# **Literature Review**

# **Introduction**

# We are reviewing assistive technology for autistic children, to understand the current research into this topic. We found that this is a narrow topic with little specific research. We are hoping to understand firstly how assistive technologies have helped in other fields, such as visual impairments or disabilities. We have then narrowed the scope of our research to be specific to autism, and how other real-world assistive technologies have helped. We are doing this to fully understand the subject area before we begin to invest time into designing, and ultimately producing our augmented reality application. The scope of our review was limited to assistive technologies specifically in augmented reality, and so we have left out areas not related to this. We have also not included non-assistive implementations of augmented reality, such as those targeted at the general population. We have however included in the scope other disabilities such as visual impairments, motor skills and learning/developmental disabilities.

# **Autism**

# “Clinically, autism is defined by a “triad” of deficits comprising impaired social interaction, impaired communication, restricted interests, and repetitive behaviours”. (Sparks et al. 2002) This general definition, however, doesn’t fit every case of autism as there is a wide range of autistic traits within the spectrum. For example, speech impairment can sometimes be reduced with people being able to hold conversations to a reasonable degree whereas sometimes the speech of the individual hasn’t developed at all.

# Autistic children think and act very difficult to the average child; this begins with their inability to interact and connect with people. Some people diagnosed with autism didn’t think about or even realise that there are other people; they are just confined to their head. (Hobson, P., 2010) Mentions quote from an autistic person and their experiences from their childhood. They mention how they didn’t know other people existed until they were seven years old when it suddenly dawned on them. Even after this though the person was unable to interact with people as normal, “I could never have a friend, I don’t know what to do with other people, really” (Hobson, P., 2010). This is an important factor to consider when making a game specifically designed to help autistic children develop.

# In Meltzer, Donald. (2008) Findings, he talks about a child named Timmy, who was diagnosed with Autism, the first five months of his life was said to be a “delight” to his mother. But not until he became of nursery age, he had a failed attempt at psychotherapy, he needed to have a mother figure present constantly, had frequent crying outbursts and destroyed anything he built with plasticine. He seemed to have a deep obsession and relationship with objects; he was easily distracted by any external stimuli. Any birds chirping or birds moving in the garden, he seemed to go and study them deeply. Timmy during a child had a very dynamic life; he could “lick the glass of a window” “smell plasticine” or could even stroke his therapist’ cheeks or hair, he didn’t seem to have any knowledge or care for social cues, and inappropriate behaviour for the specific situation.

# The main social dilemmas for someone diagnosed with autism is their ability to read facial expressions, understand different tones of voice and realise if someone is joking or being sarcastic (Autism.org.uk, 2019). This contributes heavily to why autistic children generally play alone and keep themselves to themselves, understanding other people is a huge challenge throughout childhood and generally throughout life.

# **Assistive Technology**

# Assistive Technology as a concept can be defined as “any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain or improve functional capabilities of individuals with disabilities” – as is stated in the research paper by Shinohara & Wobbrock (2011). This paper focuses on the effect that assistive technology can have on social interaction and how these technologies act as a marker for people with disabilities, leading to them feeling self-conscious or be discriminated against. Shinohara & Wobbrock (2011) also suggest that there are two common misperceptions about assistive technology, one being that the technologies “functionally eliminate a disability” and another being that “people with disabilities are helpless without assistive technologies”. It is also suggested that these misperceptions can be alleviated through making mainstream technology more accessible, such as having a built-in screen reader on a mobile device for visually impaired people.

# A critical review by Gillespie et al. (2012) looks into how assistive technology has been used to effectively support cognitive functions, such as those relating to memory, attention, organisation, etc. Gillespie et al. (2012) focus primarily on high-tech assistive technology for impaired cognition, such as people who suffer dementia or have an intellectual disability. One of the conclusions that can be drawn from this article is that smartphones are the possible platform for future assistive technologies for cognitive function, rather than specialised devices. This can be related to our research, which is primarily based on a smartphone application due to the accessibility it provides.

# **Assistive Technology for Learning & Development**

# Salomia, Anca et al. (2018) conducted a research paper documenting his findings in a special educational learning institution in Romania conducted workshops aimed at young people with mental disabilities and hearing impairments helping them with their driving lessons. The institution tested a mobile AR application is a game where the player can recreate real road scenarios; they may go through with real-life objects. The reception had been very positive, as the paper reports on the application “manifesting increased curiosity” and “strong desire to experience”. Also, “providing lower costs and higher portability” compared to regular computer game consoles. The same school SAMUS provided a regular course on driving theory with analogy learning methods with written questionnaires and revision from legislation books; the course was abandoned with no benefits achieved in favour of the new AR application.

