

# Assistive Technology for Autism Spectrum Disorder: Systematic Literature Review

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Accepted: 15 June 2022 | Published: 30 June 2022

DOI: <https://doi.org/10.55057/ijares.2022.4.2.4>

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**Abstract:** *The world is now filled with new technologies in line with the advancement of technology and those new technologies are known as smart technology. Smart technology is often integrated in the education sector to facilitate learning and teaching sessions. Assistive technology is a part of smart technology that has been emerging widely and it's employed as a teaching aid tools for persons with Autism Spectrum Disorder (ASD). The technology shows enormous potential in tackling the challenges faced by ASD. Although promising, the effective use of assistive technology (AT) in helping ASD is still limited and has its own limitations. The goal of this systematic literature review was to provide a comprehensive overview of studies on the utilization of assistive technology (AT) to help persons with ASD cope with the challenges they face. Lots of research has been undertaken to see how successful AT therapies are for improving communication and social interaction, cognitive skills, and other aspects of ASD development. Despite this, the researchers discovered that there is still a dearth of studies that include all of the technology employed. The study cites a number of recent publications in the form of systematic analysis as research findings that back up the points made.*

**Keywords:** Assistive technology, autism spectrum, robot, mobile application, virtual reality (VR), wearable devices technology (WAT), augmented reality (AR)

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## 1. Introduction

The task of an educator is to educate and help students to develop knowledge and skills that cover social aspects to increase the potential of students in an integrated manner as stated in the national education philosophy which focuses on educating future generations that is flexible from the aspect of intellectual, spiritual, emotional, and physical angles. Based on the Malaysia Education Blueprint 2013-2025 (PPPM 2013-2025) which states that every child in Malaysia is entitled to their basic rights in education to develop their potential individually. Therefore, it is important for teachers to have the ability to overcome any constraints faced by students despite the aspects of physical, mental, and social constraints. To explain in more depth, this study focuses on those who were diagnosed with Autism Spectrum Disorder (ASD) disease. On the report of the World Health Organization (WHO) (2021), ASD is a complicated and multifaceted neurological developmental disease that can be discovered during infancy. According to statistics, ASDs struggle to learn since it is difficult for them to assimilate new information, organize their thoughts and ideas, and have difficulties with social engagement and communication because they tend to avoid it (Roberts-Yates et al., 2019). They also face ongoing challenges such as having atypical activity patterns that cause repetitive behaviors,

difficulty moving from one activity to another, excessive focus on a particular detail that causes their interest to be limited (American Psychiatric Association 2013). ASD is a lifelong disorder and according to WHO's facts (2021), about one in 160 children has ASD. Meanwhile, the National Autism Society of Malaysia (NASOM) states that statistics estimate that there is 1 case out of 68 new-borns with ASD and about 9000 babies in Malaysia are born with ASD each year. The number will continue to increase, and parents can usually only see the symptoms in their children when they reach the age of two to six years. Here it is found that there are five types of ASD, namely Asperger's Syndrome, Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS), Autistic Disorder, Childhood Disintegrative Disorder and Rett's Syndrome. The following table below is the characteristics of the 5 types of ASD:

**Table 1: Types of ASD**

<b>Types</b>	<b>Features</b>
Asperger's Syndrome	Social and behavioral connections, as well as interests and frequent repetitive activities, have all deteriorated with time. There is no evidence of a major delay in language learning in clinical settings.
Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS)	The establishment of reciprocal social bonds is severely hampered. However, the criteria did not fulfill certain of the unique ASD criteria.
Autistic Disorder	The emergence of atypical social interactions. The scope of activity and interest is also restricted, and this is frequently seen within the first year of life.
Childhood Disintegrative Disorder	After a time of normal development of at least two years, some components of functioning regress.
Rett's Syndrome	After the first five months of life, there is a definite developmental regression trend. Only female children are affected.

