# Speech Assistive Device For Students With Autism Spectrum Disorder: A Review

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Abstract—Autism Spectrum Disorder (ASD) is one of the many conditions that can be observed present in the students under Special Education. It is a developmental incapacity that causes difficulty in communication and socialization, with unique behavioral challenges. Some has severe speech impairment and some has the ability to speak. For this reason, technologies such as speech assistive devices are developed to assist the needs to develop communication skills. This paper will provide a review on different speech assistive devices developed. The result of the comparison of devices shows that tablet and mobile device has more benefits over other devices. Based on the results, it can be concluded that Tablet SGD is the best assistive device compared to other seven (7) existing devices. It has an excellent functionality, best mobility, advanced user interface and most creative media used.

*Keywords*— autism, assistive device, ASD, speech, special education

# I. INTRODUCTION

A utism Spectrum Disorder (ASD) is a developmental incapacity usually diagnosed at age resulting in the difficulty of communication and socialization coupled by unique behavioral challenges., which is usually diagnosed among children [1]. The disorder was considered as "Spectrum" because of the wide variation in the severity and signs manifested by a child having this disorder. A person diagnosed with ASD seems to be act normally but has difficulty in communicating, and interacting with other people [2]. Moreover, he/she also exhibits unusual social interaction behaviors, has inconsistent eye contact when communicating and tends to look uninterested or not listening to the topic being discussed [3]. Most of the time

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they do not respond when someone calls their name. They are focused on their interest and they talk too much about their favorite subject matter, without considering reactions of other people. They usually does have unnecessary extra movements or gestures when they start to talk. when talking. Sometimes their voice is flat like a robot or apply intonations which sounds like they are singing [4]. They repeat the questions instead of answering and they are also fond of spinning objects or does something that comforts them. Some autistic kids also exhibits difficulty in sleeping which oftentimes affect their behavior. On the positive note, children with this condition are excellent in areas like in arts, music, math and science. In learning lessons, they can easily delve into audio and visual learning materials [5]. Moreover, studies have discovered that chemical imbalance range issue (ASD) totals in families, and twin examinations gauge the extent of the phenotype change because of hereditary variables (heritability) to be about 90% [6].

In United States, Risperidone, a medicine for adult antipsychotic is used to control tantrums, irritability and aggression of a person with ASD. But there is no specific medicine that can cure autism, it is a life time disorder. Providing behavioral intervention like occupational and speech therapy are some of the best approaches to improve their behavior, socialization, and communication skills [7]. In terms of communication, there are technologies like Speech Generating Device (SGD) that are already available in the market. This medical equipment that provide individuals with disability in speech to communicate to others by providing them functional speaking needs [8]. A versatile assistive device for Attention Deficit Hyperactivity Disorder (ADHD) with speech therapy using Embedded System is another technology that trains the person with ADHD to produce a normal level of voice. The voice pitch is monitored, by providing the level of sound the user produced [9]. Another technology is "Kotha", a mobile application for people with speech impairments especially for people suffering from autism and aphasia who are unable to pronounce, speak fluently and even repeat a phrase. The objective of the application is to facilitate conversation using alternative and augmentative

communication [10]. A game called "Spoke It" is an oriented mobile application that uses speech recognition to listen to users with speech impairment. The mobile application include a reward system which is to make it more engaging to the young users. [11].

The development of these technologies undoubtedly is crucial to persons with ASD. However, serious concerns on the use of these devices were raised buy concerned groups [12]. For instance, most SGDs are single function device, which is costly thus making it more difficult to acquire. For instance, the embedded system that monitors the pitch level of the user to produce normal voice will only be useful if its converted to wearable device. One of the trends on providing computing solutions is through mobile use applications [13]. It will be difficult, however, to integrate it with voice recognition especially if the audio has no filter.

Hence, this study aims to determine the cost-effective assistive application that will help people with ASD to master their lessons delivered from speech therapy classes. The supplementary activities using the assistive application can help the learners to master their lessons by practicing the lessons not only during the class or therapy session schedule, but also during their free time[14].

This can also be used to address the challenges of a child with autism who is unable to organize the words of a possible answer to basic personal questions, by practicing the statements (answers to basic personal questions) with the aid of an assistive application with voice output. This will enable the child to hear the lesson over and over again and allow them imitate the statement to perform a speech drill. A guardian, parent or teacher who can identify the cognitive and physical abilities of a child can set an array of vocabulary words or sentences based on the basic expressive and receptive language of the child which is most relevant to the child. As the child improves, the parent or guardian can enhance the lesson by adding more vocabulary words [15].

