

# Augmented Reality (AR) for Deaf and Hard of Hearing (DHH) for Animation

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## ABSTRACT

Augmented Reality (AR) technology in education faces a significant gap, especially for deaf and hard-of-hearing (DHH) students. Research has shown the vast growing technologies for AR in many sectors; however, implementing the technologies towards education for DHH students is still lacking in Malaysia. This study aims to provide a rationale and justification for using AR technologies for DHH students for Animation. Based on the literature review, five important keys drive the research questions. For the context of this paper, the three considerable keys are AR as a teaching aid (1), the importance of Art and Design (2), and social stigma (3). These primary keys are to support and justify this research. An interview was conducted with teachers who teach DHH students to further help the three primary keys. An interview with the AR developer was also conducted for this research. The study developed an AR with Animation based on the interview and record-keeping. The results show that implementing this technology will significantly impact DHH students, especially in Art and Design. When exploring and using the AR Application, DHH students felt awkward. They were unfamiliar with the use of AR applications in their class. Nevertheless, they all enjoyed using it as it will have vast potential and possibility. As technology grows, DHH students will be one step ahead of others. It is worth mentioning the social stigma among them and how future research would continue to diminish the social stigma.

**Keywords:** *Augmented Reality, Deaf, Hearing disabled, literature review, Animation.*

## 1.0 INTRODUCTION

Augmented reality (AR) education learners gain authentic experience by using virtual objects such as typography, pictures, and videos to investigate their real-world environments (Wu, Lee, Chang, & Liang, 2013). For example, AR, a more sophisticated version of reality, has many benefits for educational programmes. Moreover, when the system is linked to other technologies, it can be used to carry out a large

variety of applications (Wu, Lee, Chang, & Liang, 2013). Because it is critical to determine how AR might be used in an academic setting to accomplish educational objectives in addition to addressing the issues of students with special needs, further research on the potential of AR in a literary context is needed. (Bronack, 2011)

An individual's inability to access information and knowledge in today's tech world is a disadvantage. Physical and mental disabilities include blindness, deafness, and hearing impairment (T. Perera, S. D. Wijerathne, M. Wijesooriya, Dharmarathne, & Weerasinghe, 2012), resulting in difficulties absorbing information and knowledge. Since they need intensive parental and teacher support, these students require special assistance in learning. This has placed importance on developing technologies to assist them in school as they are distinct from other students. In addition, implementing successful strategies to achieve inclusive education in the scientific and technical fields requires AR technology. (Tkachuk, Yechkalo, & Markova, 2017)

Students with special needs, including the hard of hearing and deaf, should have access to the art and design curriculum. Each student has a different level of potential. If we guide the students in the right direction, nourish them, and educate them, the risk of them failing will be reduced, and they will reach their full potential. Deaf education is continuously improving on how to educate deaf and hard-of-hearing pupils, according to Hartman (2007). In addition, there will always be improvements in deaf education, especially in the art curriculum. Deaf students must receive extensive art education, To improve their artistic vocational skills, to enhance their personality, to bolster their future job prospects, and to help them achieve their professional goals.

According to Farhan and Passi (2016), user interfaces play a critical role in educational materials, particularly for deaf and hard-of-hearing learners. He also stated that educational technology can help students with special needs integrate into college classrooms. In his study participants were overwhelmingly in favour of using the proposed user interface design for online learning, which was more usable, more accessible, and more user-friendly than the older interfaces.

Although AR is an emerging and growing technology in education environments (Johnson, Levine, & Stone, 2010), relevant studies in Malaysia are still inadequate. And the use of AR for DHH students is still limited of AR for DHH students. They used AR mainly as a marketing tool (Ng & Ramasamy, 2018) and lacked DHH for Animation. For the context of this paper, the researcher refers to DHH for Animation as using AR technology to teach DHH students Animation.