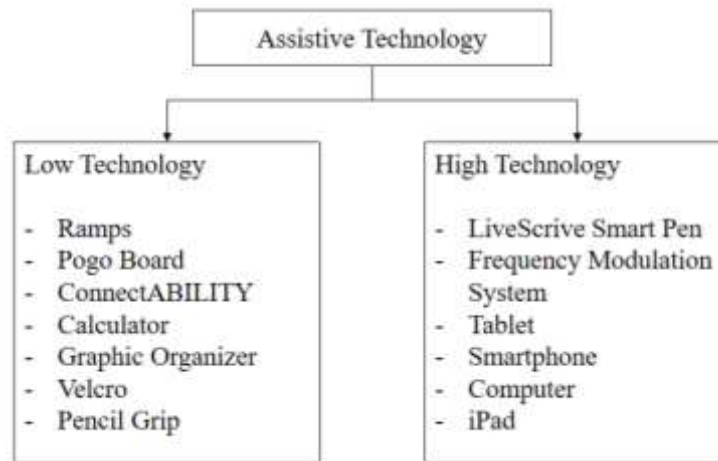
Source: Helmy, 2016

The abilities of people with ASD can evolve over time and there are people with ASD who can live independently. However, there are also those who have severe disabilities and need lifelong care and support. This ASD disorder makes it difficult for them to connect with the outside world. An individual with ASD may face difficulties in being admitted to school, slim job opportunities and engaging in activities that involve the community. If the communication and social interaction problems persist and are not treated, it is likely that the problem will continue throughout the life of an individual with ASD. The world today has passed quickly, and every sector has grown rapidly especially from the aspect of information and technology resources which contributes to the great changes in the life of the society. According to Abad-Segura et al (2020) the rapid growth of technology information resources has brought about a comprehensive and effective change in every corner of human perception for the passage of modern life nowadays. Technological advancement today is undeniable because they are already widely integrated in every sector and the education sector is not exempt from the following. In PPBM 2013-25 also emphasizes the aspect of using and utilizing ICT to improve the quality of national education where educators can apply model technological pedagogical content knowledge also known as TPACK model to achieve great outcomes in teaching and

learning session (PdP) to integrate technology in education. Therefore, educators have seized the chance to change from traditional teaching sessions to the usage of computers, laptops, tablets, smartphones, Virtual Reality (VR), Augmented Reality (AR), Wearable Assistive Technology (WAT), and other smart technologies. Researchers are able to address obstacles and develop answers to problems experienced by persons with ASD utilizing Assistive Technology (AT) due to the advancement of smart technology. The learning methods of those with ASD have also changed a lot from the use of non-interactive media learning materials such as textbooks to more interactive digital learning to enable them to go through experiences that can stimulate development (Khowaja et al., 2020). Because its primary usage has enabled information to be visualized, assistive technology can help persons diagnosed with ASD improve their skills. (Christine & Eleni, 2020). The challenges addressed were largely related to communication and social interaction skills, repetitive, hyperactive, impulsive behaviors, and short attention spans. AT showed a high probability of outcome in improving the development of communication skills and social interaction of the ASD group (Marto, Almeida, & Goncalves, 2019). In addition, it is seen to have the potential to improve individual learnability and manage repetitive behaviors. AT also allows continuous monitoring to be performed on autistic children (Mc Mahon et al., 2019). Therefore, this systematic literature review will briefly describe the AT that is often used in addressing the challenges of ASD as well as the benefits and limitations of the technology.

