Game Usability Heuristics Evaluation Approach for Speech Therapy Mobile Application Games

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***Abstract*—In this paper, we present an approach used to evaluate speech therapy mobile application games using a usability heuristics evaluation method for speech delay children. Designing a mobile application specifically for children with speech delay is always a challenge. A well-designed user interface and game flow are vital in a therapy game to promote self-learning and therapy by exploration in the game. There have been many proposed and used usability evaluation methods, however, heuristics evaluation strategy was used in our study as this method was specifically designed and developed to evaluate mobile application games. There are three components in the heuristics models which are Game Usability, Mobility, and Gameplay. In our experiment, we were evaluating a local prototype of speech therapy mobile application using the game usability component because we focus more on the user interface designs. The target group of this study was pre-school children aged 3 to 6 years old with speech delay. Questionnaires were developed based on the game usability heuristics and distributed to their parents or caregivers. Interviews were also conducted to obtain their comments and feedbacks. The study results showed that the game usability heuristics are useful in identifying potential issues and problems in user interface designs of the prototype. In addition, the results also revealed that the heuristics strategy is useful in producing a set of effective design guidelines for mobile application games.**

***Index Terms*—Heuristics Evaluation; Mobile Application; Pre-School Children; Speech Delay**

I. INTRODUCTION

Mobile devices have been widely used among adults and children, and it has the capabilities to support children's learning as they are easier to use and could also provide fun and play [1], [2] and [3]. Various benefits could be gained when using mobile-based applications as the developed application can be motivative, less expensive and more accessible and engaging resources compared to paper-based assessment [3].

Several researches show that usability and user experience are the important factors in creating effective and successful mobile applications for children's learning [4] and [5]. Eshed [5] has stated that user interface design and attention to usability in mobile learning are the key concern in children's learning experiences. Well-designed and good usability of mobile applications is one of the important factors to improve their learning ability compared to poorly designed applications which may delay their learning speed [4] and [6]. Also, it is effective for the children learning progress and skills especially children with difficulties such as speech delay.

Children with speech delay commonly have the problems to produce correct sounds, syllables and words. This could affect their learning and socialization skill if it remains unsolved [7]. Therefore, a speech therapy is needed as a treatment programme. However, the treatment requires a certified Speech-Language Pathologist (SLP) which is also costly. In addition, it might be difficult for those who live in rural and remote areas to travel to the city to undergo such treatment programme. Mobile technologies have grown enormously in recent year, it is more accessible to the users. Therefore, a local prototype of mobile speech therapy application for speech delay children is developed.

An experiment has been conducted with a group of pre-school children (age 3-6) who have speech delay problem. This study is mainly focussed on Game Usability (GU) component adapted from the heuristic evaluation approach, which will be used to evaluate a local prototype mobile speech therapy application. In next paragraph, a brief overview of the background on heuristics evaluation method were provided. Section II will briefly explain the local prototype speech therapy mobile application used in our experiment. Section III describes the method and experiment used in our study. Section IV presents the results and discussions of the study, and conclusion and future work were concluded in Section V.

A. Heuristics evaluation

Heuristics evaluation was developed to evaluate the effectiveness of an application or software products [8] and [9]. However, Korhonen and Koivisto [8] believed that the traditional usability heuristics lack comprehension when evaluating games. Therefore, they introduced and developed a set of heuristics evaluation, as shown in Figure 1, which was specifically designed to evaluate mobile games. The heuristics model consists of three components which are: Game Usability (GU), Mobility (MO) and Gameplay (GP). The game usability heuristic concerns more on the game controls and interface through which the player interacts with the game. A good game usability ensures that the player will experience an enjoyable play session. Mobility heuristic focusses on the mobile aspects of the game and deal with issues that affect the mobility of the game. The third heuristic which is gameplay concerns with issues arises when players interact with the game mechanics and rules. For our experiment, we were only focusses on the Game Usability (GU) heuristic as the interface designed for children are our

main concerns especially for children with speech delay.