While previous studies have investigated AR for DHH students (Zainuddin, Zaman, & Ahmad, 2010), they focused more on science subjects. A systematic analysis of the AR benefits of DHH for Animation is yet to be accomplished (Wu, Lee, Chang, & Liang, 2013). Previous researches did not consider the relation between AR and DHH for Animation. To narrow down this research gap and the potential of AR for DHH students, the researcher presents two research questions:

- Why is the use of AR applications for DHH students relevant?
- Why are Art and Design subjects such as Animation important to DHH students?

To answer these questions, the researcher conducted Content Analysis through the literature review and sorted it into three primary keys to support the research questions. The researcher also interviewed DHH teachers and AR experts to support and justify three essential keys.

Even though the deaf and hard-of-hearing population has made significant gains in recent years, technology in education is still far from being inclusive for this population. One of the main reasons for this is the lack of accessible user interfaces for deaf and hard-of-hearing students. Another reason is the lack of research on utilizing technology to meet this population's needs. While there have been some studies on the use of technology in deaf education, they have focused primarily on science subjects.

## 1.2 PROBLEM STATEMENT

There are many Augmented Reality (AR) apps available for download in the Google Play store or Apple Store worldwide. All apps, from daily tasks to education, have numerous features of their own. Augmented Reality (AR) is necessary as a teaching aid in today's fast-growing technology world. Using AR technologies, the learning and teaching process will become more interactive and efficient. Because of this, educators will be able to concentrate more on knowledge, and students will be able to comprehend the learning process better. (Jabar et al., 2020)

According to the Human Rights Commission of Malaysia's press release, the attitudinal, communications, physical, policy, programmatic, social, and transportation barriers faced by persons with disabilities such as the blind and deaf in Malaysia are among the most frequent. In Malaysia, people with disabilities, such as the blind and deaf, still struggle in various areas, including education. This has hindered the development of educational resources for DHH. (Human Rights Commission of Malaysia, 2020). The existence of deaf individuals influences the economy of the developing countries. This occurs because deaf children are not receiving adequate schooling (World Health Organization, 2021). Most deaf individuals have a low percentage of academic credentials compared to normal individuals. Thus, it is critical to improve earning opportunities, occupational skills, and awareness within the deaf population to assist them to succeed in school. Hence the Augmented Reality technology was selected as a tool to help them in their learning.

Even though there has been increased attention and support from various parties to help deaf and hard-of-hearing students in Malaysia, these studies are still inadequate. Because most of the books published in Malaysia are not specific to deaf students and emphasize generic skills for the disabled deaf students have had difficult time. In order to help deaf students, Yahya-Isa (2004) highlighted their problems, raised public awareness about their future, and assisted them.

Although Augmented Reality is still in its early stages in Malaysia, it is not widely used in education. According to Tasneem Khan, Kevin Johnston, and Jacques Ophoff (2019), there are still much research to be done on the effects and consequences of Augmented Reality in education. The use of Augmented Reality in education is still in its early stages. As technology becomes more accessible, its use in education is increasing. Therefore, AR is so helpful for deaf and hard-of-hearing students who are visual learners.

The materials provided DHH is not readily accessible in the Art and Design subjects. Subjects like illustration, graphic design, and Animation are just a few examples. Conventional art curriculum are available in most colleges, But there are no curriculum for art specifically designed for deaf students with disabilities. Deaf students should not be burdened with additional limitations since they are already limited by their inability to hear. (Hartman, 2007)

## 1.3 RESEARCH OBJECTIVES

This research aims to contribute to visual design by creating an Augmented Reality application for Deaf or Hard of Hearing students. This application will enable the future DHH students to gain interest and expose them to Animation.

