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Mobile Application Dictionary for Hearing Impaired Students

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Abstract—Mobile applications have been acknowledged by societies as a support tool that can be accessed everywhere via smartphone or any handheld device. The use of technology nowadays is not only limited to normal people; it can also be used by the disable community. Hearing-impaired people usually receive education via sign language and the dictionary is one tool used in schools to teach hearing-impaired students. There are several issues related to sign language dictionary such as the thickness of dictionary which makes it difficult to bring anywhere. Besides, teachers and students need to take longer time to access the targeted information. This research is conducted based on two main aspects: development of mobile application for the dictionary for the hearing-impaired and evaluation involving experts in the related research. This mobile application has been developed based on the Software Development Model of Mobile Application Dictionary. This model consists of five phases, which are analysis, design, development, prototyping and evaluation. The evaluation on mobile application for the dictionary involved four experts who have evaluated the interface design and learning design. The human computer interaction for mobile principles, dual coding theory, cognitive load theory, and multimedia theory have been used in the development of the dictionary. Based on the experts' review, it is found that the value of content validity index is 0.91 for the features of interface design and 0.83 for learning design. Hence, this shows the value of content validity index is acceptable. The research aim is to improve the quality of sign language learning for hearing-impaired students and community related to them.

Keywords—Hearing impaired, mobile application, dictionary, human computer interaction, usability, heuristic

I. INTRODUCTION

People use language or other forms of medium to interact with others. Language and communication are crucial in the process of learning in which messages (knowledge) can be transmitted from the sender (teacher) to the receivers (students) (Meadow, 2005; Hussain, Jomhari, Kamal, & Mohamad, 2014). Nevertheless, Hearing Impaired (HI) community is lack of phonemic language (Yaman, Donmez, Avci, & Yurdakul, 2016) and this community does not understand the verbal language as information that comes from voice or sound channel cannot be processed (Hidayat & Hidayatulloh, 2017; Kushalnagar, Moreland, Simons, & Holcomb, 2018). Thus, this may create a communication barrier between HI and others.

HI people has different levels of hearing problem, some of them have partial hearing loss while others are totally deaf (Garcia, Luis, & Samonte, 2016; Hamdi, 2016). Due to the lack of hearing sense, HI people usually use various channels to convey their feelings and exchange information with others (Hidayat & Hidayatulloh, 2017). Body gesture, eye contact, finger spelling and facial expression are used to help them deliver messages and to interact (Hamdi, 2016; Hidayat & Hidayatulloh, 2017). The sign language is used and it becomes the main communication channel among the HI community (Syar Meeze Mohd Rashid, Norlidah Alias, Nazeen Jomhari, & Mohd Yakub Zulkifli Mohd Yusof, 2015). In learning, sign language enables HI students to easily

understand and process messages or information that they study (Syar Meeze Mohd Rashid *et al.*, 2015).

Education is crucial for the disabled (Setiawan & Pradana, 2017). Due to the lack of cognitive experience, HI children are often delayed in speech and language development (Hussain, A., Hashim, N. L., & Nathan, 2018; Abuzinadah & Krause, 2017; Hamdi, 2016). Thus, they usually have poor vocabulary and syntax knowledge for reading skill (Ghadim, Jomhari, & Alias, 2013). Moreover, HI students usually do not understand abstract words (Awang@Husain, Zakaria, & Abd Rahim, 2012). Hence, it is imperative that HI children have an early education so that they are able to master the language skills, especially the reading skill which is crucial for them in ensuring their survival academically and socially.

As mentioned by many education scholars, children absorb information easily as sponge absorbs water (Bakri, Zakaria, & Nazirah, 2014). There are many issues involving hearing-impaired children, and family support is one of them. Family support plays an importance role in HI children's language development (Schalk & Spruit, 2017; Kraveva & Kravev, 2019). However, there will be problems when parents have limited knowledge on using sign language and this may cause communication apprehension between them and their HI children (Ghadim *et al.*, 2013; Schalk & Spruit, 2017). This is among the reasons for most parents of HI children to decide on leaving the responsibility of educating solely to teachers (Awang@Husain *et al.*, 2012).

II. LITERATURE REVIEW

In this section, the relevant literature reviews will be presented in the following subsections.

