i-Sign: Sign Language Learning Application Via Gamification

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ABSTRACT

Hearing loss is a type of disability where people who suffer from it could not hear a sound or can only listen to a sound with certain levels. People with hearing loss use sign language to communicate with others and to help them in their learning process. For this study, an interview and survey were conducted with teachers and students from SK Pendidikan Khas Melaka and few problems have been identified in the learning spectrum of children with hearing disability. They face difficulties in learning due to the lack of exposure about the correct sign language since young, difficulty in interpreting sign language in the conventional teaching material due to the nature of its static image contents, and hearing loss children are also usually less focused in the learning process and are easily distracted by their surroundings when the class is in session. To solve these problems, i-Sign is developed as a learning application that incorporates simple gamification in its development that could help hearing loss children to learn the alphabet and basic words of sign language. The use of gamification and multimedia elements provide a more interactive and fun learning environment for the students instead of using static contents, and are also used to direct students' attention to the learning activity making them more focused in the learning process. i-Sign was developed using the ADDIE model which includes the Analysis, Design, Development, Implementation, and Evaluation phases. In the evaluation phase, a usability test was conducted on 8 children with hearing loss to test the acceptance of the user towards this application and 91.89% of the respondents found that the application meets their expectation of the application capability in terms of its effectiveness, efficiency and user satisfaction. This shows that gamification can be used as an alternative learning material for hearing loss children and help expose the correct sign language to them. The application can also be used by the public that wants to learn about sign language.

INTRODUCTION

Hearing loss can be described as a condition in which one or both ears are partly or totally unable to hear. Some alternative terms for hearing loss are hearing impairment, hearing disability, deafness, and hard-hearing ("Deafness", 2017). Children with hearing loss disability are more prone to face difficulties in learning and communicating with other people. Sign language is widely used as a mean of communication for this type of disability, both for social and education communication. Sign language can be defined as the expression of communication in the form of gestural and hand signs (Neves, Rezende, Silva, Silva & Castro, 2017). It is widely used by hearing loss people which enables them to communicate and helps them in their learning process. As they cannot hear a sound, it causes them to have difficulty in communication, thus it makes them become socially isolated and lacking in self-esteem. They also have trouble in speech and language, reading, spelling, and others due to the inability to hear (Potter, Korte & Nielsen, 2014). As a result, it causes them to have a slower rate of learning compared to normal hearing children and have difficulty to communicate with hearing peers.

Problem Statement

Hearing loss children often times are faced with difficulties in communication and learning due to the lack of exposure about the correct sign language (Humphries et al., 2017). When hearing loss children are born to hearing parents, the limited knowledge of the parents on sign language makes it difficult for them to teach sign language to their hearing loss child. In the community of those with hearing impairment, hearing loss children is known as visual learners. For this study, a survey was conducted with respondents from SK Pendidikan Khas Melaka and 80% of teachers and 75% of students stated that hearing loss students are facing difficulty in interpreting sign language in conventional teaching materials due to the static images used as the content. In a conventional learning setting, hearing loss children usually do not pay attention to what their teacher is teaching due to the difficulty for hearing loss students to split their visual focus between people around them and the teacher who is the signer (Jones, Lawler & Hintz, 2014). An interview with the teacher in special education specializing in hearing loss at SK Pendidikan Khas Melaka was also conducted for this study, and the teachers mainly stated that hearing loss children are also usually less focused in the learning process and are easily distracted by their surroundings when the class is in session.

Research Objective

The purpose of this paper is to design and develop a mobile sign language learning application for children with hearing loss by incorporating simple gamification with the aim to help them in learning basic sign language that includes alphabets and basic words, and to test the usability of the application; whether or not the application has delivered the supposed tasks for them. The test would require users to accomplish a few typical tasks while using the application and the usability percentage is then measured. The development of i-Sign can be considered as an additional learning material which can help exposing the correct sign language to the hearing loss

children. Since it is difficult to learn sign language, Chuan and Guardino (2016) stated that the use of multimedia such as text, image, audio, video and animation in any learning sessions can attract the students more toward the learning content and process. According to Dicheva, Dichev, Agre and Angelova (2015), gamification implementation to any multimedia-based learning materials provides an effective way to direct the students' effort and attention toward the learning activity. The incorporation of simple gamification in i-Sign is intended for making the students more focused on learning sign language in class without being distracted by their surroundings. Since hearing loss children are often faced with difficulties in their learning process and communication, a new learning environment through interactive visualization and gamification is created with i-Sign.