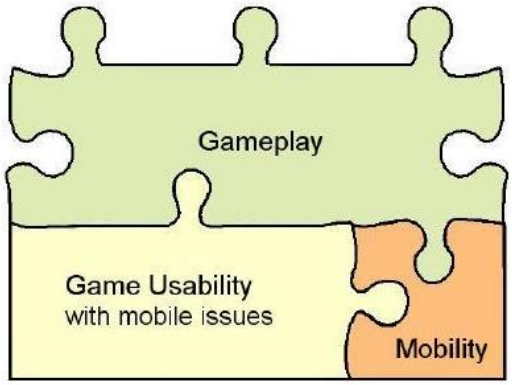

Figure 1: Three components of heuristics model [8]

Norman and Draper [10] stated that interfaces should be designed based on users' capabilities, expectations, and needs. Compared to adults, children are lack of experience and knowledge as they understand the world differently from the adults [11]. As they are growing up, their cognitive and physical abilities increase over time and the way they think and learn changes over time until adulthood [12], [13], [14] and [15]. Pre-school children of 3 to 6 years old could only hold one thing in memory at a time because they have short attention span [15]. They are also assumed as preliterate as they have difficulty to read texts at early age. Design principles that was produced and used for adults could not be applied to children's technology because their expectation, need, and skills are differ from the adults. Since children have their own goals and needs, these leads to a different design principle than the adults' [16]. Gelman [17] believes that it is very important to understand and follow the design consideration when designing basic visual and interaction design for children. Table 1 [16] shows the characteristics of 2-4 years old children that could be used as design considerations.

Table 1
Considerations for 2-4 year olds (Gelman, 2014 [16])

2-4 year olds…	This means that…	You'll want to…
Focus on details instead of the "big picture".	They can't distinguish main elements of an interface from details.	Create a very clear visual distinction between interactive items and design extras.
Can rank items by only one characteristics at a time (i.e., color, shape, and so on).	They get overwhelmed when there are too many variables competing for their attention.	Pick a smallish set of easily identifiable elements (like colors) and use them consistently throughout your design.
Can only associate a single function with an item or object.	If an item expands or makes a sound on rollover, they'll believe that's the sole purpose of that item and won't know to click on it.	Limit the behaviour of your navigation elements to navigations (for example, don't have them pop up or make noise).
Can only see items on a screen in two dimensions, not three.	Everything on a screen looks like it's in a single. Flat pane to them.	Make your foreground items much clearer and more detailed than stuff in the background.
Are just learning to think abstractly.	They are unable to understand icons and symbols that are second nature to adults.	Use icons that are highly representative of the task you're trying to communicate.
Use sound to identify items in their environment.	They get confused when different sounds have different meanings (for example, a police siren and an ambulance siren).	Make sure that every sound you use has a specific meaning and function.
Are starting to develop their own identity.	They develop a sense of self at around age 2, complete with gender identity, which forms very early.	Create a design that allows for gender identification without forcing kids down a specific gender paths.

B. Game usability heuristic

Game usability heuristic concerns more on the game controls and interface and deals with user interface issues [8]. As general rules, the game interface should allow the player to control or play the game smoothly and provides all necessary information about the game status and possible actions [8]. In general, a good game interface usability ensures that the player has an interest to keep engaged in the game until the end. The heuristics of game usability (GU) were explained in Table 2. Heuristics GU1-GU3 focusses more on the visual design of the interface. Heuristics GU4-GU6 are related to the navigation function components. Heuristics GU7-GU8 relate to the feedback components such as how the game itself could help or guide the player during the play session.

