Augmentative Alternative Communication for Speech Delay Children with Gamifications

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HIGHLIGHTS

- An aided augmentative alternative communication (ACC) web-based system with gamifications is needed to assist the speech and language learning of speech delayed children.
- There are two main modules proposed in the ACC web-based system with gamifications, which are the speech recognition and spell session modules.
- Usability testing conducted with the thirty respondents have proved that the system is suitable for speech delayed children's learning process.

ABSTRACT

This paper discusses the development of an aided augmentative alternative communication (AAC) web-based system to assist speech delayed children between the age of four to nine years old that incorporates the gamifications techniques. The aim is to provide a set of strategies and techniques that can be used to support communications for children with communication needs. The research methodology used to develop the AAC web-based system with gamifications start with the preliminary investigation, proposing the framework of the prototype system that consists of two main modules, which are the speech recognition and spell session modules, design and development of the system and usability evaluation. The results of the usability testing that has been conducted to thirty speech delayed children showed that the ACC web-based system with gamifications have been proven satisfactory to support and assist speech delayed children in improving their speech and language learning.

Keywords: speech delay, augmentative alternative communication, children, web-based system, gamifications

INTRODUCTION

According to Sundus (2018), a child with speech delay, or also known as alalia, might uses words and phrases to express one's ideas but it will be difficult or almost impossible to be understood. A cross-sectional study conducted by Tan and Yadav (2008) reported that out of 900 children with disability attending rehabilitation provided by the primary health care clinics in Malaysia, 7.6% were cases of speech delay. Since these children as reported by Leung & Kao (1999) do not speak as well as other children their age, there is a concern that these children might have difficulties in learning, and this could impact their future.

Even up until recent years, speech or language delay are getting more common among the children in Malaysia. In some cases, children who still could not say certain words perfectly by the age of seven has forced parents to send their children to speech therapy centers. In some cases, although the class session will last for an hour, however, the children tend to focus only in the first twenty minutes. This may be due to lack of interest in the learning session (Mohamad, 2016).

As children are known to be interested in playing handheld devices, there is an innovative technology to improve speech development among children by adapting the augmentative alternative communication method or known as AAC via mobile application or web application. For instance, Mohamad (2016) has proposed the used of mobile application courseware specifically to support speech delay among Malay language speakers. In her study, it has been found that the respondents have showed positive attitudes towards the mobile application, hence, the application can be used as assistive tool in supporting speech delay learning.

Other than that, a recent study done by Kodirov, Kodirov and Lee (2020) has developed an AAC software to help both speech delayed adults and children to communicate easily with other people in office environment, schools or social gatherings. The AAC software can be used fluently where the users must input a sentence that later will be converted into an audio speech with built in voices for male or female. In addition to that, the software can also convert voices that are received via the microphones into text and display it on the screen for deaf people to read (Kodirov et al., 2020).

Therefore, for the purpose of this study, a web-based application system using the AAC method is developed to assist children between the age of four to nine years old who have speech delayed difficulties. A web-based application system was chosen because of its ease of use that can be used both on desktop and mobile platforms. Other than that, the AAC system that is developed consists of different modules that incorporate gamifications techniques with level of achievements between easy, moderate and hard questions and personalized score to encourage user's motivations and achievements.

RELATED WORKS

According to McLaughlin (2011), speech can be described as oral production of language, meanwhile language is the conceptual processing of communication that includes both receptive and expressive language. In a study conducted by Dada, Flores, Bastable, Schlosser (2020), they have stated that for most children, the acquisition of language can be described as a process in which receptive language development precedes expressive language development. Nevertheless, for children with developmental disabilities, language development may be delayed and different from their developing peers (Dada et al, 2020). Therefore, to overcome this issue, the use of augmentative and alternative communication (AAC) among children with delayed developmental abilities can be seen as a platform both for learning language and for expressing themselves (Beukelman & Light, 2020).

Murray and Goldbart (2009) explained that AAC may include any types of method used for communicating that augments or provides an alternative to the impaired or insufficient of speech and/or to meet the individual's needs. AAC may also have significant role for children with learning speech and language difficulties where it can help and support them for better communication learning and understanding language (Murray & Goldbart, 2009).