## **2. Definition**

Assistive technology (AT) is described as any item, instrument, software application, or system used to promote the development and functioning capacities of persons with special needs, according to the Assistive Technology Industry Association (ATIA) (2022). AT isn't just for those with ASD, AT has the potential to improve functioning, minimize activity limits, promote social inclusion, and boost educational engagement for persons with exceptional needs. (McNicholl et al., 2019). AT has also been recognized as one of the human rights requirements stated in the convention of special needs held by the United Nations (United Nations, 2006). AT is also defined as an important facilitator in promoting aspects of self-reliance and participation. According to the WHO, AT promotes well-being and supports people with special needs to live healthy, productive, independent lives, participate in education, improve job marketability and social life. Though the definition of assistive technology appears differently for each field, the global definition of assistive technology aims to encompass a wide range of devices and services that people with special needs can use to participate in their educational programs. The major goal known based on the definition of assistive technology is to help those who were born with impairments to improve their capacity and ability to operate as a normal individual (Alper & Raharinirina, 2006). The main idea is very clear with the aim of providing facilities to students with increased access to general education programs. The era of advancement of the information technology which can be seen with the massive use of technology as a medium to improve lives has become an interesting discourse in the field of research. Like assistive technology devices, it can be categorized into two, the first is low-tech devices such as pencils with grips, page rotators, communication symbols, visuals, and daily schedules (Thoreson, 2021). Low-tech devices are also defined as devices that do not use any power source. Whereas Thoreson (2021) also stated that the second assistive technology device is a more complex technology known as high-tech devices that requires power sources such as voice-activated computers, augmentative and alternative communication systems, iPads, and electronic braille. Figure 1 shows both categories of assistive technology devices.



**Figure 1: Categories of Assistive Technology Devices (Daud et al., 2018)**

### 3. Methodology

This systematic literature review focuses on previous studies that have been conducted related to Assistive Technology (AT) upon Autism Spectrum Disorder (ASD) group. Various online database platforms have been utilized to find information related to the study issues such as Google Scholar, Mendeley, Academia, Sci Direct, ACM Digital Library, IEEE Explore, and Springer links. Several keywords were used to search for relevant information namely autism, assistive technology, robots, Virtual Reality (VR), Augmented Reality (AR), mobile applications and wearable devices. The selected articles are limited to Malay and English because these languages are easily understood by the researcher. The study was also selected starting from the year 2017 to the current year. Many research articles have been found, however only 60 studies were selected with a focus on AT related studies upon ASD group. Based on the selected study, the next step is implemented by collecting key information based on keywords performed with literature synthesis. Researcher form and identify the emerging themes and place the available data according to the appropriate themes. This process is carried out systematically, thoroughly, and repeatedly. The researcher examines line by line of data until all data is collected in an appropriate theme. Data findings based on the themes that appear in each article are compiled and summarized into this paper. The research questions are determined to be the focus guidelines of this writing so that the researcher stays on the right track and makes the writing more relevant. The research question that will be answered in this concept paper is what kind of assistive technology have been used for people with autism? The question will also be elaborated along with the use of the assistive technology.

**Table 2: Summary of selected articles**

Research design	Focus of the Study	Scope of the research
Qualitative (5)	Autism (50)	Robot (3)
Quantitative (24)		Mobile Application (11)
Mixed Method (5)		Virtual Reality (10)
Concept Paper (16)		Wearable Devices (6)
		Augmented Reality (11)
		Assistive Technology (9)

#### 4. Findings

Based on the researcher's review of this study, the researcher will answer the research question by taking into account the research related to the specific context related to the question.

##### a. Robot

Designing, creating, and analyzing robotic instruments that mix aspects from various scientific domains such as electronics and engineering is what robotics is all about. Robotics have advanced significantly and benefitted a wide range of industries, including global commerce, health sciences, and personal services. A robot is described as an automated robot that can be operated automatically, reprogrammed, has multi-purpose capabilities, may be placed locally, or can be transported in a portable form for use in industry (International standard ISO, 2012). In simple sense, a robot is a smart robot that has been programmed to engage with humans, promote interaction, and reply to them on a continuous basis. According to table 3, robots may be classified into four kinds depending on their shape and capabilities. Robots may be classified into the following categories based on their function, as shown in table 4:

**Table 3: Robot categories based on shape and capability**

Type	Shape/Capability
Humanoid/Android Robots	It's available in a humanoid form. Aldebaran Robotics' Nao robot is one example of this.
Industrial robots	In industry, it's used to execute jobs without the need for human interaction.
Telerobot	A semi-autonomous robot that is frequently deployed in telecommunications.
Autonomous robot	Artificial Intelligence (AI) was used to create this robot, which can accomplish tasks and function without the need for human intervention.

