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AR-Speaking Buddy: Designing Content and User Interface of An Augmented Reality (AR)-Based Application for Malaysian Children Speaking Practice

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ABSTRACT

The application of augmented reality (AR) as a learning tool is crucial for incorporating virtual objects into real-world environments to support learners in their educational journey. Despite the growing interest in AR applications for learning, research in this area is still in its early stages, particularly concerning the development of AR applications tailored for children, taking into account their needs and design preferences. This study aims to gain insights into children's perspectives on interface and content design, specifically for augmented reality application development. By involving children in the design process, the study seeks to identify their interface design preferences for AR characters and explore the topics that interest them the most. To achieve these objectives, the paper outlines the development process of an AR mobile application named "AR-Speaking Buddy," which was designed by considering children's content needs and interface design preferences. The application focuses on providing English language learning support to children for practicing their English communication skills. The research involved 25 children aged between 9 to 12 years old as users, and their feedback on the AR-Speaking Buddy application is presented, highlighting content and interface design elements. The findings from the children's feedback shed light on essential aspects of AR application design, which contribute to the development of future interface and content design strategies for augmented reality applications in education. By understanding children's preferences and incorporating them into AR application development, educators can create more effective and engaging learning experiences for young learners.

1. Introduction

Children's learning processes have undergone significant transformations recently as a result of the growing use of mobile devices amongst children and the development of cutting-edge computer-assisted tools like augmented reality. Augmented Reality (AR) has made remarkable strides on mobile devices, particularly on mobile phones and tablets, resulting in the development of mobile ARs. This

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exciting advancement has captured the attention of educational institutions, as they recognize the potential of AR to enrich instructional methods [1]. When mobile and augmented reality are combined, they can be used as powerful teaching and learning resources as well as support tools for children. Augmented reality is an emerging technology that fuses real-world objects with virtual reality. AR is proving to be a useful tool for achieving educational goals. Using an AR application, mobile devices can be envisioned as learning aids for children. Also, by providing a more tangible and immersive experience, AR enables students to visualize and comprehend complex abstract concepts with greater ease, leading to a positive impact on learning and education [1].

Apps utilising AR have the potential to facilitate children's early English acquisition. However, few studies have examined how suburban school children who are learning English as a second language utilise and perceive an augmented reality application for language learning. Students who resided in the suburbs also encountered numerous difficulties when learning English. Students have limited platforms and reading materials to practise their English communication skills. Students also lack interest in learning English. Li *et al.,* [2] compares this group of students to a pool of stagnant water, describing them as blindly and passively learning English without emotion. Thus, it is evident that students continue to adopt the traditional learning style in that they continue to learn English in a dull and uninteresting manner. Due to our limited understanding of children's characteristics regarding their needs in learning and preferences in the interface design of the augmented reality application that children prefer, there is a need to explore this issue and come out with an augmented reality application that meets the needs of children in learning English for their communication practice. This paper is intended to show how to develop AR platforms for children to practise their English, especially those in suburban areas. The idea behind focusing on these categories of children is to expose children in suburban areas to intensive communication practise using augmented reality applications. However, there is a lack of guidelines on the needs of children, both in terms of the content and interface design of augmented reality applications suitable for children.

To address this issue, in this paper we present a mobile application that supports children in learning the English language in a more pleasant and entertaining way by using AR applications. Our contribution is focused on understanding how augmented reality can facilitate learning by providing suitable content and interface design for children. With that, this study aims to explore children's needs in interface and content design in order to create applications that can be used as a medium for speaking practise for children. AR-Speaking Buddy is an AR application created for children between the ages of nine and twelve. This application allows children to improve their speaking skills by communicating with AR-Speaking Buddy based on selected topics they prefer and communicating with the augmented reality buddy suit according to their own preferences. Due to the lack of exposure and communication mediums for children in suburban areas to practise their speaking extensively using the AR platform, this study aims to introduce them to the augmented reality application to make it easier for them to communicate based on several topics identified.