METHODOLOGY

ADDIE model is the instructional design methodology used in the development of i-Sign. ADDIE is a model that can widely be used in a different kind of development such as instructional strategy, model, learning method, media and teaching materials where it consists of a systematic method for the development of training and education programs (Almomen et al., 2016). The model consists of five series of iterative phases which are Analysis, Design, Development, Implementation, and Evaluation (Culatta, 2013).

The analysis phase is where the details of user requirement are analyzed and being explained based on the problems gathered in the problem statement. In the design phase, the suggested interface, learning and gamification guidelines, and storyboard are being designed. Gamification, as defined by Dicheva et al., (2015), is "the use of game design elements in non-game contexts". The term gamification here means the game mechanics, game design or game elements are being used in a non-game setting. Gamification concept is not only applicable to serious games, but also for a variety of purposes. According to Caponetto, Earp and Ott (2014), the aim of gamification is to enhance the experience and process enacted by users in a non-gaming environment which consists of common game mechanisms such as points, badges, leader board and rewards. The list of common gamification elements can be referred to Table 1.

Table 1. *List of Common Gamification Elements*

Element	Description
Point	Keeps score and creates a sense of progression of the learning
Badges	As a reward when the user achieves certain achievement
Progress Tracking	To keep track of the user progress
Level	Indicates user's current progress
Leader board	Used to display rank
Time Limit	Act as timer
Challenges	Questions randomization every time the quiz section is accessed

Nowadays many gamified applications are being built since gamification are found to enhance motivation of user, enhance the learning activity, increase user engagements and

performance (Caponetto et al., 2014). Some of the fields that are applying gamification concept are including organizational management, health, social policy, and education. Suitable guidelines for hearing loss learning that have been obtained in the analysis phase are identified to design the content for i-Sign. Some of the key points used in the implementation of i-Sign are listed in Table 2. For this study, the class observation in Table 2 was conducted at SK Pendidikan Khas Melaka.

Table 2. *Learning Guideline Implementation in i-Sign*

Learning Type	Source	Guideline	Implementation in i-Sign
Learning for Hearing Loss Children	Guide & Teachers Class Observation	Use repetition in learning Use repetition while teaching	• Animations are repeated until the user clicks on another basic word
	Class Observation	Recall previous lessons/assessments	• The animation of basic words learning is repeated to help students memorize the information
	Educational Counselling and Disabilities Class Observation	The content must be in a simple format for hearing loss children Keep the instruction simple	• Learning modules used is in accordance to the national syllabus which is simple and easy to understand • Application is divided into learning and assessment modules to facilitate user in recalling previous lessons more effectively
Multimedia Learning	Huang (2005)	Multimedia learning should be developed interactively	• Consist navigational button where every path is linked to each other • User can quit the application anytime they want
	Hintermeister (2002)	Use readable family font text	• The text used is san-serif Fava-black font • The size of text used is 70 points where it is readable to the user
		Navigation buttons should be placed clearly	• The navigational button is placed at the top or at the bottom of the screen, so that the user can see it clearly

		Consistent use of navigation buttons	• The navigational button of the same function is used consistently in all pages
Learning Via Gamification	Siirilä & Aleksi (2017)	Different levels of difficulties	• The quiz section consists of three levels which are easy, intermediate and hard
	Glover (2013)	Merit points	• At the end of quiz session, the total score of correct answer is being displayed to the user
	El-khuffash (2012)	Consist of timer	• Timer is placed in every quiz level where it has been set to 30 seconds per question
		Randomize the quiz	• In the quiz part, the question and answers choices randomized so that the user will memorize the learning content not the question flow

The development phase involves the development of the application using tools such as Android SDK, Unity, Blender, Adobe Photoshop and Audacity. The development involves creating a learning and assessment module based on the guidelines from Table 2. The 3D human character was downloaded from www.maximo.com and rigged to display the gesture of signing basic words. Implementation phase involves the deployment of application to target user which are the students with hearing loss from SK Pendidikan Khas Melaka and train them how to use the application. Since communication difficulties exist with these students, therefore, the instructions on how to use the application will be demonstrated to the teachers, and the teachers will explain and perform demonstrations to the students.