Source: Amran et al., 2018

**Table 4: Robot categories based on function**

Type	Function
Social robots	Can actively participate in social connection with people via words and movement.
Assistive Robot	Used to assist persons with special needs, particularly those who have difficulty with motor abilities.
Service Robot	Designed to provide whatever form of support a person may require based on their individual needs.

Source: Syriopoulou & Gkiolnta, 2020

According to Sharmin et al. (2018), robots are frequently employed in conjunction with smartphones. In the realm of ASD research, they are often employed as assistive technology. Robots should be self-contained and require no energy or human interaction to function. Interaction with humans must be intuitive, and robots must adjust their behavior to meet the current and new needs of the user, which is a difficult problem to address because artificial intelligence and machine learning algorithms are involved (Martinez, Escalona & Cazorla, 2020). Syriopoulou & Gkiolnta (2020) stated that there are new robotic technologies that have emerged in recent years and are known as social assistance robots or Socially Assistive Robots (SAR). This category of robots aids in social contact and has the ability to exhibit emotional signals and facial expressions in order to develop social interaction abilities in greater depth. Based on the analysis of Roberts-Yates & Silvera-Tawil (2019) using a NAO robot, it was discovered that the robot's look and social features are the most important aspects of the intervention, with the robot needing to have a pleasant appearance in order to relax and minimize user anxiety. Users feel at ease with the usage of robots since they give a limitless number of repeated activities and do not exhibit various behavioral changes as a result of emotions. According to the findings of Arshad et al. (2020) who utilized PvBot, there was a substantial difference in the mean high score after employing assistive technology tools against conventional learning. Both of the research findings revealed that it fosters user interest and participation, reinforces healthy social behaviors, builds users' confidence and resilience, and offers an enjoyable environment for them to participate in each activity.

#### b. Mobile Application

Application for mobile devices such as smartphones, tablets, and iPads are known as mobile applications. Mobile applications are also frequently used to educate people with ASD (Sharmin et al., 2018). Because of its flexibility and affordability, it has become the preferred assistive technology tool of educators and researchers. Furthermore, it enables the programme to be upgraded in a short period of time, with each new version of the application bringing new features that make it simpler to use and satisfy the demands of the user (Stathopoulou et al., 2020). Mobile applications can also be integrated with the concept of gamification or serious games to produce interesting mobile application software and can enhance the development of the ASD group to reach their major goals using a variety of techniques. The features of game design and game experience in the learning process are referred to as gamification by Dichev & Dicheva (2017). The concept of gamification supports learning from a variety of contexts and subjects. Dichev & Dicheva (2017) also stated that it can be used to address attitudes,

activities, and behaviors such as involving participation, cooperation, self-guided study, completing assignments, making assessment easier and effective, and incorporating exploratory elements in learning to strengthen student creativity. Serious games vary from gamification in that they are meant for educational purposes rather than enjoyment. Despite the fact that the core principles are different, the aims might be the same despite the diverse development approaches. Smartphone capabilities enable consumers to access additional services at any time and from any location. For example, the utilization of multi-camera solution lenses, biometric sensors, augmented reality capabilities, and other software all contribute to it being a cutting-edge application development. Stathopoulou et al. (2020) further state that an application that is properly developed and fits the needs of the user is one that provides consistent and clear tasks as well as visual cue instructions rather than convoluted spoken instructions that might lead to misunderstanding. The findings from the researcher's study, it is stated that the application for Android tablets aids in enhancing the social skills of the ASD group with instructional teaching methods. Fage et al. (2018) have developed and tested the School+ app on tablets to encourage the enrolment of ASD children in secondary school. The application includes exercises from the aspects of compensation and cognitive. The aspects of exercises that are included in that application are compensation and cognition. The elements of the application are especially developed to solve issues via planning and implementation, such as offering assistance on daily routines such as going to class, entering class, removing school equipment, taking notes, and departing class. In terms of socio-cognitive function, adaption, and social responsiveness, the overall findings revealed a clear substantial improvement. Based on the results of the study of Ntalindwa et al., (2019) and Lee (2018), it was also found that mobile applications can be well integrated to teach the ASD group, and it not only focuses on children, but for adults as well. Mobile applications help them become more cognitively efficient. They're also more likely to follow the exercise because the application includes visual and imaginative presentations that keep their attention span steady. Furthermore, using mobile application devices is a simple technique since it is cost effective and may raise knowledge about ASD, hence reducing stigma among ASD patients' families.