2. Literature Review

Since AR can provide additional digital content for any difficult-to-understand subject, a substantial amount of literature on its use in educational contexts has been published [3,4]. For example, Xue *et al.,* [5] demonstrated that the most frequently cited positive effect of using AR in education is user satisfaction. Students in rural Malaysia, on the other hand, receive less exposure to the English language than their urban counterparts, whether through communication or language materials and resources, with both exposures occurring solely through their English teacher [6,7]. This problem arises primarily as a result of their lack of exposure to the English language in their

environment. They consider English to be a foreign language and have expressed no desire to learn it. As a result of the existence of this augmented reality platform, children may be encouraged to practise their English-speaking skills, resulting in students in suburban areas becoming more confident and fluent in the English language. Aside from that, augmented reality applications cannot be developed on the basis of intention in the context of technology. Several important factors must be considered in order to develop useful augmented reality applications that can serve specific functions, particularly for children. As a result, understanding children as potential users in the way that children need to learn and their preferences for the augmented reality application that can be fully utilised for these children in learning to speak English with an augmented reality application is necessary.

2.1 Augmented Reality in Learning

AR is one of the most advanced information visualisation technologies available today. Azuma [8] defines AR as a potentially immersive environment that combines digital and physical elements. Mobile AR and game-based learning, according to Taskiran [9], have a positive impact on English language instruction. Because powerful mobile devices are becoming more affordable, AR in education is expected to be one of the most influential technologies of the next decade [10]. AR applications are well-suited to be used in language learning, particularly for young children. Young children who are "digital natives" are more interested in handling devices and exploring. Therefore, the existence of this augmented reality platform could ensure that children practise their English-speaking skills, resulting in students in suburban areas becoming more confident and fluent in the English language. Other than that, in regards to technology, AR applications cannot be developed based on intention. There are several important considerations that need to be taken into account in order to come up with useful AR applications that can serve specific functions, especially for children. Therefore, there is a need to understand children as potential users in the way that children need to learn and their preferences for the AR application that can be fully utilised for these children in learning to speak English with an AR application.

AR increased learner engagement and motivation by utilising animations, videos, and sound in a 3D environment that could be viewed from all angles. According to Han *et al.,* [11], an AR application can increase users' interest and attractiveness in a fun way, especially for young children. The strong visualisation features that the AR application can provide to enhance language understanding are possible reasons why young children prefer to use AR applications [12,13]. AR applications, in particular, have the potential to provide students with more active, effective, and meaningful learning experiences. In fact, AR improves student interaction and engagement by facilitating the visualisation of abstract concepts in learning. For example, AR could facilitate interaction between real and virtual environments, as well as the use of a tangible interface metaphor for object manipulation [7]. Furthermore, AR provides a novel way of manipulating and interacting with abstract concepts in the real world, which could add a whole new dimension to the study of numerous disciplines [3]. In this sense, AR improves an individual's physical and visual environments, ensuring that AR has been used as a tool to assist a teacher and student in the teaching and learning process [14]. AR has variety of educational applications. For example, Rahani *et al.,* [15] used AR to learn Logic Gates, Singhal *et al.,* [16] to learn Chemistry, Wong *et al.,* [17] to learn social learning, Litvak and Kuflik [18] to learn cultural heritage, and Yang [19] in learning object-oriented programming. Empirical research on AR enhanced English as a foreign language instruction, on the other hand, is "still scarce" [18].

2.2 Augmented Reality Application for Children in Malaysia

In recent years, there has been a tremendous increase in technological developments, which has indirectly resulted in some changes in education, including in teaching and learning in Malaysian education. Digital technology has gained significance in education, contributing to improved student understanding, knowledge retention, and visualization. Technology in education has made teaching and learning more accessible, comfortable, and enjoyable by providing easy access to information and offering engaging opportunities [20].

Several education experts also emphasised the need for some changes in the delivery of teaching and learning, as well as the development of content. In a positive way, the changes in technology and the way that children learn provide opportunities for new and emerging learning approaches. The use of AR applications is one of the current trends. AR is a promising technology that provides previously unimagined technology that better meets the needs of 21st century learners [21]. AR is said to be a proven innovative learning technology, even in Malaysia. AR has demonstrated a high potential for making learning more active, effective, and meaningful. This is due to its advanced technology, which allows users to interact with virtual and real-time applications while also providing natural experiences.