Table 2
Game Usability (GU) heuristics (Korhonen and Koivisto, 2006 [9])

No.	Game Usability Heuristics	Descriptions
GU1	Audio-visual representation supports the game	The game should look visually appealing. All graphics and audio should support game play and story; consistent and informative to player.
GU2	Screen layout is efficient and visually pleasing	The screen design should present all necessary information to player and follow the general principles of good screen layout design.
GU3	Device UI (user interface) and game UI (user interface) are used for their own purposes	The player interacts properly with the game user interface and device functions. Full-screen mode is preferable.
GU4	Navigation is consistent, logical and minimalist	All buttons and navigations should be organised reasonably, provide more clarity and easy to remember. The navigation should also be intuitive and natural.
GU5	Control keys are consistent and follow standard conventions	Standard control keys can be used since the player already knows from other games played.
GU6	Game controls are convenient and flexible	The game controls can be customised. The controls also should be designed based on device's capacities.
GU7	The game gives feedback on the player's actions	It is preferred if game user interface has a quick response on player's actions. The feedback can be presented in graphics, audio, or be tactile.
GU8	The game contains useful help	The game provides instructions to player for playing the game. It is unnecessary for player to read manuals frequently.

Table 3
Menu and activities in a local prototype mobile application

Menu	Activity
ABC	Children to learn the sound of phonic for each letter of A to Z .
Word	Children to learn the sound of each word based on the phonic sound for each letter of A to Z.
Quiz	Consists of two quizzes: a) Children to identify the phonic sound b) Children to match the same phonic sound (memory game)
Voice Record	Children to record and listen back to their own produced sound.

II. MATERIALS

As mentioned in the first section, a local prototype speech therapy mobile application for pre-school children with speech delay was developed. This prototype was developed to be used by children with speech delay and their parents or caregivers as supplementary activities at home. The content of the prototype was tailored and designed with the help of our local paediatrician and speech therapist from the Borneo Medical Centre, Sarawak. This mobile application is consisting of several activities in each of the menus. Table 3 describes the details of each activity designed in the prototype.

The interface designed was based on the design considerations and principles developed and produced for children by Gelman [6], Gutwin and Chiassonm [16]. To evaluate the designed interface of prototype mobile application, we have adapted a game usability heuristic which was developed by Korhonen and Koivisto [5]. We also believe that this evaluation method could help us to identify potential problems as it concerns more on the game control and user interface issues.

III. METHOD AND EXPERIMENT

This experiment aims to look at the game usability of the local prototype mobile speech therapy developed for pre-school children with speech delay. We have evaluated the prototype based on the game usability heuristics which was adapted from the heuristics evaluation strategy by Korhonen and Koivisto [5]. Questionnaires used during the evaluation session were designed based on the game usability heuristic. We changed the term 'game' and used 'application' since the developed prototype has been a mobile application. The feedback of the questionnaires was based on the five-point Likert Scale: Strongly agree (5), Agree (4), Neither agree nor disagree (3), Disagree (2), and Strongly disagree (1).

A. Participants

The experiment was piloted with a small number of recruitments. We have distributed advertisements at several clinics and only 10 children (6 males, 4 females) of age 3 to 6 years old with speech delay were recruited. They were referred to the study by the local paediatrician from Borneo Medical Centre, Sarawak and their parents have consented to allow their children to participate in the experiment. The experiment was conducted at Institute of Social Informatics and Technological Innovations (ISITI), Universiti Malaysia Sarawak (UNIMAS). 100% of the participants are mobile application users with experience playing mobile applications on mobile devices.

B. Procedure

The experiment was conducted on a weekly basis, 2 times a week, for a six-month duration. Parents or caregivers were allowed to join their children during the session. An hour or less was given for each session, depending on the children's emotion or mood. We will have to postpone the session if the children were in unhappy, mad, or sick state. While the children were playing the mobile application, we observed their behaviour, facial expression, and responses. An interview was conducted at the end of each session with their parents or caregivers. They were asked about their child's progress and comment on how the mobile application could affect their child's interaction with them. Once the experiment was finished, the evaluation session was conducted by distributing questionnaires to the parents or caregivers. Since our participants are pre-schoolers with speech delay, they have not yet learned how to read any texts, we let their parents or caregivers to fill in the questionnaires.