# **II. PROBLEM/EXISTING CONDITION**

Teaching students with special needs requires individualized approach because each student has different levels of learning capabilities. For students diagnosed with Autism Spectrum Disorder, they are learners with speech delay and with weak communication skills [16]. These children usually mimic the words they hear in their surroundings. This is a condition most commonly known as echolalia [17]. These children also manifest repetitive behaviors and limit their activities aligned with their interest. In addition, there were recorded behavioral problems, like destructive behaviors, lack of fear or excessive fearfulness and temper tantrums [18]. These conditions serves as major challenges in the part of the teachers as it requires patience, innovative teaching styles, catchy teaching materials and activities to calm the child and ensures to use or apply the simplest form of communication or discussion to deliver the lesson. Teachers must also provide visual graphics to support the discussion of the lesson, in this case the students engage in the lessons for they are the kind of learners who appreciate more visuals graphics [19]. Furthermore, communication skill is one of the competencies required by the Department of Education (DepEd) in the Enhanced Basic Education Program which must be possessed by a student to avail or be part of the inclusion program in primary and secondary level [20].

Since communication is one of the challenges in teaching a child with autism, there is a serious need to develop such skill [21]. As such, most of the special education (SPED) schools offer or recommend speech therapy to address this problem. Studying in a SPED School with a transition and streaming program, is truly expensive. Therapies, such as speech therapies, cost an additional of 500 pesos per hour. Moreover, an hour's speech therapy session may not even be inadequate to master the lesson. There is also a need to support and provide supplementary activities from speech therapy to allow the child with ASD to practice the lesson which will lead to mastery.

The use of a mobile device with educational app greatly helps an autistic child to engage with lessons and activities. It helps to improve communication skills of a child [22]. But using multimedia applications alone is insufficient there is a need to target, what engage them most is important to sustain the interest of the child. Like the use of not just voice output but incorporating the voice of that is familiar to them. The use of algorithm will support the application of specific voice as voice output.

Even though the use of these assistive device are beneficial to the speech development of a child with ASD, it must take into account that there is a need for assessing the status of the child with ASD to identify the urgent need [23]. This process may avoid the incorrect usage or implementation of assistive technology to the speech development of a child. Using the summary of seven stages of communication matrix as shown in Table 1, one can identify where to start in the intervention [24].

Stage	Form	Symbolic Level	Function	Behaviors	Phase
Ι	Pre-intentional behavior	Pre-symbolic without intent	Expresses discomfort, pain, hunger	Vocalization; facial expressions	
II	Intentional behavior	Pre-symbolic with intent	Expresses intrest, pain, hunger, desire to seek out	Vocalization; Eye gaze, facial expressions	
III	Unconventional communication	Pre-symbolic behaviors used to intentionally communicate and considered unconventional because socially unacceptable	Uses behaviors to get needs met; demonstrates an increase in these behaviors when reinforced	Crying; screaming; body movements such as; kicking, hitting, and tugging on others to get needs met	
IV	Conventional communication	Conventional means are used to communicate	Uses communicative initiations and hands and body for interaction	Gesture; nodding or shaking head; looking from object to person; pointing	Phases 1 and 2
V	Concrete symbols	Symbol is physically similar to what is represented; toy teacup for "cup" or "drink"	Initiates communication and one-to-one correspondence with photographs/objects	Pictures objects given to others to express wants, needs and ideas	Phase 3
VI	Abstract symbols	Symbolic: may not physically look lile the object or idea it represents; e.g. stop sigh for "stop"/"all done"	Symbol used one at a time to express ideas	Written words, signs, braille, line drawings	Phase 3
VII	Language	Grammatic rules followed representing abstract concepts	Used in two or three symbols combinations	"I want juice"; "Truck go!"; may be verbal or non-verbal	Levels 4,5 and 6

TABLE I Seven Stages of Communication Matrix

## III. METHODOLOGY

#### A. Search Strategy

Research papers and articles included in this study were from high quality and reputable journal databases such as Elsevier, Journal of Special Education Technology, ScienceDirect and Springer. The keywords used were assistive technology, guide for assistive technology, assessment of assistive technology, technology, ICT, and persons with special educational needs. In this study, a literature review is done to search for quality academic literature databases in order to access applicable research manuscripts.

#### B. Data Extraction and Analysis

In order to extract the data, a coding system is developed. The English-based documents were selected by considering the title and the information in the abstract/content as they related the general themes of the use of assistive technologies and implementation models. The criteria considered in this study are functionality, mobility, user interface and media used.

#### 1) Functionality

Functionality is defined as the features of the assistive device appropriate to the needs of the persons with disability.

#### 2) Mobility

This refers to the ability to use the assistive device, anytime anywhere.

## 3) User Interface

It is defined as the interactivity design of the device or application. How the user will issue command and other inputs to communicate with the device.

4) Media Used

It is the use of text, image, audio, video and animation in the application or device to make it more engaging to the user.