### c. Virtual Reality (VR)

The term augmented reality or known as Extended Reality (XR) has risen and been inspired in various studies among researchers as a unified platform. XR is a general term that encompasses mediated reality (AR), virtual reality (VR) and mixed reality (MX). Ongoing XR research is being conducted in order to establish a collaborative system of design and user experience (UX) elements to support features that allow many users to interact (Coltekin et al., 2020). Virtual reality (VR) is gaining traction as a possible platform for teaching interactive social skills. A commonly known definition of VR is a three-dimensional simulation generated by a computer enabling users to experience and explore real life environments and interact in real time (Ke, Moon & Sokolikj, 2020). Users may interact with virtual items and enjoy the experience as if they were in a three-dimensional world with virtual reality devices. For persons with ASD, virtual reality provides various therapeutic benefits in a virtual environment (VE) that allows them to move wherever they wish, even if they have mobility issues (Cunha, Neiva & Silva, 2018). Virtual reality may take many forms, from highly interactive virtual world desktop computer displays to head-worn display systems. There are two categories of VR namely immersive virtual reality (IVR) and Desktop Virtual reality (DRV) (Herrero & Lorenzo, 2019). Although they have similar characteristics, they present different advantages and disadvantages to be translated into means of assisting people with ASD. The environment created by VR is an environment that provides a safe and controlled situation but highly interactive and realistic virtual scenario that facilitates the teaching of psychoeducational needs for people with ASD (Ip et al., 2017). Those statements are supported by Herrero & Lorenzo (2019) with the

statement of their research finding that the use of VR learning environment provides a safe and controlled context for ASD students that allow them to be prone to social interaction and increase flexibility to variation. VR has an intrinsic appeal for use as a teaching aid technology tool for people with ASD who tend to learn with visual support. Based on the results of a study conducted by Yuan & Ip (2018) there was an improvement in the expression, emotional regulation, and social-emotional reciprocity of the study participants. It was told as well that social skills, emotions, continuity of everyday routines, communication, cognitive training, and physical or motivating activities are some of the challenges that may be handled utilizing VR technological solutions (Mesa-Gresa et al., 2018). However, according to the findings of Abduljabar (2021) and Bradly & Newbutt (2018), VR has limitations since most ASD students dislike wearing headsets or perceive the VR experience to be a strain on components of their sensory sensitivities. Due to the high expense of VR deployment, it is frequently chosen to not be an option.