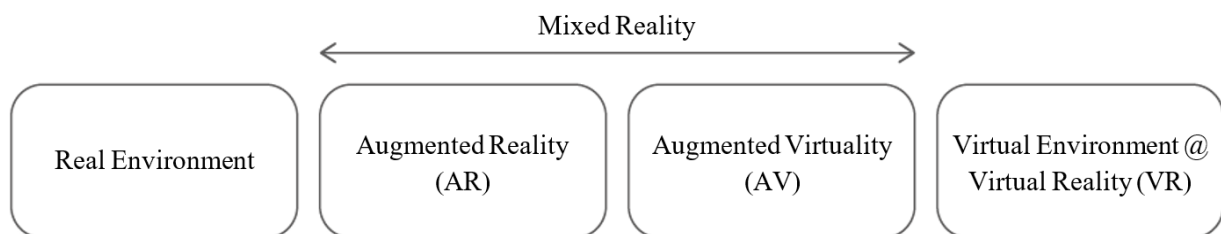
- To identify Malaysian educational materials for Deaf or Hard of Hearing students through their content in the Art and Design field.
- To create a sense of interest towards Animation subject among Deaf and Hard of Hearing students. Hence, AR app support will benefit Deaf students as immersive Visual Learners.
- To design a practical Augmented Reality and take full advantage of the features, particularly in the Animation field, in order to help Deaf and Hard of Hearing students.

## 2.0 LITERATURE REVIEW

This section will discuss previous researches conducted on AR and DHH Students and their related education. It will examine the predictors of The Introductory of Augmented Reality and the correlation of Augmented Reality for Deaf and Hard of Hearing Students.

## 2.1 THE INTRODUCTION OF AUGMENTED REALITY

The technology was invented in 1962 and has grown from retail to education to manufacturing (Gandolf, 2018). AR is predicted to generate \$108 billion (RM486 million) in revenues by 2021 and is the forerunner of future computing (Blackeye VR Limited, 2017). AR and VR have been tied together by the "mixed reality" concept developed by Boeing researcher Tom Caudell in 1990. According to Boyajian (2017), AR has outpaced VR in terms of providing more practical day-to-day applications (Boyajian, 2017). Since AR has a broader range of situations where it is utilised, VR has been overshadowed (Boyajian, 2017). Augmented Virtuality (AV) allows the virtual reality environment to be enriched with real-world information to connect the virtual and the real worlds. France is the leader in introducing and nurturing students to AR. Students will be taught how to use AR in addition to their studies as part of a new curriculum released in 2015 (Klaspad, 2017). The government understands that immersive AR technology can be used in public schools to give all students a better understanding of the contemporary technological environment and the ability to act (Klaspad, 2017). Many AR apps are available for download on the Google Play Store and the Apple Store worldwide. All apps include various features, from daily chores to education. AR is considered a vital teaching tool in a society where technology is constantly evolving (Johnson, Levine, & Stone, 2010).



**Figure 1: Reality-Virtuality Continuum (Milgram, Takemura, Utsumi, & Kishino, 1994)**

AR can be interpreted as a view of a physical world environment whose elements are integrated with computer-generated sensory input (Freina & Ott, 2015). The aim is to see and experience the natural world mixed with various virtual objects without losing the sense of reality (Persefoni & Tsinakos, 2015).

## 2.2 AUGMENTED REALITY FOR DEAF AND HARD OF HEARING STUDENTS

In their research, Aristamy, Sudana, and Wirdiani (2016) mentioned that AR 3D applications for Android Devices can assist the average student in learning sign language to communicate with DHH students. They urged more researchers to use AR features in education in an effort to help the DHH population at large. There are currently a lot of Augmented Reality apps available for DHH individuals. However, most of them were developed to assist in communication and focused on sign languages (Chang, 2018).

Researches related to AR in supporting DHH students in mainstream schools have increased by numbers in the European countries. The exceptional teachers positively endorsed the experience of AR technology in real-world settings, serving the needs of special education students and potentially contributing to a more inclusive classroom environment (Loannou & Constantinou, 2018). There are recent studies on AR for DHH students in Malaysia (Zainuddin, Zaman, & Ahmad, 2010), the studies focused more on science subjects. It is crucial to highlight the importance of AR to help visualize the approach toward DHH students. Because they are visual learners (Zainuddin, Zaman, & Ahmad, 2010), they will be able to grasp more content through AR, which would be beneficial to them. Furthermore, it is worth mentioning how essential to have the empirical study of Art and Design subjects on DHH students since Saxena and Jain (2013) revealed that social intelligence in the Art and Design stream is better than in the Science stream (Saxena & Jain, 2013).