#### C. Limitations

Given that the purpose of a rapid review of the literature is to explore a large body of literature over a short period of time, the fundamental task requires to reconcile how useful the search results are versus how complete the results are within the constraints of time, human energy, and analytic power. Therefore, while a significant body of literature was identified in this study, it is highly probable that key documents were overlooked. Furthermore, given that the majority of project effort focused on locating and capturing relevant documents, the time available for analysis was significantly constrained. Therefore, there is much more to be learned from this dataset.

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Device	Functionality	Mobility	User Interface	Media used
Picture Boards ACC	A board consist of are 50- 400 words that consists of commonly used phrases in communication.	Can be used any time any where	Finger or stick to select identify picture	Text and images
Sophisticated SGD	Dedicated device can only be used as speech assistive device	Limited Stationary designed device	Use buttons like computer keyboard	Audio
A Versatile assistive device for ADHD with speech therapy using Embedded System	Dedicated device can only be used to monitor the level of pitch of the user	Limited Stationary designed device	Use buttons and sensors	Light Indicator
"TongueToSpeech[22]	Dedicated device can only be used to input text using tongue	Can be used any time any where	Use of tongue	Audio output using mobile device
Speech-Assistive Device Integrated in an Android Mobile Application for Individuals with Incomplete Locked-In Syndrome	Dedicated device but with multi way of accessing the app	Can be used any time any where	Body movements	Audio output using mobile device
Tablet SGD	Multi-functional Other applications are available like calendar, video player and communication	Can be used any time any where	Touch screen uses swipe drag and drop	Text Image Audio Animation Video
Development of 'Kotha' for the people with speech impairments,"	Multi-functional Other applications are available like calendar, video player and communication Speech Recognition Provides articulation feed backs	Can be used any time any where	Touch screen uses swipe drag and drop	Text Image Audio Animation Video
Spokeit	Multi-functional Other applications are available like calendar, video player and communication Game oriented	Can be used any time any where	Touch screen uses swipe drag and drop	Text Image Audio Animation Video

	TABLE II
SUMMARY OF	SPEECH ASSISTIVE DEVICE

## IV. RESULTS AND DISCUSSIONS

Table 2 shows the summary of the developed speech assistive devices. The use of picture board ACC, which is considered low cost, has the characteristic of mobility and addresses the communication needs but are less engaging since it uses limited media. In considering electronic device, SGD best fits to users. If the user has other impairments or disorders that prevents the user to navigate freely, then focused only in addressing speech issues. But if cost is not a major factor, one can use the SGD.

A Versatile assistive device for ADHD with speech therapy using Embedded System, on the other hand, is an embedded system technology that trains the person with ADHD to produce a normal level of voice while speaking. It limits the training of the user in monitoring the pitch of voice. Although, the message conveyed does not matter. This device will be more useful if converted to a wearable. "TongueToSpeech" and "Speech-Assistive Device Integrated in an Android Mobile Application for Individuals with Incomplete Locked-In Syndrome" are embedded systems used to assist persons with severe speech impairment. They are not applicable to persons with ASD who wants to develop their verbal communication skills.

Tablet SGD is less expensive compare to SGD and has the mobility characteristic. It has other functionalities and can be use for educational purposes. Kotha, a mobile application for people with speech impairments, especially for people suffering from autism and aphasia who are unable to pronounce, speak fluently and even repeat a phrase. It is an electronic version of ACC that allows the user to select images from the application and these images will generate a spoken word, these will in turn convey a message. Although the device is inexpensive and engaging to the user, it is not applicable to train the user whose goal is to improve speech.

Since SpokeIt is gamified mobile application, it is a very engaging. The use of speech recognition is a very good tool that provides articulation feedback. This feature allows the user to practice speaking. But the accuracy of capturing the speech is one major concern, because it has the possibility to capture the noise in the environment.

When it comes to functionality, the tablet SGD device is the best among others. All of the devices has a great mobility except for the sophisticated SGD and the versatile assistive device for ADHD. Moreover, in terms of user interface, the touch screen technology is a best approach. The devices that has this kind of technology are Tablet SGD, Kotha and SpokeIt. For the media, the student with autism will learn fast with the inclusion of animation as seen in Tablet SGD, Kotha and SpokeIt.

#### V. CONCLUSION

Autism Spectrum Disorder is one of the many conditions that a child may have and can be noticed or observed while they are young. The guidance of an adult or someone with knowledge on how to assist this children is a very relevant task. Thus, this study is conducted in order to determine which among the existing speech assistive device is best suitable for children with ASD. Based on the results, it can be concluded that Tablet SGD is the best assistive device compared to other seven (7) existing devices. It has an excellent functionality, best mobility, advanced user interface and most creative media used.

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