#### d. Wearable Devices Technology (WAT)

Wearable devices (WATs) are small, pleasant electronic devices that are comfortable and can be worn on a user's body or affixed to their clothing (Shen et al., 2017). WAT can take numerous forms and can be used in conjunction with Internet of Things (IoT) technologies. The fourth industrial revolution has evolved quickly, resulting in IoT technology, which allows for small electronic and computational equipment to be worn on a person's body (Niknejad et al., 2020). Based on the systematic literature review carry through by Benssassi et al., (2018) the existing devices that have been used by past researchers are wearable cameras with a mix of PDAs/minicomputers and smart glasses to detect emotions, an eye detector mixed with camera to train eyesight and attention joints, infrared sensors to improve the ability to know the distance to interact, accelerometers to deal with stereotypical behavior and smartphones to improve general sociability. According to the findings of a research done by Keshav (2018), smart glasses are a valuable assistive device since they are lightweight, can gather information and offer feedback to users, and can collect behavioral and cognitive data metrics in real time. In addition, Benssassi et al., (2018) also stated that in the presence of WAT, ASD patients can learn skills that are applicable not only in the classroom or clinical setting, but also in real-world settings by receiving real-time feedback in a range of social scenarios. WAT is viewed as a critical assistive technology tool for improving ASDs' abilities to integrate into society and their knowledge of various social circumstances. However, according to Sharmin et al. (2018), the application and assessment of WAT technology was confined to a pilot research in which it was employed in a controlled setting for a limited amount of time. The fundamental issue is that when it is dealing with complicated data processing, there is a lack of processing power, storage, and battery life to be considered as a viable alternative. Even when only worn for a few hours, certain WATs were deemed stressful by research participants, adding to questions about their usefulness as a continuous data source, monitoring tool, and intervention. Researcher Sharmin et al., (2018) also stated that the vital element that plays an important role for WAT technology is from the point of view of appearance so that WAT devices do not have a significantly different appearance and cause ASD people seem different from others to avoid the possibility of social prejudice.

#### e. Augmented Reality (AR)

Augmented Reality (AR) is one of the elements that fall under the Extended reality umbrella (XR). AR is a technology that allows any visual item or picture to be viewed as augmented reality through a device such as a computer or smartphone, converting information, material, and images to the user's screen (Cakir & Korkmaz, 2019). When the literature review was conducted on the study of Ramli et al., (2018), AR is also described as a system or programme



that produces visuals in the actual world using aspects of 3-dimensional virtual objects by computer into the environment in real time (Azuma, 1997). AR is a technology that applies the properties of overlapping pictures, text, video, and audio components to existing objects and places. AR differs from VR in that users do not interact with virtual items; instead, they observe virtual objects appear in the real world and experience them (Arango et al., 2018; Ayse, 2018; Diego et al., 2017). Based on the findings of Cavus et al., (2021) each research employed different tools, packages, and methodologies to construct AR systems for diverse applications. Researcher Cavus et al. (2021) also claimed that it is critical to design technological aids that are both cost-effective and high performing. The key point raised is that AR applications require a consistent design for interfaces and objects, as well as the elimination of redundant and superfluous material. Simultaneously, modern technologies such as computer vision (Computer Vision) and machine learning (Machine Learning) are used to incorporate AR technology in a seamless manner (Vanneste, 2020). Furthermore, there is a pressing need to create AR apps that can run on both mobile operating systems of smartphones (Cakir & Korkmaz, 2019). AR can help ASD sufferers gain cognitive empowerment by stimulating critical thinking and problem-solving abilities, as well as foster inclusion and social integration (Lorusso et al., 2018). Researcher Cakir & Korkmaz (2019) also stated that the use of AR in teaching and learning sessions benefits positively in terms of preparedness, excitement, motivation, self-confidence, academic accomplishment, and degree of perseverance. Based on a study conducted by Antao et al., 2020, ASD research participants exhibited a considerable increase in numerical abilities when participating in problem-solving activities, as well as sophisticated ways to tackle the problem, which enhanced their cognitive and motor performance indirectly. After the literature analysis was conducted, the usage of AR has become the most popular alternative for ASD sufferers where at the end of the study all research participants express seriousness and interest in utilizing AR intervention tools since it boosts their confidence and makes learning more enjoyable. Cavus et al., (2021) suggested more research should be done to incorporate AR technology with special needs assistance technology tools to support the physical skills domain. In addition, he indicated that it is so critical to do a more thorough study of the usage of the XR consolidation platform in this respect, since little research has been conducted on the subject.