The evaluation phase is then carried out by conducting a usability test of the application on 8 students with hearing loss at SK Pendidikan Khas Melaka. As suggested by Bevan (2006) a minimum number of 8 to 10 participants are generally required in order to make reliable estimates to uncover the usability problems. According to Nielsen (2012), usability is defined as a quality attribute that measures how easy user interfaces of a system are to be used, and the attributes that can be used to measure the usability includes learnability, efficiency, memorability, errors, and satisfaction. The purpose of conducting this evaluation is to determine how well the user can learn by using the application. The participants are required to answer a set of questionnaires, where each of the evaluation elements are given a scale ranging from 1-Yes, 2-Partial and 3-No based on their evaluation regarding the application's effectiveness, efficiency and satisfaction. The percentage score for each usability attribute is obtained by calculating the sum of the total score of questions answered Yes and Partial with corresponding weights of 1 and 0.5 respectively. Higher

percentage score indicates higher agreeability level of the participants. The testing instrument and scoring mechanism are adapted from the question set by Ismail, Diah, Ahmad, Kamal and Dahari (2011) where they used it in their testing to pre-school children learning basic Malay words.

RESULTS

i-Sign is developed based on two main modules by following the learning guidelines from Table 2 which are the learning module and assessment module. The learning module is categorized into alphabets and basic words while the assessment is divided into three levels according to the question difficulty. Figure 1 shows the interface for the learning Module Menu.

Figure 1. Learning Module Menu

Based on Figure 1, learning module consists of two topics which are alphabets ("Abjad") and basic words ("Perkataan Asas"). If user chooses the alphabet learning, it will display the alphabet learning menu screen. If user chooses the basic word learning, it will display the basic words learning menu screen. Basic words learning consists of three topics which are object ("Benda"), family ("Keluarga") and fruits ("Buah-buahan"). Figure 2 and 3 show the learning content of alphabets and basic words respectively.
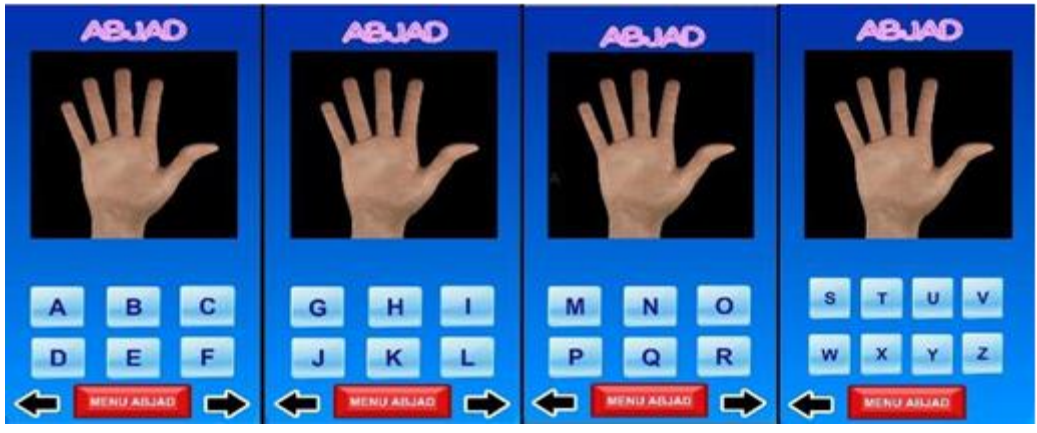
Figure 2. Alphabet Learning Content

Based on Figure 2, user can click the alphabet A button and it will display the sign language of alphabet A. This concept is also applied to all of the remaining alphabet buttons from B to Z.

Figure 3. Basic Word Learning Content

Based on Figure 3, the user will be directed to the learning site of basic words based on the chosen topic from the menu in Figure 1. In this section, when user clicks on basic word "Cermin" button, it will display the hand sign for "Cermin". This concept is also applied to all remaining basic words. Once the user has finished with the learning module, they can access the assessment module which contains random questions based on level difficulty. Figure 4 shows the quiz content for i-Sign.

