



INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES



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To Link this Article: <http://dx.doi.org/10.6007/IJARBSS/v11-i11/11356> DOI:10.6007/IJARBSS/v11-i11/11356

Received: 25 September 2021, **Revised:** 30 October 2021, **Accepted:** 06 October 2021

Published Online: 22 November 2021

In-Text Citation: (Hashim et al., 2021)

To Cite this Article: Hashim, H. U., Yunus, M. M., & Norman, H. (2021). 'AReal-Vocab': The New A La Mode of English Vocabulary Learning for Children with Autism. *International Journal of Academic Research in Business and Social Sciences*, 11(11), 1383 – 1393.

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Vol. 11, No. 11, 2021, Pg. 1383 – 1393

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www.hrmars.com

ISSN: 2222-6990

'AReal-Vocab': The New A La Mode of English Vocabulary Learning for Children with Autism

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Abstract

American Psychiatric Association defined autism spectrum disorder as a neurological disorder due to which diagnosed child may face difficulty in social communication or have a repeated or restricted set of behaviours. Learners with autism are mostly visual strategy learners and they tend to learn better through pictures and images. Due to their cognitive disabilities, most learners with autism struggle to acquire new vocabulary and with the existence of fourth industrial revolution, the use of technology is no longer a stranger to the education field. Hence, the use of augmented reality technology is considered in this study as past literature has proven that augmented reality technology could help to provide autism learners with a more meaningful learning session. In conjunction to that, this study is aimed at developing a mobile augmented reality application named 'AReal-Vocab' to help learners with autism, which then later to be employed as an intervention to autism learners in their English vocabulary learning process. The developed mobile augmented reality application is employed to two mild autism learners aged 7 and 10 years old to qualitatively discover their acceptance towards the developed mobile application. Based on the findings, it can be seen that AReal-Vocab application has given a significant impact on autism learners' language learning process. AReal-Vocab has helped autism learners to learn English vocabulary in a more interesting yet meaningful manner and at the same time sparks their interest in their English vocabulary language learning process.

Keywords: Autism Spectrum Disorder, Augmented Reality, ESL Learning, English Vocabulary, Mobile Learning, Mobile Application

Introduction

The fourth industrial revolution (4IR) technological advancements are changing our lives and are extending possibilities that were never possible before (Du Preez & Sinha, 2021; Kravchenko & Kyzymenko, 2019; Hashim, Yunus, & Hashim, 2018). As rapid advancement continuously alters the day, we do things and enhance our daily activities, these technologies are merely tailored for normal citizens causing people with special needs, including children with autism, to be left behind. Previous studies have indicated that there is an urgent need for learning to be inclusive regardless of special needs, especially children with Autism Spectrum Disorder (ASD) (Thompson et al., 2021). Previous studies have also revealed that

4IR research is lacking in the field, yet could potentially be used to assist children with autism in their English language learning, specifically English vocabulary learning (Ally & Wark, 2020).

In the global and local landscapes, a pressing issue has been illustrated, in which the underprivileged community, especially children with special needs, are left behind (Asamoah, Tam & Cudjoe, 2021; Sulasmi & Akrim, 2020). When it comes to education, especially English language learning, children on the spectrum tend to have less tools that are able to assist them with the English language learning. As we move towards UNESCO's sustainable development goals (in which number four lays emphasis on inclusion of education via quality education), there is an urgent need for learning to be inclusive regardless of special needs, especially children with autism spectrum disorders (ASD) (UNESCO, 2017; Balakrishnan & Alias, 2017). To date, an increasing number of children across the globe are being diagnosed with autism. ASD causes a child to experience persistent problems in social communication and interactions across multiple contexts as well as show restricted, repetitive patterns of behaviour, interests and activities. These symptoms can be categorised into mild and severe symptoms, where higher levels require more support in daily life (Koo, Gaul, Rivera, Pan & Fong, 2018). In previous research with regards to learning, children with autism usually learn about social communication and interactions with physical media such as visual cards (Allen et al., 2017). For example, in indicating whether a child is in hunger, visual cards help to indicate level of hungriness. While the physical cards have been discovered to assist ASD children (Satari, Yasin, Toran & Mohamed, 2020) fourth industrial revolution integration of fourth industrial revolution technologies can further extend these possibilities, with regards to mobility, seamlessness and contextual learning (Rafiq & Hashim, 2018).