A. Sign Language

Sign language is a nonverbal language that uses body gesture, facial expression and sign code to deliver messages (Abuzinadah & Krause, 2017; Garcia *et al.*, 2016; Setiawan & Pradana, 2017). It has its own set of grammar and most of HI people use finger spelling to bring about unfamiliar words when communicating (Goyal & Goyal, 2016). Sign language differs geographically according to the spoken language (Goyal & Goyal, 2016); for example, there are the American Sign Language (ASL), Brazilian Sign Language (Jones, Bench, & Feron, 2014), French Sign Language (Silva, Silva, Aquino, & Teixeira, 2017) and New Zealand Sign language (McKee & McKee, 2012). Some countries such as Indonesia and Malaysia have bilingual sign languages. In Indonesia Isyarat Indonesia (BISINDO) is used among the HI community and Sistem Isyarat Bahasa Indonesia (SIBI) is used for educational purposes (Setiawan & Pradana, 2017). While in Malaysia Kod Tangan Bahasa Melayu (KTMB) and Bahasa Isyarat Malaysia (BIM) are used among the HI community and educational purpose respectively (Yanuardi & Nainggolan, 2016). Sign language can also be different according to the regions in a country; each region may have its own sign language (Yanuardi & Nainggolan, 2016). Hence, this may also cause

confusion among the HI as there are many sign languages with different lexical and structural differences (Cristina da Costa Rocha, 2018).

B. Dictionary

Dictionary is a tool that provides the meanings of words, synonyms and antonyms and provides information on the spelling, pronunciation and different forms of a word. There are two types of dictionary which are traditional dictionary and digital dictionary (Goyal & Goyal, 2016). The innovation in technology has enabled the creation of digital dictionary. The content of this dictionary is developed by integrating the multimedia components such as picture, graphic, animation (Mokhtar & Anuar, 2015) and video (McKee & McKee, 2012). The availability of online dictionary has helped the HI people to access it anytime and make it easier for them to search for a word which corresponds with its sign (Setiawan & Pradana, 2017). Moreover, it takes a shorter time to search for a word online compared to using printed dictionary (Jensen & Øvad, 2016; Setiawan & Pradana, 2017). In brief, it can be said that digital dictionary benefits the HI community by making word search easier and faster.

C. Learning Theories

Dual Coding Theory is a theory of cognition which states both visual and verbal information is processed separately. This theory explains that visual is processed images and events whereas verbal is processed linguistic information (Paivio, 1986). According to Anderson and Bower (1973), verbal information can be enhanced when paired with a visual image, real or imagined. In addition Levie and Lentz (1982) stated that children learned more from text that was presented with illustration. Hence, incorporating the dual coding theory with the proper technology can make the educational process more meaningful (Norziha Megat, 2014; Aanstoos & Academy 2003).

Cognitive Load Theory (CLT) was introduced by John Sweller in the late 1980. CLT suggests learners' mental capacity should not be overloaded to ensure that they could absorb and retain information effectively. Short-term memory or working memory can only retain in a certain amount of information at once. Thus, students will not actually learn what is being taught nor recall that information for later use if more information is delivered at once. (Sweller 1988, 1994). This theory is suitable for instructional designers to control the conditions of learning within an environment or most related to instructional materials (Norziha Megat 2014; Nor'ain Mohd. Tajudin *et al.* 2007; Sow 2007).

According to Mayer (2005), people learn more intensely from words and pictures than from words alone. In addition, multimedia instructional design is used for cognitive research in order to combine words and pictures to enhance learning skill. The brain selects and organizes information in order to produce mental construct from words, picture and audio.

Thus, this article highlights how the mobile application dictionary for the HI was developed and evaluated the interface design using the heuristic method.

III. METHODOLOGY

The methodology employed is divided into two parts, which are the software development of Mobile Dictionary Application for the Deaf and the evaluation of the application by experts. Before the development of the application, this research has conducted a preliminary study to identify the issue faced by the HI in understanding the dictionary (N. R. M. Suhaimi, N. M. M. Zainuddin, R. C. M. Yusoff, R. Ali, N. Maarof, R. Ibrahim, 2016). This activity was conducted at the special education school for deaf, which is located in Kuala Lumpur. From the feedbacks gathered, it showed that teachers and students had difficulties to bring the sign language dictionary everywhere because of the thicknesses of the dictionary. In addition, the thickness of sign language dictionary has caused teachers and students took longer time to access targeted information. Thus, developing mobile applications for HI dictionary can bring positive impact to the sign language learning environment.

A. Software Development Model of Mobile Dictionary Application for the Deaf (SDAAD)

In developing the mobile application, the Waterfall Model and Mobile Application Development Life Cycle were combined. Fig. 1 shows the five phases in SDAAD development. The phases duplicated the Waterfall Model (Royce, 1970), while the repetitive cycle at the development phase duplicated the Mobile Application Development Life Cycle (Vithani, T and Kumar, 2014). The mobile application development life cycle was used to overcome the limitations of the Waterfall model. This has been due to the fact that repetitive cycle allows room for improvement during the execution phase without having to finish all the sequences.