The use of AR technology in mainstream classrooms, especially for deaf and hard-of-hearing students, has not yet been fully explored and exposed. AR technology is mainly used outside of school, and the teachers are not fully aware that such technology could potentially benefit both parties; the teacher and the students. The current study is the first attempt to expose the use of AR technology for deaf and hard-of-hearing students in a classroom setting. According to Shirin (2018), despite recognising the importance of ICT in improving education, teachers and students fail to utilise it properly and fruitfully in real-world contexts.

It is often the case that students spend the majority of their time on their phones scrolling through social media rather than engaging in educational activities. Similarly, teachers often express frustration that students are more interested in their phones than in the lesson's content. To solve this problem, education must become more engaging, active, and relevant to students' daily lives. Integrating technology into the curriculum can make education more attractive and relevant to students' everyday lives and make learning more efficient. The benefits of this are not just theoretical. By making education more relevant, engaging, and active, students are more likely to absorb the information and skills they are being taught. This can be particularly helpful for students with learning disabilities.

### 3.0 METHODOLOGY

#### 3.1 INTERVIEW

The target population of the study involves a total of 3 groups. The first group is the deaf teachers. The second group is the Augmented Reality experts Followed by a group of deaf students.

The target schools involve primary schools for the deaf and hard-of-hearing students. Although There were only few teachers in the first group, the researcher managed to interview several of them.

As for the Augmented Reality experts, the researcher interviewed the two experts involved in education in Augmented Reality. Both have played an essential part in the Augmented Reality industry in general. And they are currently teaching people about Augmented Reality.

The researcher also managed to get deaf students involved. Most of the interviews affected the students' thoughts on Augmented Reality. The researcher also managed to interview a few deaf teachers. Most of the discussions involved the teachers' thoughts on teaching deaf students. Table 4.1 summarizes the total population of the current study.

**Table 1: Total Population of the current study**

Total population of the current study	
Type of groups	Total number
Primary School Deaf Teachers	4
AR Experts	2
Deaf Students	5
<b>Total</b>	<b>11</b>

For the purpose of the interview, the researcher managed to find out the teachers who teach deaf students in Vocational Special Education Secondary School Shah Alam, specifically the one who teaches the students Art subjects. Later, the researcher contacted them all through Whatapps messengers, inviting them to participate in the current study.

As for the Augmented Reality experts, the researcher managed to contact the head of researchers and provided the details of the two experts. The AR experts Were involved with in education in Augmented Reality generally.

As for the deaf students, the researcher managed to contact the teachers. A few students were selected to participate in the study.

The researcher employed structured interviews with teachers who teach DHH students. The interview was based on the research questions and to get the ground rules of the current state of their teaching. This interview was to support and justify the previous section, and to identify the support of technologies among DHH students in class. The findings are in accordance to with the following set of themes.

- Art and Design Subjects as elective courses among deaf students.
- Learning Module through AR and VR technologies.

- Teaching deaf students.

In the first theme, the researcher asked three sets of questions regarding Art and Design subjects. Based on the answer, art and design subjects had a firm foundation among deaf students. This will amplify the needs and essentials of the Art and Design stream subject. Furthermore, Saxena and Jain, 2013 mentioned that social intelligence in the Art and Design stream is better than in the Science stream (Saxena & Jain, 2013). The researcher focused on using technology in class and AR and VR technologies as teaching aid in the second theme. Results of interviews with teachers found that technology is necessary for class. However, the use of AR and VR technologies is still far-fetched. The teachers themselves may not be familiar with the help of the AR technologies among deaf students in class; they only encounter the AR technologies with other implementations in a non-learning environment. This amplifies Sudana, Aristamy, and Wirdiani (2016), urging more researchers to apply augmented reality features to apply learning/education aimed at the broader scope of the DHH students. On the last theme, this question highlighted some problems teachers face when teaching deaf students. To summarise, they were some limitations when using sign language. Teachers came out with their sign language through graphic demos and tutorials.

The researcher employed structured interviews with AR experts who develop AR applications. The interview was based on the research question. The interview found out the limitation when developing a brand-new application and the importance of this technology used in the education environment—the finding follows the following theme.