There are quite a number of learning theories research that has convinced both educators and researchers on the impact of augmented reality technology in education. Children with Autism Spectrum Disorder (ASD) are unique in their own ways. They definitely have different ways of thinking, also different way of behaving. Due to that, their characteristics and behaviours when it comes to learning are also different from other people. Children on the spectrum tend to learn differently from the mainstream children. Personalised learning notion supported the individual learning differences among autism children (Good, 2012; Colley, 2013). Technology is well known for its flexibility and it is believed that personalised learning can be inculcated via technology; specifically augmented reality technology. Milne, Raghavendra, Leibbrandt & Powers (2018) have gathered that existing research on children with autism suggest that autonomous learning approach via technology or virtual world can be used to improve their language and social skills. In conjunction to that, this study is aimed at 1. Developing a mobile augmented reality technology application for vocabulary learning of children with autism, 2. Implementing the prototype of the developed application to two autism children and 3. Evaluating the acceptance of the two autism children towards the developed mobile augmented reality application.

Literature Review

Technology in Autism Education

Technology is apparently has been making its waves among autism children and education as early as 2012, as proven by (Vellonen et al., 2012) in their study on communication of children with autism in a technology-enhanced learning environment. They have conducted the study in a Finnish comprehensive school that uses technology based workstation such

as building with bricks, symbol matching and storytelling via technologies to the learners with autism. Both educators and specialists believed that teaching children with developmental disabilities like Autism Spectrum Disorder (ASD) requires special set of tools and methods, due to decreased level of attention towards stimuli presented and lessened capability to learn in ways typical children do. This is agreed by (Hulusic & Pistoljevic, 2018) who have invented the 'Read, Play and Learn' which is an interactive E-book for children with autism. They believed that children with autism may master more educational objectives using a computer compared to traditional teaching strategies. Gadgets and their unique features make it as an attractive medium for very young children and with appropriate usage, content and context, the use mobile application may indeed contribute positively to learning (Papadakis, Vaiopoulou, Kalogiannakis & Stamovlasis, 2020). These very young learners will also more interested and motivated to learn through computer-assisted instruction. From the teachers' survey they have conducted, the findings have revealed that the students found iPads motivating which made them reinforces, and in turn decrease their inappropriate behaviours in the classroom. They believed that technology such as game based experience provides these learners with a multi sensory experience to relate to basic learning concepts.

Augmented Reality (AR) Technology for Children with Autism

Evidently there have been many previous literatures written upon the use of augmented reality technology in the education field for children with autism. Quintero, Baldiris Navarro, Rubira, Cerón & Velez (2019) in their study on the current state of Augmented Reality (AR) Technology as an educational technology in today's world have figured out that a high percentage of studies were applied to primary education, but studies are lacking among the education for secondary school, early childhood and short-term education. They believed that AR assisted in boosting up motivation, interaction and catching students' interest regardless of their level of education and age including the students with disabilities. Bhatt, De Leon & Al-Jumaily (2014) have also developed games using augmented reality through Actionsript 3.0 and Adobe Flash CS6 when they discovered that children with autism need an assisting tool in helping them to become more comfortable and familiar with unfamiliar people, also surroundings. In Delhi, India, a mobile phone application called ARWAK which stands for Augmented Reality Wordbook Smartphone application was invented for kindergarteners. Jain, Patil, Nawal & Chakraborty (2018) developed the application to make the learning process more interactive and intuitive. They have implemented the application to the kindergarteners from January to April 2018 and they have gathered that the children can learn slightly more number of words from the application rather than from a printed wordbook. They were also able to increase the children's participation and keep them engaged for a long time.

Locally, in Malaysia, Suparjoh, Shahbodin & Mohd (2019) have conducted a documentation on the potential of Augmented Reality Technology to support the interest based learning of children with autism. They have accumulated that Augmented Reality has wide potential in supporting the therapy, intervention and also the education of children with autism. They believed that three main advantages of Augmented Reality in autism education would be helpful in learning engagement, learning interaction and also learning process. Nazaruddin & Efendi (2018) believed that children with autism encounter the difficulty of focusing through the object carefully, especially when the objects are not able to attract their attention. Hence, in their study, they have invented a prototype of an augmented reality pop up book to

increase focus and object recognition capabilities for children with autism. They believed that the pop up book in a way will be able to increase the autistic students appreciation on objects introduced to them.