Regularly, types of AAC are partitioned into two general gatherings, known as aided and unaided of communication as depicted in Figure 1. Unaided types of AAC comprise of nonverbal methods for normal

correspondence including signals and outward appearances. Meanwhile, aided types of AAC are those mechanisms that need some extra outer help, for example, a communication board with images, for example, pictures, photos, line illustrations, images, printed words (Otsimo, 2017; Kodirov, et al., 2020).
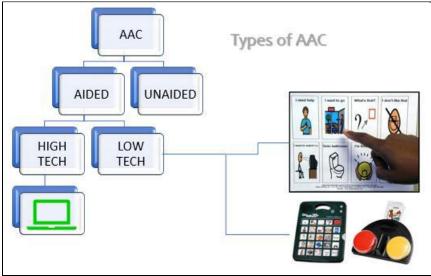

Figure 1: Types of AAC (Kodirov, et al, 2020)

In addition to an aided AAC where it can be sub divided into two other categories, which are high technology and low technology as shown in Figure 1, recent progressions in innovation have extended the adaptability, convey ability and accommodation of AAC gadgets with multiple advancements, for example, contact screen cell phones and tablets with an extensive variety of utilization, including those planned to help communication. High technology aided ACC are also described as mechanical helpers framed by peripherals, advanced slopes and AAC programming intended for individuals with complex correspondence needs. They are imagined as help instruments for the advancement of communicational skills that assist the individual identifies with his/her condition (Baldassarri, Marco, Cerezo, Moreno, 2014).

For the past years, many researches have come out with high technology AAC systems such as the use of AraBoard player, where the application that allows a user with correspondence needs to utilize correspondence sheets recently created with the constructor (Baldassarri, et al., 2014). Via this app, the user can communicate by pressing the diverse cells that create it. When a cell has been stamped, it plays the sound related to it. Other example includes a study done by Grossinho, Cavaco and Magalhaes (2014) that proposed facial paralysis patients with visual self-observing, which incorporate biofeedback in speech and language treatment by giving reward system in engaging them. The analyst proposes a toolset that can be utilized by the patient that have speech defer the issue.

Meanwhile, games in education provide a vehicle by which students can explore, solve problems, attempt challenges, make decisions, and has been proven to contribute to learning broadly (Citra & Trisna, 2013). In this new era of Education 4.0, digital gamification has been seen as part of the rehabilitation process in speech therapy where children with such disabilities have broad accessibility and motivations to practice in a more fun way outside the speech therapy clinic (Edberg & Gustafsson, 2017). For mental disabilities or delayed developmental children, game elements associated with game design can be used to assist their learning process (Lokhorst, 2014). Furthermore, Lokhorst (2014) in her study, has also emphasized on the use of avatar, 3D environment, narrative, feedback, ranks and levels in the design of the application to intervene learning process for Autistic children. Nevertheless, the research in incorporating gamifications into AAC system for speech delayed children in Malaysia is still in its infancy stage. Only few has

emphasized in using multimedia elements in the mobile app to encourage speech language learning such as study done by Mohamad (2016). Therefore, this paper focuses on the proposed framework for AAC with gamifications, design and development of the prototype system as well as usability evaluation.

METHODOLOGY

This study has undergone four main phases of research methodology, which are; i) preliminary investigation ii) proposed frameworks of AAC with gamifications, ii) system design and development and iv) usability evaluation. The explanation for each of the phases are explained below:

i) Preliminary investigation

In this phase, initially, interviews have been conducted with the therapist and the teachers, who guide and teach the speech delay children in order to acquire brief understanding of the current learning approaches and the problem that the disabled children have frequently faced. The respondents have highlighted the concern of learning process of speech delay children with language-related learning issue such as writing, listening and speaking. Further information gathering technique is used in this study, which is distributing questionnaires to the parents of the disabled children to further understand the current situation and measuring development, behavior, impairment and parental concern.

ii) Proposed frameworks of an augmentative alternative communication for speech delay children with gamifications