In terms of the Malaysian teaching and learning scenario, the implementation of teaching and learning in Malaysia, particularly in primary schools, continues to rely on traditional methods such as textbooks and the traditional chalk and talk, book to story, and image to explain methods [22,23]. The traditional chalk-and-talk teaching method and the use of static textbooks are failing to engage students, leading to poor learning outcomes and shorter periods of attention in a traditional class environment, and their interests can be easily distracted [24]. Hence, students become bored and easily fall asleep during class due to their inability to visualise certain concepts provided in the textbooks [4]. The introduction of technology-based approaches such as AR provides a supportive environment for all children's learning. This is synchronised with the statement mentioned in Lawrence and Tar [25] that the process of teaching and learning should be enhanced in parallel with technology's evolution to ensure children in the future are exposed to the new approach to learning.

Although the implementation of AR in Malaysia is still new, the vast potential of AR applications provides better support for learning, especially for children in primary schools. AR applications offer a new environment for primary school education. AR is also said to be the best tool for better support, allowing children to see the real-world environment with virtual objects superimposed or composited in real time. The interactive tools provided by the AR application provide learning support to the traditional teaching and learning methods, which provide an interesting approach for children to grasp new concepts and promote more interest in learning. Furthermore, AR is an alternative learning support that enables teachers to use technology to attract children to learn. These are the changes that teachers need to adapt to and try to find several ways to do. Thus, educators must find an appropriate method to deliver instruction to students and provide better approaches to improving their learning experiences. Children in primary school need to have a positive learning experience that can boost their motivation in school. According to Bistaman *et al.,* [22], one-way methods of teaching and learning as practised currently in Malaysian schools must be changed to include more senses such as sight, hearing, sound, and touch. This can be done with the help of technology such as AR applications.

However, there are some limitations in the actual adaptation of AR in education regarding some technical and social issues [26]. It is necessary to know how to build and deploy AR applications that best meet the requirements of the learner. AR has been widely applied to teaching, learning, and instructional design. However, there is currently a lack of research that discusses the user needs and

preferences for the development of AR applications. The 21st century world is becoming increasingly digitized, which is another reason why it is important for academics to be more aware of the specifics of their learners and find ways to engage with and support isolated learners [27]. Furthermore, as part of their research, Wreikat *et al.,* [7] designed and built an Augmented Technology system (aka ATTech System) for educational purposes. The element of Human Computer Interaction (HCI) is highlighted in the research with the intention to provide AR applications that meet user needs and knowledge. However, this research failed to discuss the elements of interface design and content for AR applications developed and how the user's needs and knowledge were achieved.

The AR application was chosen as the new approach as a speaking platform for children in this study. This is suggested by Petrovich *et al.,* [28]: "AR applications enable social interaction and communication through dialogue and interaction with the application and other children as well." The visualisation technique provided by the AR application provides a new learning experience for children to reach a common goal through fun interaction with the AR objects and activities. In this paper, we take a look at the importance of developing an interface and content suitable for children in the AR application being developed. This is inspired by Shneiderman and Plaisant [29] in their book, "Designing the user interface: strategies for effective human-computer interaction" stating that appropriate user interface design had changed the lives of many people by providing specific needs of interface and content while also providing effective learning for children. They also emphasised the importance of recognising the needs of diverse users in the design and facilitating the content of the application developed.

3. Methodology

Figure 1 depicts the Human-Centered Design (HCD) process that was adapted in the process of designing the user interface and content design for an AR application.