- Limitations when developing or starting a brand-new application

This theme is to discover the overall limitation of developing an AR app, and supporting The relevance and practicality on the use of AR for DHH students for DHH students. In referring to the use of VR, even though today's mobile smartphones are capable of running high computational graphics, a fully immersive experience can only be achieved with an HMD device with a larger field of vision (FOV) and robust interactivity with the joystick or hand gestures, such as the Oculus Quest 2. And again, supporting the use of AR is more relevant than VR among DHH students in a current education setting. It is hassle-free and more convenient to set up.

### **3.2 Record Keeping**

#### ***3.2.1 Augmented Reality as A Teaching Aid***

One of the keys to supporting AR as a teaching aid is its improved development of spatial abilities. Previous studies mentioned that results support the hypothesis and suggested that AR has some potential to aid the learning of 3D concepts effectively. (Diegmann et al., 2015). With the help of AR, students can acquire a new level of spatial abilities. Students are also satisfied and motivated when physical interaction is identified as a driver of enhancing emotional engagement (Diegmann et al., 2015).

#### ***3.2.2 The Importance of Art and Design***

All students have the potential to become great at Art and design, including students with special needs such as deafness. Some students, particularly those with hearing impairments, can achieve much in this subject. Hartman believes that deaf education is continually evolving in terms of educating deaf and hard-of-hearing students. Art education will constantly grow as a result, particularly in the area of deaf education (Lan, 2018). Deaf students must receive extensive art education. It will enhance their professional viability by improving their art vocational skills, contributing to their healthy personalities, and promoting future employment opportunities (Lan, 2018).

Spatial ability is the capacity to understand and remember the spatial relations among objects. It is the ability to visualize with the mind's eye, mentally manipulate 2-dimensional (2D) and 3-dimensional (3D) figures, notice fine details in the environment, and have a good sense of direction. Good spatial ability is essential for success in many areas, such as engineering, architecture, science, medicine, and Art. In this context, Art & design would be necessary for deaf and hard-of-hearing students.

### 3.2.3 Prototype Development

The researcher developed a prototype based on the previous studies and interviews with teachers and AR experts. The outcome of the prototype development is a three-dimensional, immersive learning environment for DHH students. The design aims to enable the students to learn, interact, and feel like they are in the physical world. The design outcome is a 3D Animation, immersive learning environment for DHH students. The researchers chose one of the introductory interior design chapters for this prototype. These chapters cover the fundamentals of becoming an interior designer and expose them to basic furniture. In order to create a successful interior design career, it is essential to have a strong foundation in the fundamentals. One of the most fundamental concepts is furniture, and this chapter teaches students about different types of furniture and their uses. Through WebAR, students can explore the furniture in detail and learn more about its functionality and how to use it correctly in a design setting. The content includes deaf interpretation by Dr. Sharmizi. The researchers are using WebAR for this prototype. WebAR is a platform where users don't have to download any application, and the content is rendered through their browser on the phone. The figure below shows the screenshot of the prototype.

A non-complicated user interface was designed using a responsive design. The user interface was designed to be intuitive and easy to use, simple and straightforward to avoid unnecessary complexity since it is used solely to focus on animation and visuals of the main content. The furniture models were designed in Cinema 4D and textured using Substance Painter. At the same time, the environment was created in Unity software and integrated into the WebAR platform using AR.js. The content was developed based on the interior design chapter from the official syllabus textbooks on Art & Design. The content includes an introduction to interior design, furniture, and its uses in interior design.

Each object or furniture in the prototype was designed based on the type of furniture in the textbook. Each piece of furniture is explained through a sign language video and animation as a highlight key of the AR content. This prototype is just an introduction to the research project and the future potential of using AR for deaf content.

