training for children with cochlear implants. In Proceedings of the 20th ACM International Conference on Multimedia (pp. 429-438). ACM, (2012, October).