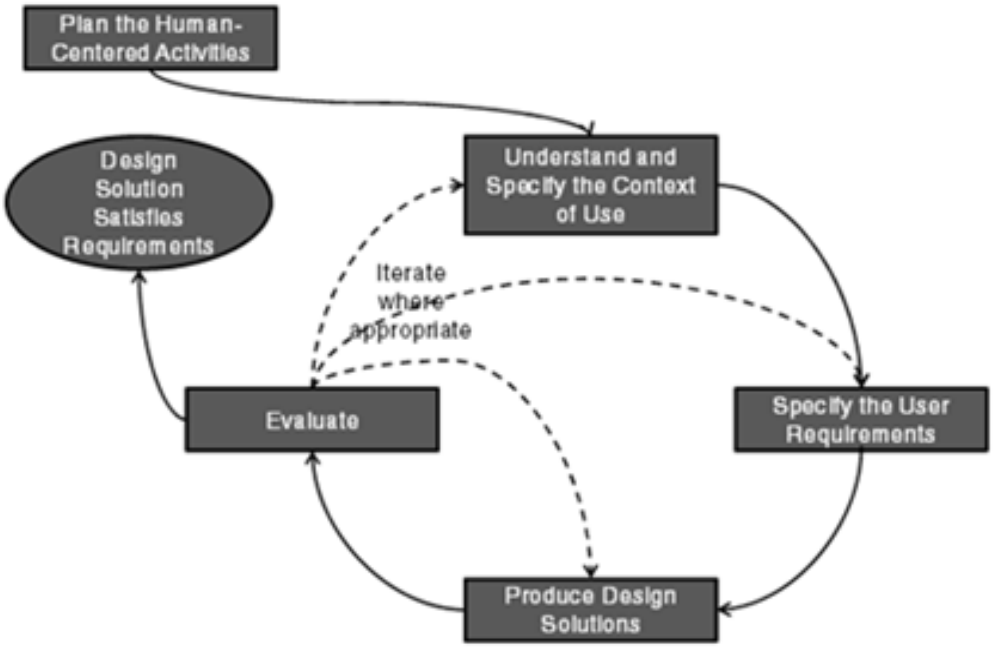

Fig. 1. The HCD process model in ISO9241-210 (1999) from Bevan [30]

The HCD process entails four (4) critical stages that are implemented in this research, including the following:

Stage 1: Understand and specify the context of use
Stage 2: Specify the requirements
Stage 3: Produce design solutions

This study collects the user's explicit information by gathering the necessary data in a primary school setting. For the production of AR content for children, the explicit information is useful in providing the necessary understanding of the suitable topics to be included in the application. This study examines the content as a solution due to the necessity of selecting appropriate material for children who struggle speaking English for communication. To discover acceptable content for children, specific data on their needs and preferences in English-speaking countries and personal information about each other child were gathered. All the information gathered is necessary to have a comprehensive understanding of the real causes of children's difficulties in English communication and to establish each child's individual needs and preferences for a user interface and content design. Figure 2 details the data collection activities used and the outcome(s) of each activity.

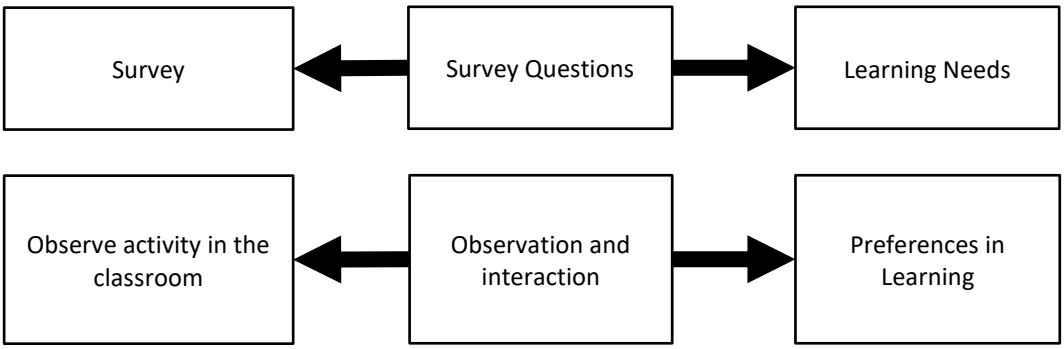

Fig. 2. Data collection process

4. Designing Interface Design and Content of AR-Speaking Buddy Application for Children

4.1 Understanding Children Needs and Interface Design Preferences in Learning

In this study, the component of needs refers to the things required for the tasks to be completed. Needs are inextricably linked to the learner's interests and preferences. Meanwhile, the preferences are components that are important in determining the structure of the interface and content design. The ability to track a user's needs and preferences is a critical indicator of a successful AR application. Children require repetition, a speaking buddy, and the ability to choose their own topic of interest for speaking purposes in an AR application. These two components—needs and preferences—serve as the foundation for developing the AR application for children to practise speaking. The observation and survey conducted show several important findings that allow us to understand children's perspectives in designing user interfaces and children's experiences to be applied in the AR application for children.

4.2 Specify the Design Requirements on Children Feedback on Interface Design and Content for AR Application

In this study, there are five-character types introduced for the children. The data collection allows children to be involved in the selection of the AR character to be included in the application. The five types of AR characters include the humanoid character, the robot character, the animal character, the object character, and the strange things character. In addition to that, the children are also asked

to determine the characteristics of the character design and attributes that suit their needs and preferences. For the content design of the AR application, students participating in this study are asked about the most interesting topics they would like to talk about. Provided here are several findings from data analysis on the needs and preferences of children in relation to the user interface design and needs for designing AR applications for children.