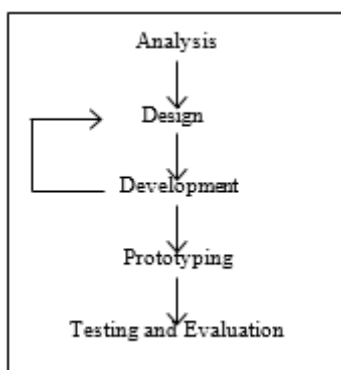


Fig. 1. Software Development Model of Mobile Dictionary Application for the Deaf (SDAAD)

1) Phase 1: Analysis

Analysis phase helps to identify necessary specification of the interface design and learning technique that needs to be embedded in mobile application for the dictionary. In this phase, any specification needed was captured by analyzing data gathered on phase 1 which involved interviews with teachers and the literature review done. As a result, analysis phase was able to identify important attributes of interface design and learning module that were needed in order to proceed to the next phase which was the design phase.

2) Phase 2: Design

This phase utilized the conceptual model to get interface design accordingly. Conceptual model helps a designer to avoid unnecessary factors during design phase. During the design phase dual coding theory, cognitive load theory and cognitive theory of multimedia were employed in designing the application. There were eight main modules which were Abjad, Angka, Anggota Badan, Haiwan, Buah-buahan, Sayur-sayuran, Ucapan and Suku kata.

3) Phase 3: Development

In this development phase, output in design phase was an input for the development activity. Activities that were involved in the development process were building several interface designs, developing the navigation button, and organizing each topic accordingly to ensure users understand the content and could manage the application easily while using it. The use of color, text size was based on human interactions for mobile application principles used in developing the application. This developed application focused on the early education, hence it was suitable for preschool and year one HI students. It covered simple words and their signs. Justinmind prototyper was used as the platform for developing mobile application for the dictionary. Justinmind prototyper was chosen as a platform because it had the needed functions. In addition, it was also faster and simpler to use which could save much time in the development stage.

4) Phase 4: Prototyping

Prototyping phase focused on implementation of mobile application of the dictionary involving the integration of interface, the module and the sub module. The mobile application operated in Justinmind prototyper application that was installed in mobile devices.

5) Phase 5: Testing and evaluation

During the testing and evaluation phase, experts' assessment was used to improve the application. More explanation will discuss in next section.

B. Evaluation of Mobile Application Dictionary for the Deaf

The number of experts involved in evaluating application was important. There were various research opinions on the number of experts involved in evaluating a software. Based on previous studies conducted three to five experts in one area of expertise involved in consumerism testing already cover 80 per cent (Nielsen & Molich, 1990; Turner, Lewis, Nielsen, & Karwowski, 2006; Virzi, 1992). However, two to three experts could be employed if the expert has expertise in two fields or double experts. The expert can find 60 per cent of consumer issues that make 2.7 times better than novice users and 1.5 times better than experts in one field (Nielsen, J., and Mack, 1994). Therefore, this study involved only four double experts who had the expertise in human computer interaction, sign-language or software development. Quality of the users' experience when interacting with the prototype was important to measure, hence this phase involved the evaluation which consisted of two parts which were evaluation of interface design (Nielsen & Molich, 1990) and evaluation of learning design (Albion, 1999). The face validity and construct validity of the instrument were done before experts' analysis was conducted.

IV. FINDINGS

Findings of this research are divided into two parts, the software development and evaluation of the mobile application dictionary for the HI.

A. Development of Mobile Application for Deaf

Based on the obtained data through analysis phase, this study designed and developed the mobile application for the dictionary for the deaf. The prototype contained 13 main screens, which were the welcoming screen, four home page screens, alphabet screen, number screen, basic human body part screen, animal screen, fruit screen, vegetables screen, greeting screen and noun screen.

Fig. 2 depicts a screenshot of the welcoming screen. This was the first page that users would see. This screen played for a few seconds then, the next screen would be displayed. The element in the welcoming page was integrated with the human computer principle for mobile devices.