IV. RESULTS AND DISCUSSION

The quantitative results were obtained from the game usability heuristics questionnaire which was distributed to the parents or caregivers of our participants during the evaluation sessions. There were 20 respondents (2 respondents for each child) that have answered all the questionnaires. The results of the game usability heuristics for the prototype mobile application were shown in Figure 2. The overall means for game usability components is 3.98. GU7 (The activity gives feedback on the player's action) and GU8 (The activity contains useful help) has the highest mean of 4.65, and GU1 (Audio-visual representations supports the game) has the lowest mean of 3.4. 65% of the respondents were very satisfied with the feedback features provided in the prototype. We have also noticed that the children will clap and raises their hands whenever they received positive feedback from the mobile application.

However, 60% of the respondents claimed that the interface designed is lack of attractive graphics. They have also suggested during the interview that the interface of the mobile application should be designed with more colourful graphics and funny audio or sounds to attract children's attention.

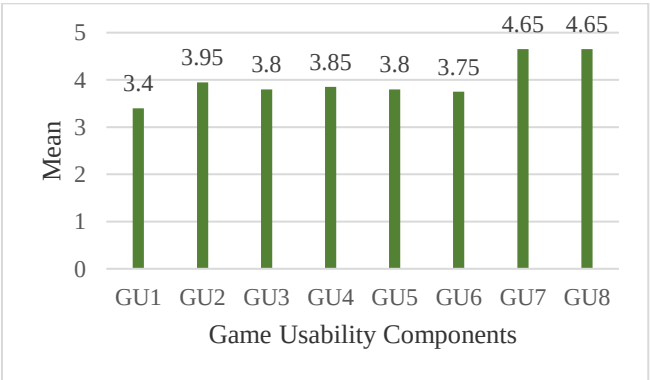

Figure 2: Average mean for each of Game Usability (GU) components

Based on the results obtained from the observation, interview, and evaluation sessions, we have noticed that interactive features play major roles in attracting children's attention to play or keep engaged to a mobile application. They are more attracted to interactive features such as animation, attractive and colourful graphics, and sound effects. Based on the results obtained from the evaluation session, GU7 and GU8 have the highest mean. These two components are related to the feedbacks components and during the interview session, most of the parents or caregivers did mentioned that the feedback features was very interesting and motivating as their children shows positive expression such as smile and cheering whenever they received interactive feedback from the mobile application.

"The feedback is very interactive and my child really enjoys it!" – Interviewer 5

"The feedback features motivate my child to finish the task given without any difficulties" – Interviewer 17

"My child really enjoy the feedback feature and cheers because it is very interactive" – Interviewer 18

These finding has proved the design principles of feedback and guidance for children's technology which was summarized by Chiasson and Gutwin [16]. Children expect and need immediate feedback just to see the results of their prompted action. They may keep repeating their actions until there is some effect from their input [16].

They also claimed to be very satisfied with the verbally-based instruction used in the mobile application. The instruction provided in the prototype mobile application is verbally and visually-based as pre-school children especially children with speech delay have not yet learned how to read any texts.

"I really like the instruction provided because my child still don't know how to read yet." – Interviewer 5

"The verbally-based instruction is very helpful for my child." – Interviewer 6

"I'm really satisfied with the instruction given and my child has no difficulties to understand it and able to follow the instruction." – Interviewer 10

Having verbally-based or text instructions read aloud are highly recommended as children are not usually read any texts on a screen [16]. Although the buttons in the prototype interface menu, as shown in Figure 3, are text-based, each button is also verbally-based which indicated the function of each buttons. The verbally-based features of the buttons in the menu was designed to help children recognized or understand the function of each buttons, otherwise they would be confused as their literacy skills level are still lower compared to an adult [16]. In Figure 4, verbally-based instruction was also applied in the interface design. The give instruction is mainly used to guide and help children to complete the activity in the mobile application.