4.2.1 AR application character design and attributes

Figure 3 depicts the type of AR-Speaking Buddy that children prefer. The result indicates that the majority of children preferred a robotic humanoid character, while the strange creature character is the least preferred character chosen by them.

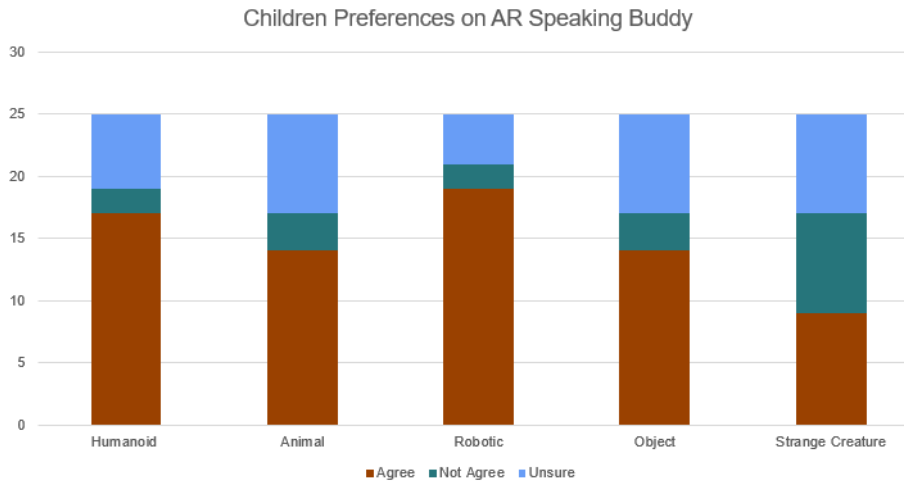

Fig. 3. Children preferences on AR-Speaking Buddy

In terms of physical appearance and characteristics of the AR-Speaking Buddy, Figure 4 shows each character of the AR Buddy with specific characteristics that the boy prefers.

Fig. 4. Boy preferences on character and characteristics of AR-Speaking Buddy

In terms of physical appearance and characteristics of the AR-Speaking Buddy, Figure 5 shows each character of the AR Buddy with specific characteristics preferred by girls.

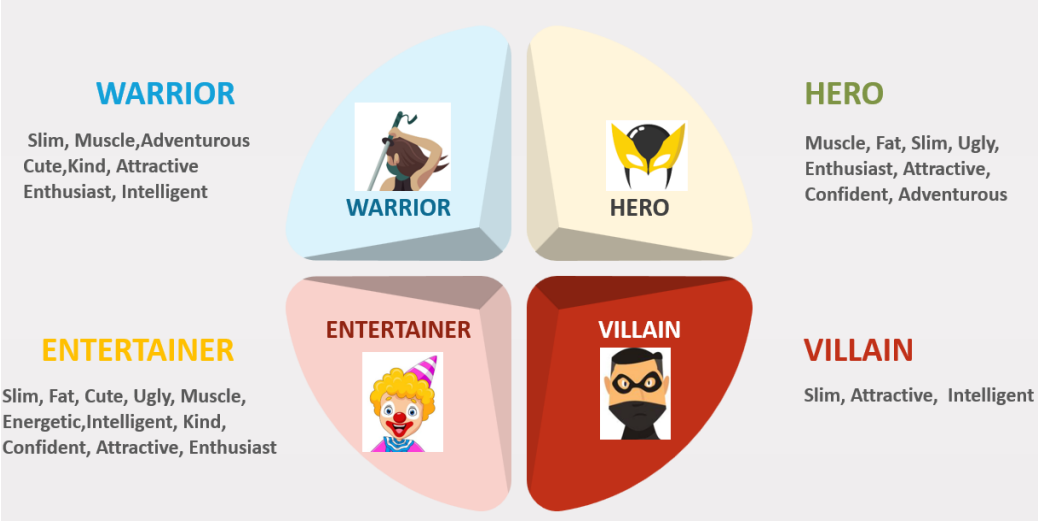

Fig. 5. Girl preferences on character and characteristics of AR-Speaking Buddy

4.2.2 Content design of AR application

In regards to the content preferences of children, children were asked about their preferred topic to talk about. All children were allowed to choose more than one topic. The results shown in Figure 6 indicate that there is not a big difference in the topics preferred by boys compared to girls. The topic is merely related to the children's environment and easy to talk about with them. Hobbies and ambitions are the most popular topics for both genders. Meanwhile, topics about teachers, favourite games, and video games are among the least favourite.