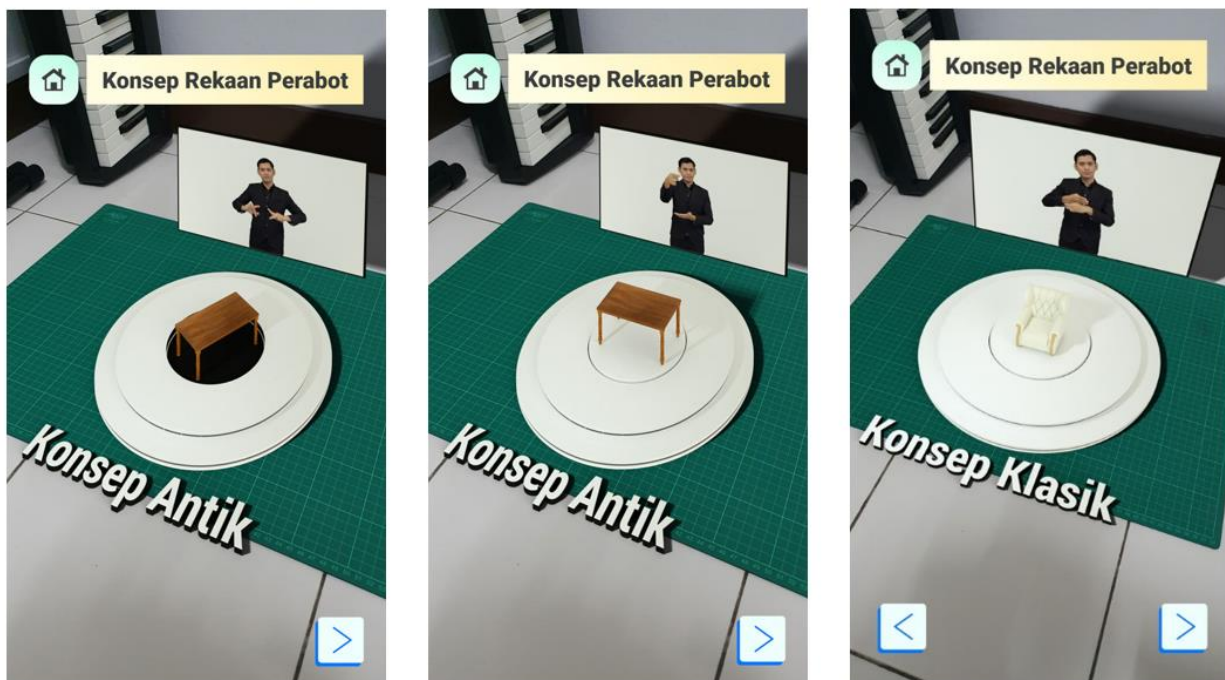


Figure 2: Animation, the furniture is raised, along with Deaf interpretation

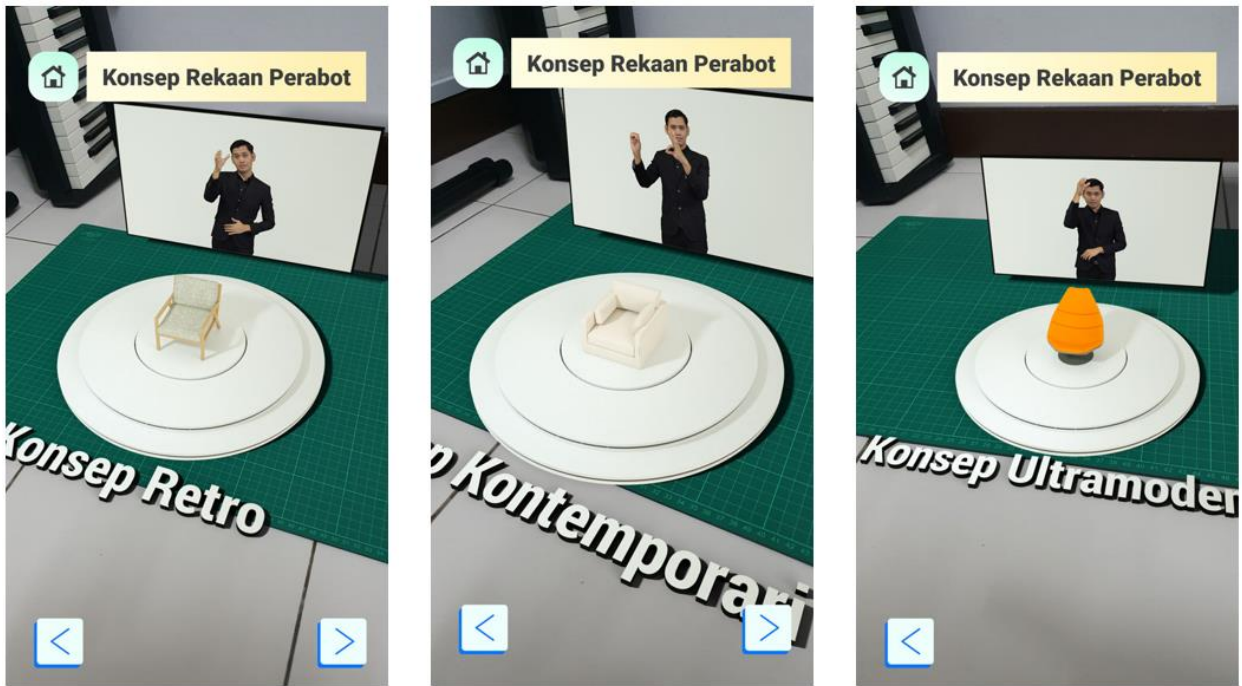


Figure 3: Animation, the furniture is raised, along with Deaf interpretation



Figure 4: Set of furniture close-up in 3D



Figure 5: Set of furniture close-up in 3D



### 3.2.4 Testing

Non-formal testing was conducted virtually. The researcher managed to get five DHH students through the teachers. The WebAR prototype link was given to the teachers, then passed to the students. The students were guided to explore the WebAR prototype by the teacher to understand what it was. Then the teacher facilitated the students to explore the prototype and came up with their reviews on the prototype. The researcher designed a brief survey to make it easier for the students to give review and feedback. The WebAR prototype development is an excellent way for DHH students to learn about interior design. With the help of this prototype, they can learn about furniture and how to create a comfortable and aesthetically pleasing space. In addition, the non-formal testing showed that the students could understand the prototype and gave feedback that was helpful to the development of the prototype.

## 4.0 RESULT AND DISCUSSION

The study's findings were analyzed qualitatively. The Likert-scale data from each element of the question, including demographic background, teaching and learning experiences, fieldwork experiences, job preparedness, and other associated information, and was described using descriptive analysis. The data was used to calculate frequencies and percentages. The open-ended data were qualitatively evaluated.

There is a total of eleven people involved in the study. The first group consists of four female teachers. The second group consists of two male AR experts, and lastly, the third group comprises the five male deaf students. Two out of the three students were from the Vocational Special Education Secondary School Shah Alam. The teacher population consists of teachers from the same school, providing each student with a unique background of experiences and teaching practices. Table 2 below shows the summary of participants in this study.