Mahayuddin & Mamat (2019) have also investigated the use of augmented reality technology on mobile devices in fostering literacy for children with autism. The prototype innovated has helped the autistic children to capture and associate the graphics or pictures of the surroundings, as well as has improved the literacy and learning skills of the children. Augmented reality technology has manage to create an interesting approach to enhance the effectiveness and attractiveness of the language learning for the children with autism in real-life scenarios.

Methodology

This study employed a developmental research approach based on Richey & Klein (2014) whereby five phases are applied in this study based on ADDIE Model Type 1;

Needs Analysis

Researchers analysed previous literature on the implementation of mobile augmented reality technology in Autism education for autism learners. There have been many past literature that touched upon the use of augmented reality technology for children with autism. However, a gap is identified whereby the use of augmented reality technology for English vocabulary learning that cater to children with autism is lacking. In conjunction to that, the needs analysis stage was conducted using review of literature and triangulated using observation and interview as instruments. The observations and interviews were conducted at two autism centres in an urban area, Selangor, Malaysia. The sampling involved in this phase were forty-five autism children and fourteen teachers who are in charge of teaching the autism children at the centres. The observations and interviews were aimed at investigating the challenges faced by the autistic children in their English vocabulary learning process

Design Phase

The findings from the needs analysis phase are used to design a mobile augmented reality technology application for English vocabulary learning of children with autism. The designed augmented reality application is aimed at helping children with autism with their English vocabulary learning process. The design mobile augmented reality application can help them to learn English vocabulary in a more interesting yet meaningful manner. In addition to that, the mobile augmented reality technology application at the same time can spark their interest in their English vocabulary language learning process. In this phase, Malaysian English Special Education Syllabus is reviewed and revised in making sure the content of the mobile application is parallel to the learning objectives of their age. This phase involved the designation of storyboards and deciding on the content of the mobile application.

Development Phase

Researchers and a team of mobile application developer decided on the software to be used in developing the augmented reality mobile application. The type of augmented reality technology is also decided in this phase. The storyboards and contents are to be exported into the mobile application.

Implementation and Evaluation

The prototype of the mobile augmented reality technology application is implemented to two autism children aged 7 and 10 years old. The implementation is employed qualitatively using observation and field notes as instruments. The acceptance and responses from the respondents are taken into consideration. The data gathered from the pilot study are then presented.

Findings and Discussion

ADDIE Model Type 1 is employed as underpinning model in gathering necessary data needed for this study. The data gathered from each phase employed in this study are arranged and presented accordingly; a. Children with autism and their voyage of English vocabulary learning, b. AReal-Vocab mobile application : the new À la mode of English vocabulary learning for children with autism and c. The future of AReal-Vocab mobile application for children with autism.

Children with autism and their voyage of English vocabulary learning

Children with autism usually encounter problems in learning and acquiring vocabulary due to their cognitive disabilities. Although past literature have proven that learners with autism usually have the tendency to grasp English language faster than their mother tongue language due to the linguistic aspect of English, children with autism still encounter difficulties in their English language learning process. Based on the findings, it can be seen that children with autism are different and unique in their own ways. Each one of them has different traits and characteristics that make them different from each other. Due to their uniqueness, each of the autism children has different learning styles and preferences. Due to their different behaviours and characteristics, teachers sometimes struggle in their effort of trying to personalise the learning materials for them. This leads to the findings gathered based on the observations that lacking of learning aids that could help them with their learning process is also an issue. The materials prepared at the autism centres through the observation are only handmade modules and worksheets created by their teachers. Handmade modules can be tiresome for the teachers, not to mention that the teachers are needed to ensure that the materials provided to the autistic children follow their preferences. Not having the materials reach to the autistic children's liking might not be able to spark their interest in English vocabulary learning process.

AReal-Vocab mobile application: The new À la mode of English vocabulary learning for children with autism

Based on the data from the needs analysis, a mobile augmented reality application is designed and developed. The content of the mobile application is based on Malaysian English Special Education Syllabus. The English language component in the syllabus was taken out and converted into the developed mobile application. Figure 1 shows the English language component from the syllabus.