From the preliminary investigation, the following frameworks of an AAC system with gamifications have been proposed as shown in Figure 2 and Figure 3. There are two main modules, which are speech recognition and spell session. The gamifications elements included in this framework are levels or ranks and personalized score for each user. These elements were proposed in the development of the system to encourage the children to rank up to the next level once they have successfully collected their individual scores, thus, promoting motivations and achievements.
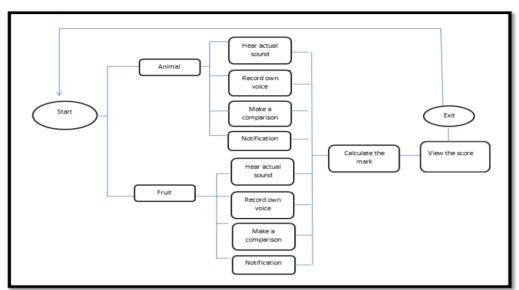

Figure 2: Framework of speech recognition module

From Figure 2, it shows the process begins with choosing the category which is "Animals" and "Fruits". For each category, the children will be asked to listen to the actual sound for each of the image. Next, the

process will continue by recording their own voice. They have to voice out the words correctly that tally with the image given. Next, the process continues with a comparison of the actual sound and recording voice by the user. The system will pop up a notification to notify whether the answer is correct or wrong. As the system had recorded the answer, it will then proceed with the calculation of the score. After that, the children can view the score that they manage to obtain. Level of satisfaction consists of five phases which are excellent, very good, good, quite good and satisfactory. Lastly, the children can exit from using the application and go back to the home page.
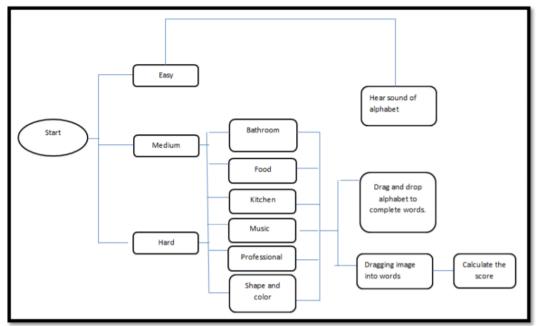

Figure 3: Framework of spell session module

Meanwhile, for the spell session module, as proposed in the the framework from Figure 3, the children will need to go through each level of difficulties starting with the easy level, then proceed to the medium and hard levels where drag and drop games are available. To encourage motivations and achievements among children, each of them need to successfully complete the easy level before they unlock the next level, which are medium and hard. Personalized scores are also given to the children to encourage them to score higher in the next attempt or session.

iii) System design and development

After the frameworks are designed, the system's interface and database are then designed. For this study, the storyboard techniques are being used to depict the overall user interfaces and use-case diagram has been created. The web-based system for ACC with gamifications is developed using web-based applications such as Php, MySQL, XML and CSS. Figure 4 below shows the storyboard designed for this system.

Figure 4: Storyboard for the AAC web-based system with gamifications

iv) Usability evaluation

Usability testing was conducted to thirty children with speech delayed disability from preschools and primary schools around Perlis, Malaysia, aged between four to nine years old. Prior to answering the questionnaires for the usability testing, the participants were briefly explained about the AAC web-based system with gamifications and then were given ample time to try the application. At this age, it is difficult for the children to understand the instructions and the way the web-based system works. Nevertheless, the participants were able to complete the usability testing after being guided and explained by the therapist, teachers and parents. The usability testing evaluated the satisfaction towards the system's user interface, interaction and navigation, content of the application, functionality and general feedbacks from the real users.

FINDINGS AND DISCUSSIONS

i)   System's Prototype

As mentioned from the previous section, the AAC web-based system with gamifications consist of two main modules, which are the speech recognition module and spell session module. These modules were selected based on the interviews conducted with the therapists and the teachers, as well as from the questionnaires distributed to the parents of the disabled children.

Figure 5: Two main modules in the AAC web-based system

Upon accessing the system via the web browser, the children will be displayed the homepage of the AAC web-based system that consists of the two main modules (Figure 5). Each module has their own games to be played by the children and scored will be saved to progress to the next levels or ranks'.

Figure 6: Speech recognition module

As described in the framework discussed in the previous section, Figure 6 above shows the categories available in the speech recognition module. Participants need to click on one of the categories, and a list of image will be displayed. Participants need to click on the image and listen to the actual word being verbally pronounced via the system. Later, they have to record their own voice pronouncing the word. The system will then compare the actual sound with the participant's speech and display their satiscatory levels and scores.