Figure 3: Screen shot of speech therapy mobile application prototype (Main menu)

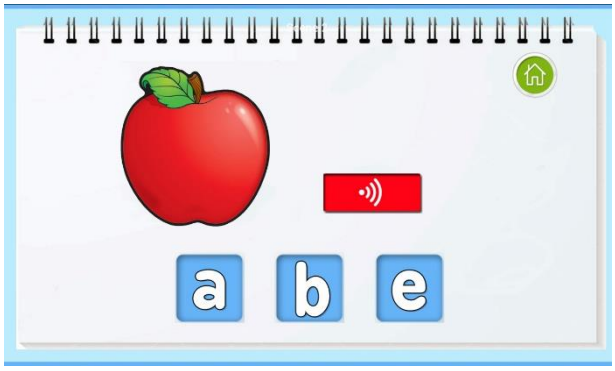

Figure 4: Screen shot of speech therapy mobile application prototype (Phonic sound)

GU1 has the lowest mean and this component is related to the visual design of the interface. Most of the respondents stated that the interface designed was too simple with lack of attractive graphics. As shown in Figure 5, most of the respondents were not very satisfied with the interface designed for the sound recording activity. They have stated in the interview that the interface designed are dull and lack of attractive features.

"The interface is too simple and not attractive." - Interviewer 3.

"The interface designed is alright but lack of interactive feature such as animated button." – Interviewer 9

Interviewer also commented that there are some features, graphics and the background colour are less preferable. For example, the blue colour background (Figure 5) and the interface of the memory game activity are less attractive compared to other interfaces (Figure 4) which is brighter and interesting.

"I don't really like the background colour in the Voice Record menu because it is so dark." – Interviewer 2

"The background colour for Voice Record interface is not attractive." – Interviewer 10

"I don't think that the background colour used in Voice Record interface is suitable for children." – Interviewer 13

We noticed that the children did not show any excitement and the facial expression is neutral when they started with the memory game activity. This shows that an interface with

attractive graphics and sounds, and with minimal use of texts are more valuable and age-appropriate, as long as the necessary information displayed is clear to the children [16].

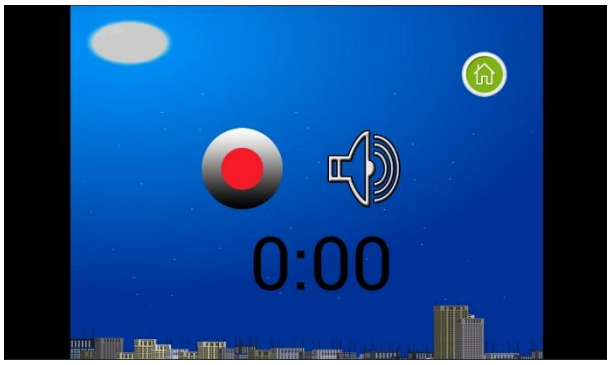

Figure 5: Screen shot of speech therapy mobile application prototype (Sound recording)

V. Conclusion And Future Work

We have adapted the heuristics evaluation strategy by Korhonen and Koivisto [8] in evaluating the game usability of the local prototype mobile speech therapy application developed for pre-school children with speech delay. These heuristics evaluation was not only useful in evaluating the game usability of the prototype, but also has allowed us to identify potential problems. We have identified several potential problems especially on the interface design of the prototype mobile speech therapy application. Children are more likely attracted to interactive features such as colourful graphics, animation, and sound effects. In addition, we have also noticed that the results indicated that these heuristics strategy could be useful in producing a set of effective design guidelines for mobile applications or games.

There are several limitations in this study. It includes the limited number of pre-school children to undergo our experiment. Also, the time constraints in running the experiment. In the future work, we are looking for more samples to evaluate the effectiveness and usefulness of mobile application therapy for speech delay children. We will also improve on the duration of each experiment session.

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