## **5. Discussion**

Based on past study, researchers can confidently claim that the usage of assistive technology is beneficial and can indeed tackle the challenges faced by ASD groups with improving academic performance, communication skills, and social interaction, promoting behavioral development and emotional aspects. However, although the following technologies show a high potential to achieve the results of the objectives of the study, there are certainly limitations and constraints of the study that arise to allow platforms and opportunities for other researchers to fill the gaps. It is also safe for researcher to state that the assistive technology results in significant differences in the social performance of people with ASD where they can interact better with people around and it allows them to learn to integrate in society. The studies that have been analyzed were not related at all to each other because the selected study articles were conducted in different countries and places, being done in different times, used different intervention tools and the researchers investigated the capabilities of assistive technology according to their own different scopes, e.g. improve cognitive skills, improve healthy physical activity, improve emotional skills and social adaptation, improve writing skills, recognition of facial expression and so on. At the same time, it not only benefits the ASD group, but also benefits the educators where assistive technology tools help teachers to facilitate the learning and teaching process in the classroom. However, educators must carefully pick the appropriate

assistive technology tools to meet the objectives, and this decision is frequently impacted by budgetary considerations, necessitating the cooperation of other parties. According to Sharmin et al., (2018), the goal of selecting assistive technology tools should be to enhance the natural abilities of people with ASD rather than merely focus on deficiency ability skills in order for them to be proficient with their own unique talents. Aside, an issue that is often overlooked is the respondents of study from various ages. Therefore, it is a wakeup call for all researchers to conduct studies that design the assistive technology for all stages of age because ASD is a lifelong persistent disorder. Thus, it is a critical aspect for researchers to design technologies that can provide support to various different life stages for people with ASD. This is because it has been found that most of the research and technology related to ASD is focused on the early stages of childhood while for the adult stage it is still under-represented. However, the assistive technology can be well received by the families of ASD sufferers who are the respondents of the studies because it helps a lot in managing ASD sufferers and paves the way for the group to better achieve high development in various aspects. Despite this, many parents in industrialized nations opt not to expose their children to ASD for fear of societal stigma, a lack of regular life chances, and social prejudice. Despite the fact that technology may help persons with ASD, and their families improve their lives without requiring social approval, it is difficult to get family members to participate freely in research and engage in research conversations. Researchers believe that if awareness is spread widely about ASD, it will contribute to a better understanding of ASD in society and will undoubtedly inspire more ASD family members to come forward and engage in assistive technology research.

## **6. Summary**

The employment of assistive technology in the promotion of ASD development is a teaching and learning strategy that provides many benefits from various aspects. Starting from the academic aspect, the ASD group was found to successfully improve language, writing, speech and cognitive skills. They are doing better in adopting new knowledge in a broad environment when they use assistive technology. As for the aspect of social skills, they can be seen to show better social interaction, high involvement in each activity, have a high tendency to share experiences with friends and show more interest and consistent span of their attention. The usage of assistive technology was also discovered to be able to execute a transfer skills approach by educating the ASD group to get familiar with the sharpened abilities even if they did not have access to the assistive devices after a period of time. The transfer of acquired skills can open up better opportunities for people with ASD to become more independent as individuals and able to mix with society. This in turn provides a platform and opportunities for other researchers in future to use and create assistive technology as a way to enhance the development and address the challenges faced by ASD group. Although the potential of these assistive technologies has wide coverage in the face of unique clinical challenges to ASD, researcher believe that lots of smart technologies are still rarely used and integrated in the education of people with ASD. Researchers believe that in order for such interventions to be effective, these assistive technologies need to function in facilitating data collection and real-time problem detection according to specific contexts. This assistive technology should also be able to adapt the device features to user behavior in real time based on user preferences, affective conditions, and environment. In addition, it should also act analytically, facilitating the detection and highlighting of every progress even if it is small progress that can be achieved by an autistic child. The researcher believes that this study can contribute in terms of ideas to other researchers to further explore assistive technology to facilitate the needs of the ASD group.

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