Meanwhile, for the spell session module, there are three levels of difficulty, where each participant need to complete each level before progressing to a higher level or rank (Figure 7).
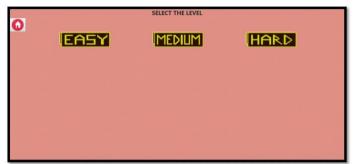

Figure 7: Level of difficulties in spell session module

For each of the level, participants need to click one the categories and will be presented with a drag and drop game for spelling as depicted in Figure 8. The audio for each of the item is also provided in this game to assist the participants in listening the name of the items and then spell them. The need to complete each challenge before progressing and score higher marks in the final level.
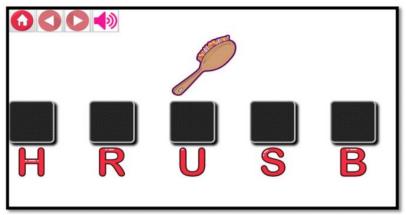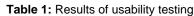

Figure 7: Example of frag and drop game in spell session module

ii)   Usability Testing

For the usability evaluation, upon using the AAC web-based system with gamifications, the participants with the guidance of the therapists, teachers or parents will answer the 5-point Likert-scale questionnaires that will evaluate the satisfaction towards the system's user interface, interaction and navigation, content of the application, functionality and general feedbacks from the real users. Table 1 below shows the mean score of each of the categories in the usability testing, derived from the descriptive analysis using SPSS analysis tool.

Table 1: Results of usability testing

User Interface Satisfaction	
The design of interface is attractive and appealing	4.16
The icon used is suitable	4.1
The quality of image is aesthetically	3.73
The quality of sound is good	2.96
The image used is easy to understand	3.43
The image used is suitable	3.36
The size of font use is suitable	2.53
User Interaction and Navigation	
The instructions given are understood	3.0
The tasks look varied and easy to follow	2.8
The system clearly laid out and easy to navigate	2.96
Content of AAC Web-based system	
The technique used for the learning is suitable	3.6
Each level task required a shorter time to finish the task	2.4
Functionality of AAC Web-based system	
Drag and drop button of alphabet functionally well	3.96
Voice is clear to be heard	2.93

All button functionally well	3.83
Speech detect effectively	3.13
The notification response is fast	3.03
The scoreboard showed the marks	4.0
General Feedbacks	
I summarized by using this application would enable the children to improve their speech developmental.	3.96
I can summarize by using this application could encourage the children to speak fluently	4.2
I can summarize by using this application enable the children to improve their memory	3.9
I can summarize by using this application enable the children to learn in attractive way	4.96

Based on Table 1 above, most all of the respondents have agreed that the user interface design is attractive and appealing. Meanwhile, only 2.96 scored for the quality of sound. This shows that the system needs to improve the sound quality in the speech recognition and spell session modules. For user interaction and navigation section, the respondents agreed that the instructions are easy to follow, although the mean score of 2.8 for the tasks look varied and easy to follow shows that some of the participants were facing problems while using the system. For the contect of the system, the technique used is suitable for learning, although it required a longer time for the participants to finish the given tasks. As for the functionality section, the audio for the voice scored only 2.93. This shows that the audio needs to be improved. And, finally, for the general feedbacks section, most of the respondents have agreed that the application enable the children to learn in attractive way with the mean score of 4.96.

CONCLUSION AND RECOMMENDATIONS

This study is carried out for the purpose of designing and developing an aided AAC using web-based application. The prototype system developed in this study is aimed to help and assist children with speech delayed concerns with the use of gamifications techniques to increase children's motivations and encouragement for achievements. From the usability testing session conducted, it is obvious that the system has contributed to a more attractive and fun way of speech and language learning for the disabled children. Although the modules covered in the prototype system only emphasized on two main modules, which are the speech recognition and spell session, however, the children managed to complete all the tasks given and have enjoyed the learning process. Based on the usability evaluation, few matters also need to be taken into considerations for future enhancements of the system, which are written instructions must be clear so that the speech delayed children will not misinterpreted the instructions and are able to use or play the system without the guidance of the therapists or their teachers. Furthermore, the system must also include verbal instructions along with the written instructions so that the younger speech delayed children can also enjoy the system without the present of their teachers, parents or therapists. Other than that, the audio quality of the AAC web-based system with gamifications also need to be improved as it will help the children to better understand the words and speech delivered via the system.

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