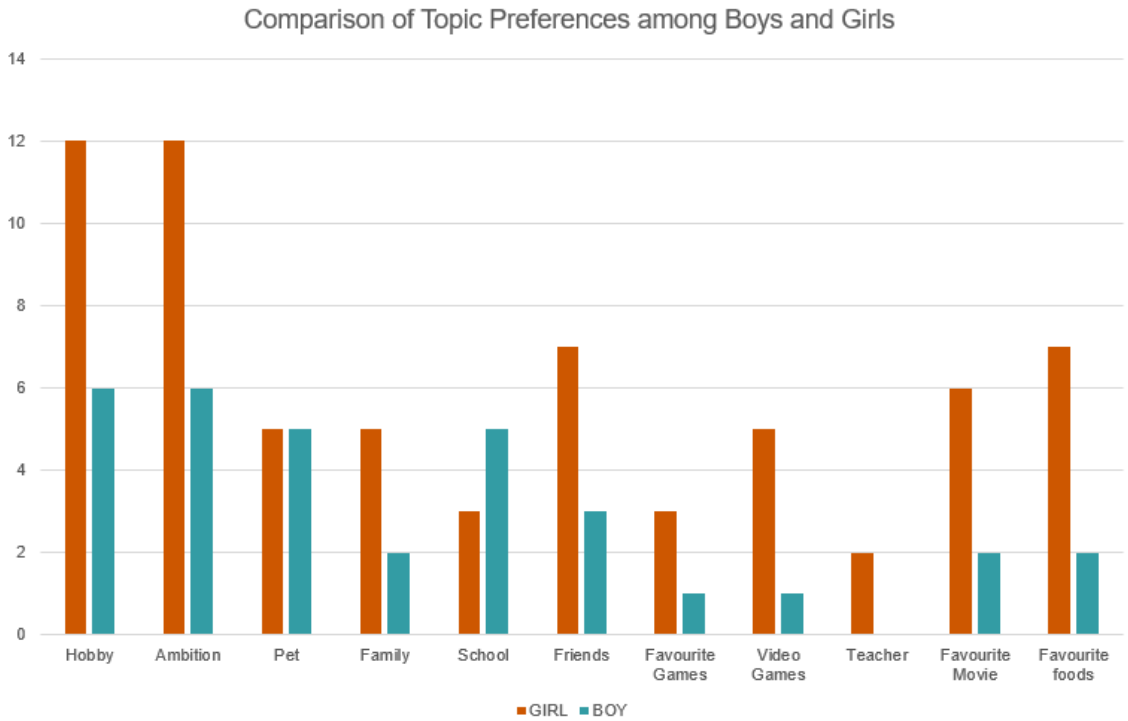

Fig. 6. Comparison of preferences topic to talk between boys and girls

4.3 Augmented Reality Application for English Speaking for Children

In the AR English speaking platform application, the interface design is determined by the requirements gathered during the analysis phase. These elements include a variety of multimedia components, including characters and their attributes. The application of the elements will make the product stand out because it will appear more engaging. In this paper, we present the interface preferred by children for the AR-Speaking Buddy. This is inspired by Elmqaddem [26], which stressed the importance of designing a character with suitable traits and attributes to promote the interest of the learner. Meanwhile, content design focuses on interesting topics that children are comfortable talking about. By providing the needs in interface design and suitable content for speaking practice, it allows the children to interact in a comfortable manner that will help them indirectly improve their English speaking with good practice. Table 1 provides a summary of children's needs and preferences that need to be taken into consideration when developing AR applications or children's speaking practice. The needs of children are important elements that need to be embedded in the development of the content and interface design of the application. By providing the necessary needs, it provides supporting solutions for the children to improve their learning. Meanwhile, preference elements promote the interest of children to use and engage with the application for the learning process to happen in an effective manner.