**Table 2: Summary of participants**

Summary of participants			
Type of groups	Total number	Age	Gender
Primary School Deaf Teachers	4	30-35	Female
AR Experts	2	28-33	Male
Deaf Students	5	16	Male

The teachers and the deaf students came from the same school, both in art-related fields. As for the AR experts, they both involved education-related. The first expert is part of the education team in a technology company, and the second one is an educational researcher in a university. The three groups have a wide range of ages, which is beneficial for the study as it allows for a broad range of experiences and perspectives. The three teachers were from the same backgrounds and experiences and, they are currently working together at the Vocational Special Education Secondary School in Shah Alam.

Based on the prototype that has been created, the researcher used it to enhance the learning environment of deaf students through AR. The researcher leveraged this prototype as a tool to create a platform that will facilitate the interaction between teachers and students. With the help of AR, the researcher provided more visual materials to improve the understanding of sign language, along with using Animation for the content. The researcher leveraged AR to create a platform where teachers and deaf students can interact. Deaf students, when exploring the prototype, felt awkward as the prototype is branded for educational purposes; this indicates the use of Augmented Reality in their regular class is still new. Deaf students need to become accustomed to the new concept and become comfortable with AR usage for educational purposes. This is to ensure that they can fully utilize the technology in the future. Nevertheless, they all enjoy using AR technology. It sparks their interest and piques their curiosity. AR technology has the potential to be an integral part of the teaching-learning process. The fact that the DHH students enjoyed using the technology indicates that the AR world could be a vital tool to engage them in the learning process.

