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Implementing Assistive Technologies in Education for Differently-Abled Children

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Abstract* — Children with disabilities in any of the physical organs or children who are mentally unstable are specially abled, and we must consider and provide them with a supportive and growing environment in which they can live and grow. Our project's primary focus here is on mentally challenged children, typically aged 3 to 6 years. As we know that mentally challenged children require more time and effort to learn and understand basic concepts such as alphabets (A-Z), numbers (0-9) and so on, we propose to develop a system in which the children can easily identify and learn alphabets using RFID-embedded flash cards that are also combined with Arduino-based text-to-speech, speech-to-text as well as spell-checking software, allowing teachers and parents to monitor the time taken and thus monitor their progress. The purpose of this paper is also to contribute to this research by investigating the benefits, challenges, and effectiveness of implementing ATs in education for differently-abled children.

Keywords— ***Assistive Technology, Children, Differently-abled, Education, Learning***

I. INTRODUCTION

Education is a fundamental right for all children, regardless of ability or disability. Traditional methods of education, on the other hand, may not be adequate for differently-abled children. Today, we regularly see kids' United Nations agencies struggle with physical and mental tasks. For several kids, exploiting technology to boost learning is an efficient strategy. The World Health Organization estimates that there are one billion disabled people worldwide, with the majority of them living in low and middle-income countries (WHO, 2021). Children with disabilities face numerous educational barriers, including physical, communication, and societal inequalities. Assistive technologies have become an intriguing way to close this gap and provide these children with equal opportunities. These technologies can aid in the accessibility, learning, and engagement of differently abled students in the classroom. ATs have the potential to break down some of these hurdles and provide inclusive learning opportunities for children with disabilities. What is more, students with LD (Learning Disabilities) usually accomplish bigger success once they are allowed to use their skills (strengths) to figure around their disabilities (challenges). helpful technology tools mix the simplest of each of those practices. A variety of studies have shown that helpful Technology is effective for individuals with learning disabilities over the last decade.

Assistive technologies (ATs) are intended to help people with disabilities achieve greater independence, access to information, and social participation. The use of assistive technologies (ATs) in education for differently abled children has shown great promise in facilitating their learning and development. With technological advancements, there is a greater availability of various ATs that cater to various disabilities and needs.[1]

Assistive technology does not cure or completely eradicate learning disabilities; however, it can help children reach their full potential by allowing them to invest on their strengths while avoiding problem areas. While most people associate "assistive technology" with computers and computerised devices, it can also refer to low-tech devices. Items such as pencil grips are examples of assistive technology. Assistive technology for students with learning disabilities includes software products that provide text-to-speech (e.g., Kurzweil 3000), speech-to-text (e.g., Dragon Naturally Speaking), word prediction capabilities (e.g., WordQ), and graphic organisers. [2]

Computer-assisted technology has grown in popularity as a teaching aid in schools around the world, particularly for children with special needs. This is due to the fact that learning technology has earned a reputation for significantly improving a child's experience and performance in a traditional school setting when used appropriately.

II. LITERATURE SURVEY

Numerous studies have demonstrated the positive impact of ATs in education for differently-abled children. For example, a study conducted by Sideridis et al. [3] found that the use of ATs, such as text-to-speech and speech recognition software, improved the reading comprehension and writing skills of students with learning disabilities. Similarly, a study by Abdullah and Alqahtani [4] reported that the use of ATs, such as interactive whiteboards and digital textbooks, enhanced the engagement and motivation of students with visual impairments.

Braille literature cannot be used to translate everyday information. This prototype has been proposed to make reading easier for visually impaired people. Text information can be converted into an audio format using this prototype. This is accomplished by connecting the camera module and speakers to the Raspberry Pi 3 model B, a credit card-sized single board computer. Assistive technology is equipment or a system that enables people with disabilities to live better lives. They will improve a disabled person's ability to perform specific tasks.