Table 1
Summary of children needs and preferences for AR application

Needs	Preferences
Speaking companion	Selection of type of speaking buddy
Repetition to use the AR platform	Characteristics/traits of speaking buddy
Guide on correct English pronunciations	AR-Speaking Buddy suit with their preferences and their interest
Familiar topic to practice speaking	

4.3.1 Interface and content design strategies

Table 2 provides the information on strategies to design user interface and content of the AR application based on children needs and preferences. The information is crucial and becomes a source of reference in helping the designer to make decisions on the interface design elements and the process to be included in the application.

Table 2
User interface and content design strategy

Needs	User Interface Design Strategy
Speaking companion.	Provide AR-Speaking Buddy to interact with children.
Repetition to use the AR platform.	Allow children to use the application based on their pace in learning at their requested time.
Guide on correct English pronunciations.	Provide English pronunciation practice.
Familiar topic to practice speaking.	Provide list of topics for the children to choose.
Preferences	**User Interface Design Strategy**
Selection of type of speaking buddy**.**	Provide list AR character for the children to choose.
Characteristics/traits of speaking buddy.	The most preferred characteristics and traits are embedded in the development of AR-Speaking Buddy.
AR-Speaking Buddy suit with their preferences and their interest.	The most two preferred character types are included in the AR application for the children to choose.

4.3.2 AR application screen design

Provided here in Figure 7, Figure 8 and Figure 9, are examples of several screen designs of the AR application developed after taking into consideration the needs and preferences of children based on the findings of this study.

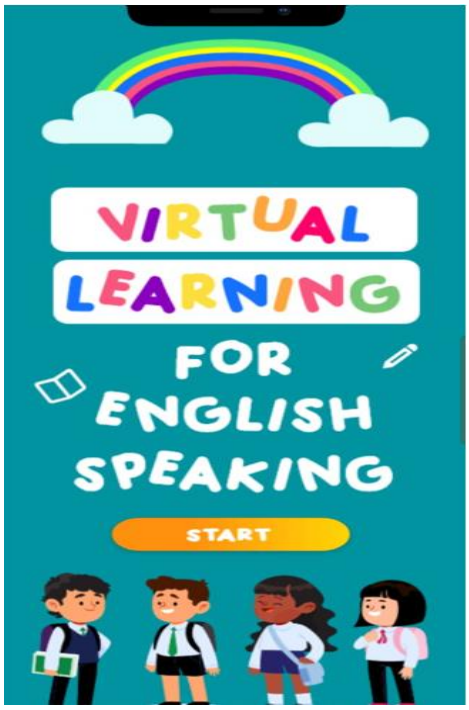

Fig. 7. Main page

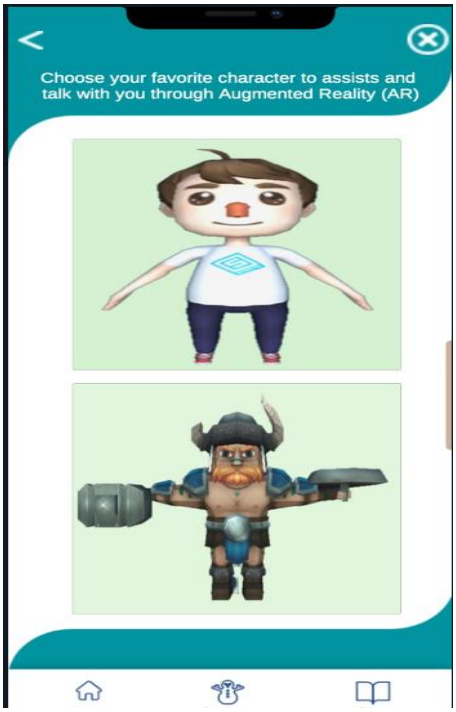

Fig. 8. Selection of AR buddy

Fig. 9. Available characters

5. Conclusions

When compared to the existing applications on the market today, this AR-Speaking Buddy application has several advantages. To begin, it is possible to conclude that the development of this AR English speaking application is successful in providing an enjoyable application due to the consideration of children's needs and preferences as priorities in the user requirement process collected at the start of the development. Aside from that, this application employs multimedia elements, which are required to provide interactive elements in the AR application developed. In addition, the findings of this study are also useful to be used as a source of reference for the designer to design the user interface and content for the development of AR applications for children. By considering children's needs and preferences, perhaps this study can provide benchmarks on several important elements that have been overlooked by previous research in the areas of interface design, AR, and education on the importance of understanding users before the designing and development process begins.

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