1.1.2.4 English Language Component.

i.	Greeting and social expressions.
ii.	Personal details.
iii.	Family members
iv.	Places in the school
v.	Things at home.
vi.	Parts of tehe body.
vii.	Clothing.
viii.	Food.
ix.	Fruits/Vegetables.
x.	Plants.
xi.	Transportations.
xii.	Numbers.
xiii.	Calender.
xiv.	Time.
xv.	Colours.
xvi.	Shapes.
xvii.	Animals.
xviii.	Insects.
xix.	Occupation.

Figure 1 : English Language Component from the Malaysian English Special Education Syllabus

Later, researchers and the team of mobile application developer created the storyboard and developed the mobile augmented reality application using Unity software. The feature used in the mobile augmented reality application is the 3D Marker feature and also Text Recognition Marker. The difference between both features are that the mobile application can read the images from the flash cards prepared and also from the word text, hence the Text Recognition Marker.

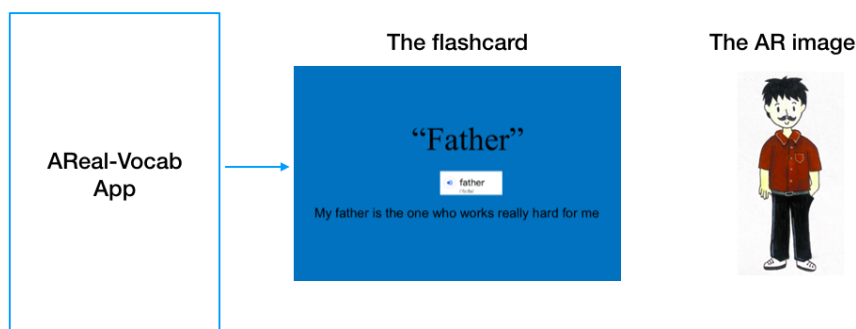


Figure 2 : 3D Marker Feature

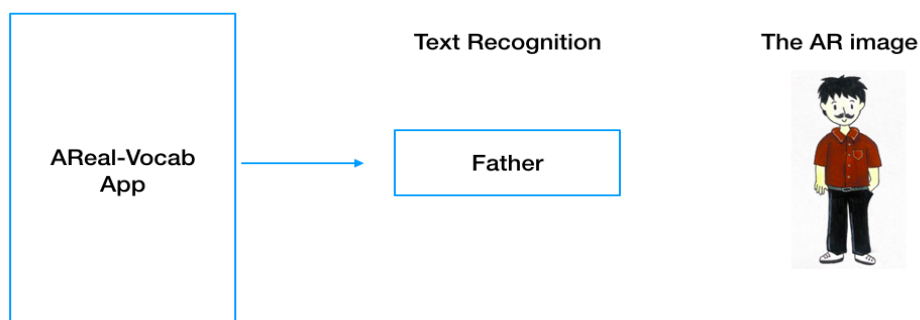


Figure 3 : Text Recognition Marker Feature

Both Figure 2 and Figure 3 show the features of the interface feature of the developed mobile augmented reality application. The existence of flashcards will help children with autism to learn English vocabulary in a more interesting manner and also for them to understand the purpose of each word. In addition to that, Text Recognition feature is also added as an advantage feature aiming at making the application to be convenient and accessible even without the flashcards for the children to enjoy their English vocabulary learning at their leisure time with the help or guidance of their parents. Figure 4 is an example of the end result of the prototype of the developed mobile augmented reality application. By using the application from the learners' or parents' mobile, learners only need to scan the flash cards prepared and the visual of the 3D images feature will appear. Learners will be able to acquire and learn new English vocabulary in a more intriguing manner with the help of the mobile augmented reality application.