The result shows a vast gap between education and technology among DHH students, especially in AR technology. It is also essential to highlight the importance of art and design subjects for DHH students, as emphasized by previous researches and confirmed by teacher respondents. These results were built on existing evidence from Parton, Hancock, & Dawson (2010). When digital and real-world events are combined, they will create immersive learning opportunities for students. The previous researches also showed parallel result with the current study. The results' generalizability is restricted by theoretical progress and justification from the literature review and interview. It is beyond the scope of study to create an extensive scale prototype pilot test among deaf students during the current pandemic. However, the result verifies the importance of AR technologies and their possibilities. This leads to further research to establish a pilot test and prototype.

The education system must also be changed and adaptable as the world is becoming increasingly digital. With the current pandemic, online learning has become the new norm. However, this may not be the best solution for all students, especially those with hearing impairments. Augmented Reality (AR) can help bridge the gap between education and technology for these students.

Based on the prototype that has been created, the researcher used it to enhance the learning environment of deaf students through AR. The researcher leveraged this prototype as a tool to create a platform to facilitate teacher and student interaction. With the help of AR, the researcher provided more visual materials to improve the understanding of sign language, along with using Animation for the content of the Art and Design subjects. The researcher leveraged AR to create a platform where teachers and deaf students can interact and improve the learning environment for deaf students. The main contribution of this research is the development of a novel prototype that utilizes AR technology to provide an immersive experience for DHH students.

## 5.0 CONCLUSION

Integrating technology into the classroom is still lacking, particularly for deaf students. Although most students are equipped with their own smartphone, it has not been fully utilised for education. On top of that, technology in a classroom is only limited to a projector and computer. With the use of Augmented Reality (AR), this project seeks to provide an immersive experience for deaf students. Utilising a prototype, the researcher enhanced the learning environment for deaf students by providing more visual materials and animations. This project has significantly contributed to the field of education by providing a novel AR technology that facilitates interaction between teachers and students. With further research, this technology can be used to bridge the gap between education and technology for all students.

There are many AR applications and materials on the internet that most users can choose and download. There is a need to make sure that the content is available to deaf students, especially in educational fields. However, technology is slowly becoming more accessible to deaf students, such as applications used in a classroom. AR technology has the potential to change the way deaf person visualize more. The use of AR can also be used in school to improve the learning environment for deaf students. AR provides an immersive experience for students, which can help them to visualize the information more clearly. Additionally, AR can be used to facilitate the interaction between teachers and students.

The literature review, which highlights three significant points, justifies the research questions based on the analysis and the research findings. In addition, all respondents were interested and highly agreed on utilizing AR for DHH students. In addition, teacher respondents showed an interest in AR technology and its learning styles for DHH students. Therefore, it will have significant potential and relevance in providing effective learning for students and teachers. This research is essential to narrow the gap between education and technology for DHH students. The press statement by the Human Rights Commission of Malaysia (SUHAKAM) in 2020 stated that persons with disabilities such as blind and deaf in Malaysia still face difficulties in various common aspects. The most frequent barriers are attitudinal, communication, physical, policy, programmatic, social, and transportation. This research is one step closer to creating a benchmark for deaf students, creating competitiveness in their future careers with normal students

Since the prototype is branded for educational purposes, deaf students felt awkward when using it. This indicates the use of Augmented Reality in their regular classes is still new. It is vital for deaf students to become accustomed to the idea and feel at ease with AR technology for education to use it in the future effectively. It piques their interest and stimulates their curiosity. Even though they all enjoy using AR technology, it may have an important role in teaching-learning. AR technology has the potential to be an important component of the learning process. Because they are interested in AR technology, the AR world has the potential to be an important tool in engaging them in the learning process.

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