Figure 4. Quiz Content

Figure 4 shows the content of quiz section that is divided into level 1, 2 and 3. Level 1 consists of alphabet question and four answer choices while level 2 consists of question and four alphabet answer choices. For level 3, it consists of basic word question and four answer choices. The total question for each level is 10 questions. Each user will be provided 5 lives and the time allocated for each question is 30 seconds in line with the use of gamification.

Usability testing is then conducted on the target user. Usability is defined as a quality attribute that measures how easy user interfaces are to be used (Nielsen, 2012). The selected usability components for the test are efficiency, effectiveness and satisfaction. According to Ismail et al.(2011), efficiency measures how easy it is for the user to accomplish basic tasks for the first time that they encounter the design, effectiveness measures how easily user can re-establish proficiency when they reuse the design, and the accuracy and completeness with which the user achieves specific goal, while satisfaction can be defined as how pleasant the user feels toward the application. Figure 5 shows the usability testing results based on efficiency, effectiveness and satisfaction based on the usage from students with hearing loss.
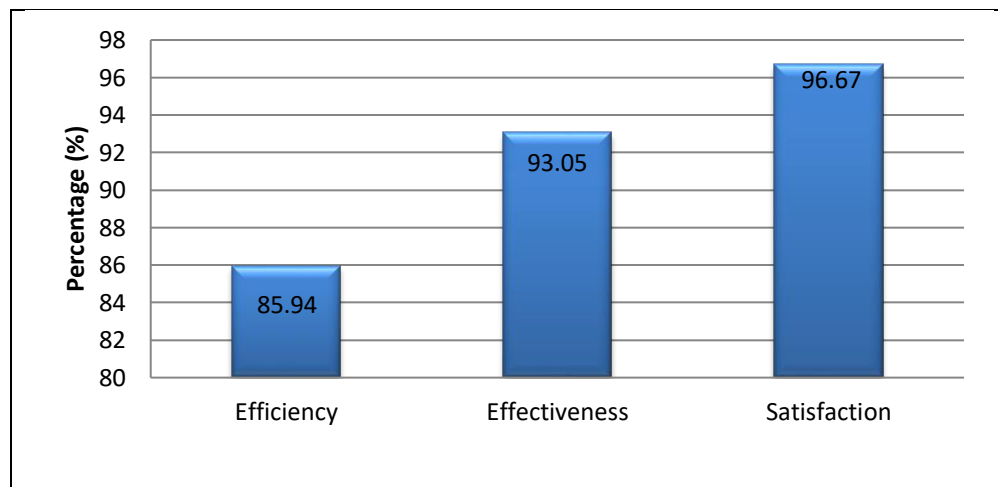

Figure 5. Usability Components Results

The participants are required to answer a set of questionnaires, where each of the evaluation attributes are given a scale ranging from 1-Yes, 2-Partial and 3-No based on their evaluation regarding the application's effectiveness, efficiency and satisfaction. The percentage scoring method for each usability attribute is obtained by calculating the sum of the total score of questions answered Yes and Partial with corresponding weights of 1 and 0.5 respectively. Based on Figure 5, the total percentage for efficiency is 85.94%, 93.05% for effectiveness and 96.67% for satisfaction. Total usability value is calculated by combining the results of all three attributes and finding the average percentage. The result for the final usability testing is 91.89% where it meets the expectation of the application capability in assisting hearing loss children in their learning.

CONCLUSION

i-Sign is developed in order to provide help and act as an alternative learning material for children with hearing loss. It consists of two modules which are learning and quiz where the quiz section is separated from the learning part. Therefore, the user can focus on one module before they move to another. The user can repeat the learning process until they understand the content and then move on to the quiz module to test their understanding on what they have learned in the learning section. Simple gamification method is applied in developing the application such as applying randomization to the question and answer choices in the quiz section. This would require the user to fully understand the learning content and do not just depend on memorizing the question and answer that appear based on fixed sequence, setting a timer for the quiz section to give a sense of pressure and suspense, different level of difficulties and also providing reward points at the end of assessment based on user achievements. The contents are delivered in a 3D animation sequences making it easier for the students to understand compared to the static images from the textbook. Based on the usability test result, it shows that a multimedia application with simple gamification can help in delivering lessons effectively and efficiently for the hearing loss children.

ACKNOWLEDGEMENT

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