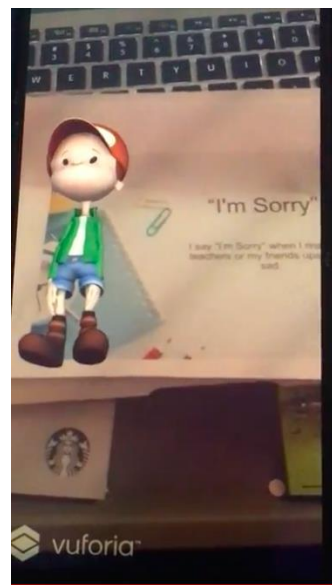


Figure 4 : End result of the prototype

The future of AReal-Vocab mobile application for children with autism

Augmented Reality (AR) technology is not new in the field of education. Vellonen, Kärnä & Virnes (2012) has proven that the Augmented Reality (AR) technology has been making its waves in the world of education, specifically in the autism education as early as 2012. Different from other technology advances, augmented reality technology is believed to be able to offer many possibilities of creating connection between the real and virtual universes. Providing and creating real images virtually can be very beneficial for children with autism. Children with autism are not familiar with abstract features, hence having an application or tool that can help them to connect the real and virtual universe will be able to help them in the English vocabulary learning process. Learning via augmented reality technology mobile application is also to be considered as interactive and today's millennial kids are no longer a stranger to gadgets. Being able to learn using mobile phones or gadgets can make the learning to be more engaging and fun for the children with autism. Hulusic & Pistoljevic (2015) believed that children with autism may master more educational objectives if they are to be given the chance to use computers or technologies rather than the traditional learning methods. It is also proven from past literature that not only mainstream learners, but even children with

autism are more intrigued and motivated to learn through computer-assisted instruction. Augmented reality technology can act as an assistive tool to help children with autism with a multi-sensory experience to relate to basic learning concepts and making lessons to be more meaningful.

In addition to that, it can also be seen from the findings that augmented reality technology is also proven to help inculcate personalised and autonomous learning in autism education. Autistic children find learning using mobile phones are interesting enough, to add a touch of augmented reality where the images seem real, it sparks their interest at the same time. They tend to be more engaged in the learning process. There have been many past literature that agreed on the use of augmented reality technology in autism education. Nazaruddin & Efendi (2018) believed that since autistic children find it hard to focus through objects especially if the objects are not able to capture their attention, an augmented reality or pop up book is very beneficial in increasing focus within the children with autism. Jain, Patil, Nawal & Chakraborty (2018) in the same year also developed ARWAK, an application that stands for Augmented Reality Wordbook which they believed that the application has helped kindergarteners to learn a slightly more number of words rather than from a printed wordbook. Their findings have also proven that the augmented reality mobile application has helped increasing the children's participation and able to keep them engaged in the learning process for a long time.

Suparjoh, Shahbodin & Mohd (2019) later have gathered that augmented reality technology has wide potential in supporting the therapy, intervention and also the education of children with autism. In their documentation on the potential of augmented reality technology, they have accumulated that three main advantages of augmented reality technology in autism education would be that AR helps in learning engagement, learning interaction and also in the learning process. In the same year, Mahayuddin & Mamat (2019) conducted a research on the use of augmented reality technology in fostering literacy for children with autism. Their prototype has helped the autistic children to capture and relate to the graphics or pictures of the surroundings, as well has managed to improve the literacy and learning skills of the autistic children. Their research has proven that augmented reality technology has managed to create an interesting approach to enhance the effectiveness and attractiveness of the language learning for children with autism.

Conclusion

Every learner, be it typically developed learners and autistic learners deserve the same privilege to education. The goal towards this matter has motivated researchers to conduct a study on the use of augmented reality technology to assist children with autism in their English vocabulary learning journey. This study is hoped to be able to help children with autism to cope with their learning disabilities and also to help bridge the gap between autistic children and typically developed children in learning. The uniqueness of children with autism are not making their abilities any lesser than other children. Children with autism will still be able to learn the way normal learners learn. It is believed that in helping children with autism to cope with their learning disabilities, one of the ways is by approaching them with the materials that are intriguing and can be helpful to them. Augmented reality technology is proven to be one of the most intriguing learning materials as it will help autistic children to connect the virtual and real life scenarios better. Augmented reality technology is indeed able to provide children with autism with a more meaningful learning journey and at the same spark their interest in English vocabulary learning. It is hoped that this research could

contribute to not only children with autism, but also to the teachers and parents with autistic children. The mobile application can be useful in helping both teachers and parents in assisting and being part of their autistic children's English language learning journey.

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