# **Assistive Technology in Autism**

# In a paper by Ennis-Cole et al. (2011), it is stated that there are “three categories of assistive technology: high, mid-level, and low can be used to improve the communication skills, organisation, motivation, academic skills, independence, and attention of students with ASD”. It is shown in the paper that assistive technology focused on communication was effective at improving communication functions across all subjects. As the paper is about the use of assistive technologies for school librarians, the subjects are children, which is highly relevant to the research and application we are currently undergoing. A paper by Cramer et al. (2011) presents the results of a study using vSked, “an interactive and collaborative assistive technology for students with autism, combining visual schedules, choice boards, and a token-based reward system into an integrated classroom system”. The results were shown to be positive to the children involved, further enforcing the idea that assistive technology is highly beneficial to children with ASD. It also highlights the challenges that computer-based assistive technology might face in comparison to traditional paper-based methods, such as the inflexibility if an individual child has a schedule that is not aligned with most of the class.

# **Augmented Reality**

# Augmented reality has seen a large increase over the years. Billinghurst et al. (2015) highlighted how augmented reality had seen a widespread implementation since 2010, after a slow and steady development beginning with early research in the 1960s. In their research, they discuss how it can be applied to a wide range of technologies. In particular, they found that while only ten million people used augmented reality in 2010, this number is expected to exceed one billion by 2020.

# Gartner has indicated that augmented reality is now past its peak hype for emerging technologies since 2014. (Gartner, 2017) This would indicate that there is a growing familiarity with augmented reality as a technology; this view is backed up by the explosion in growth AR saw through games like Pokemon Go in 2016, and if Billinghurst et all (2015) are correct, we are well on course to having 1/7th of the global population regularly using augmented reality. Hrytsyk, Grondzal and Bilenkyj (2015) looked specifically into creating a virtual collaborative environment in augmented reality, and found that through use of such a tool, augmented reality can provide a significant boost in the development and overall educational experience of those with learning disabilities and visual impairments and create a level ground for their peers who may not suffer from similar issues.

# **Augmented Reality as an Assistive Technology**

# Augmented reality has seen a growing use as assistive technology; much of the research available has indicated how this technology has helped with everything from learning disabilities to aiding surgeons to carry out surgery. It is clear that interest in how augmented reality as assistive technology is growing. Squires, D. (2017) researched how augmented reality can be used to assist in education, and similarly how it may contribute to development. His research found that augmented reality can be used in children to help with children’s cognitive ability, provide visual and spatial memory boosts and ultimately make a better, more tailored and interactive learning experience for the children who took part in the trial. Working memory was one area which was shown to be particularly boosted, proving that augmented reality can greatly supplement a child’s education while also being a fun experience. Similarly, Mehmet & Yasin (2012) highlighted how augmented reality, over its long existence, has greatly boosted other fields like military science and medicine. They do conclude however that more research was needed into exactly how viable the technology is in education.

# The scope of this research was then narrowed, to look specifically at how augmented reality as an assistive technology has helped in situations like those with learning disabilities, as it has been proven in trials to help with learning in children in general. A large piece of research was undertaken by Lin et al. (2016) into how augmented reality can support education in children with a range of disabilities. Performance data resulting from the study showed a clear conclusion; the use of augmented reality was specifically helpful in reducing learning frustration and boosting the motivation to learn, in children with special needs. As a symptom of autism, a reduction in frustration with the learning experience could be a major boost resulting from the use of AR as assistive technology.

# Similar research was undertaken by Correa et al. (2007) into the use of AR, specifically in the form of a game, can help in cognitive and motor rehabilitation. A game called GenVirtual was made by the researchers and proposed to help those with learning disabilities. The general functionality of the game is that it is a musical augmented reality application. The application was shown to improve the experience with learning, and a motivational aid in education, to help people with special needs. As autism can impact motor and cognitive skills, this research was particularly relevant. It did, however, leave some questions, as data on whether it helped with rehabilitation or boosting skills was noticeably absent, with most data emphasising the motivation boost it provided.

# Following on from this further research was investigated specifically into how such technologies have been used in the past in children with autism. Escobedo et al. (2014) found that in a classroom setting, attention, in particular, could be boosted by using augmented reality as an aid to education, superimposing the learning materials into a fun setting for a child with autism. This method was also correlated with a boost in positive emotions, which may in turn further improve the child’s focus and help them to learn and co-operate better with their peers. Lin and Chang (2015) carried out similar research which backed this finding and also correlating the use of such technologies with a significant increase in test scores for the participants in the study.

# **Conclusion**

# In conclusion, it is clear augmented reality is a useful tool in providing not only a useful learning environment for young people but a fun almost challenging experience too. Also, our research suggests that AR directly uses and builds the user’s motor skills, challenges their attention, motivation and memory skills, which people diagnosed with Autism tend to struggle with. Thus, in our research, proving that an AR integrated game application is the way to go, not only this but since we are integrating this into a mobile platform, providing a cheap and wide access way to utilise our application providing our application for all. Since all the technology is already widely available in our smartphones, we can get our app to a very wide audience, and schools using this app can access the app cheaply and easily, without any special equipment. Also, AR provides a new avenue on providing a new fun learning experience that in our research suggests is better than analogy means through written answer books and reading paper textbooks. Our research conducted that AR assistive tech boosts the user’s positiveness, which can increase the user’s focus and co-operation, which also, in turn, can lead to an increase in good social skills, and has led to an increase in test scores. We have concluded an AR assisted learning the mobile application, is the way to go providing an educational but fun learning environment that enhances the user’s skills and attributes.

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