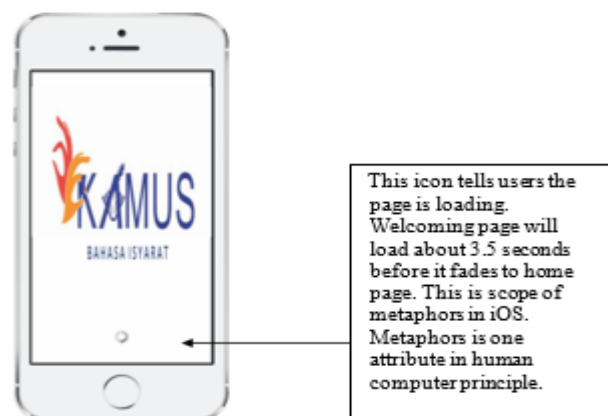


Fig. 2. Screenshot of the welcoming screen

Cognitive load theory explains only limited information have to present at one time. This study applied this theory in developing the modules. Some example of modules that applied this theory are depicted in Fig. 3. Only one object and text was displayed on that screen. Besides, dual coding theory explains the way users process information through verbal and visual. Users could hear the pronunciation of the alphabet and word by clicking on the alphabet and the audio was provided. This was suitable for HI who had low hearing rate. Moreover, students also could also view the sign language by clicking the button "Isyarat Tangan". The home button was included in the mobile application shown in Fig. 4. This was based on the human and interaction principle which encourages users to use shortcuts (Nathan, Hussain, & Hashim, 2018).



Fig. 3. Welcoming screen

V. CONCLUSION

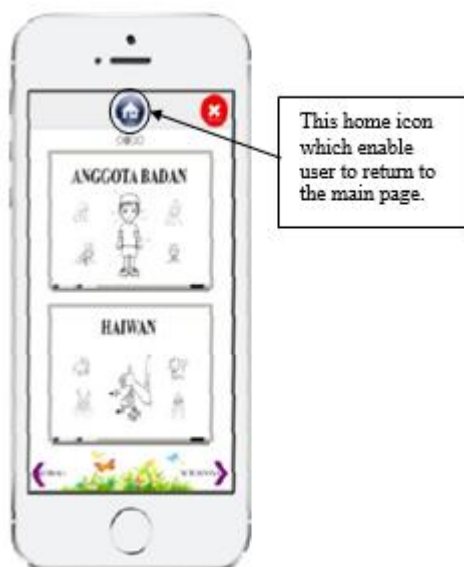


Fig. 4. Basic human body and animal screen

The results for the testing and evaluation were analyzed to show the necessary change that needed to be done in this mobile application. Table 1 shows the suggestions from the experts.

TABLE 1. Suggestion from Experts on Mobile Application for Deaf Dictionary

No	Suggestion from experts	Reason
1	Font need to change from times new roman to century gothic	Deaf student easy to understand with century gothic font
2	Alphabet with uppercase need to change to lowercase.	Pre-school and year one students start to learn with lowercase
3	Color the object	To make the learning process more interesting.
4	Add element to search for category	More user friendly
5	Increase time display for sign language when button 'isyarat tangan' is click	Information display can be absorbed effectively

Content Validity Index (CVI) was used to evaluate the experts' findings (Pilot & Back, 2006). A questionnaire was employed and it consisted of two parts- part A and part B that focused on the evaluation on interface design and evaluation on the learning design respectively. The collected data from the experts' review was summarized and it was found that the value of CVI was 0.91 for the features of interface design and 0.83 for learning design. Hence, this has proven that the value of content validity index (CVI) is acceptable.

This study focuses on the development and evaluating of mobile application dictionary for HI students. The current manual dictionary for HI is heavy and using it requires students and teachers more time to access the information needed. SDAAD model was used in the development of mobile dictionary application. Certain principle and learning theories such as HCI principle and Dual Coding Theory, Cognitive Load Theory and Cognitive theory of multimedia learning were applied in the developing of mobile application. An expert assessment was carried out once the prototype had been developed. This assessment was conducted to seek the experts' opinions on improving the application and hence, based on their suggestions and comments, the necessary improvement works were done. The findings showed that the CVI was 0.91 for the features of interface design and 0.83 for learning design. Therefore the result was acceptable (Pilot & Back, 2006). The study can bring about the change in teaching and learning from the traditional learning into the technology-friendly environment. The use of mobile dictionary application in the classroom can make the learning process more meaningful and effective. Hence, special education students like the HI students can have the same quality education as any typical students. Some limitations might be related with the design features. The mobile application design should consider adding more colors, changing the font type and font size that can attract the HI students' interest and help them to better understand the content as HI students are visual learners. Moreover, animations can be added to make the learning process more appealing and interesting. Besides, time taken to display the sign language that corresponds with the word should be longer as to enable HI students to understand and absorb the information effectively. Hence, the application should have user-friendly interface to ensure that the navigation is smooth and easy. Besides, the members of the society can also use the mobile application as a tool to communicate with the HI people. As a result, the communication gap between them other people can be reduced.

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