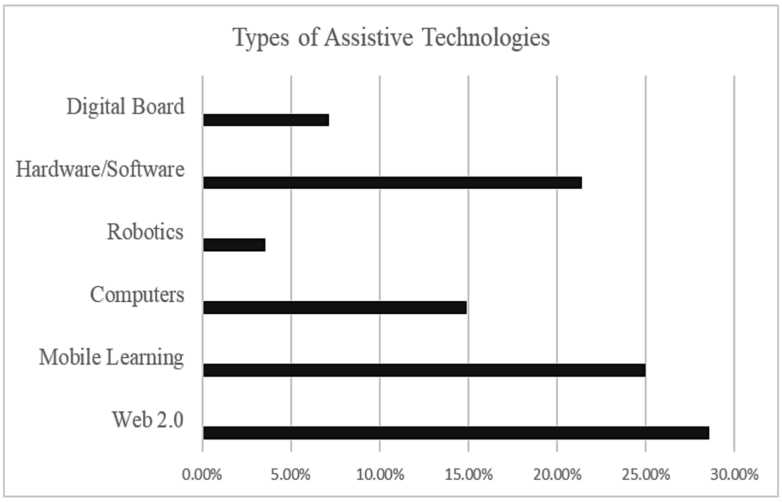
Nowadays, computers are designed to interact by reading books or documents. Synthesised voice is used to read the content by the computers. We also have devices that scan the documents and use an interfaced screen to allow the blind to sense the scanned documents on the screen either in Braille or by using the shape of the letters itself with the help of vibrating pegs. With the use of wearable healthcare monitoring devices, data could be received from the sensors to the controller through wireless transmission technologies (LTE/3G/Wi-Fi). The controller is implemented using an Arduino board which then pushes the accumulated values to the Hadoop system. In Hadoop, the data is received in the csv format with the help of Apache Sqoop tool.[6]

Because of the similarities in its symptoms, executive function development is typically associated with Attention Deficit/Hyperactivity Disorder (ADHD). For affected individuals to be properly treated, systems that can correctly diagnose problems with executive functions are required. This paper describes the device's design, implementation, and experimental results. This device is divided into two parts: the image processing module and the voice processing module. The process of converting scan or printed text images into text format for further processing is known as optical character recognition (OCR). This paper described a straightforward method for extracting text and converting it to speech. [7]

ADHD (attention deficit hyperactivity disorder) is characterised by symptoms of inattention, hyperactivity, and impulsivity. It is a neurobiological disorder with a broad range of causes. It appears in childhood and affects 3 to 5% of all children worldwide, being able to accompany the individual throughout his life, though some symptoms become milder over time. ADHD affects people, resulting in a low quality of life not only for those who have the disorder, but also for those who live with them. The paper was proposed with the goal of minimising all of those complexions and achieving maximum accuracy in sign language to speech conversion with gestures. Human gestures are an essential component of human communication and an aspect of human actions known colloquially as body language. Many methods are used to track human gestures. Many methods are tried to achieve maximum accuracy and make the system unique, with the best-case being user defined actions (gestures) to operate the system. [8]

Assistive technology not only allows differently abled children to live a normal life, but it also enables them to overcome their disability and obtain an education. Statistics in India show that differently abled children are more prevalent in rural areas than in urban areas. The main cause of this situation is a lack of good paediatricians and gynaecologists. Children with special needs face discrimination in rural areas. Some of these children are even abandoned when they are young. The reason for this is that such parents are uneducated, come from a low socioeconomic background, and have little knowledge of current technologies. The purpose of this paper[8] was to provide information on the following assistive technologies for children: (1) Assistive technology for autistic children: mobile robots and wearable body sensors. (2) Text to Speech (TTS) System: Assistive technology for children with dyslexia. (3) Wheelchairs and robotic arms are examples of assistive technology for physically challenged children.

The systematic literature review in [10] focused on scientific articles published between 2009 and 2020 that aimed to assess the impact of assistive technology use in the education of students with disabilities. There is a wide range of Assistive Technology tools used for those groups of students. Fig. 1



depicts the use of Web 2.0 (for example social networks,

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websites, and browsers) stands out (28.57%); mobile learning (25%), which includes the Tablet, iPad, or mobile phone; and the use of hardware or software (21.43%).

Fig. 1 Types of Assistive Technologies

Similarly, Fig.2 depicts the group of students who fall into various categories, such as visual disability (25%), hearing disability (21%), physical disability (14%), intellectual disability(7%), autism(10%), and finally, NoData(17%) for the group of students for whom data is not available/specified, using the various types of assistive technologies mentioned in Fig.1.

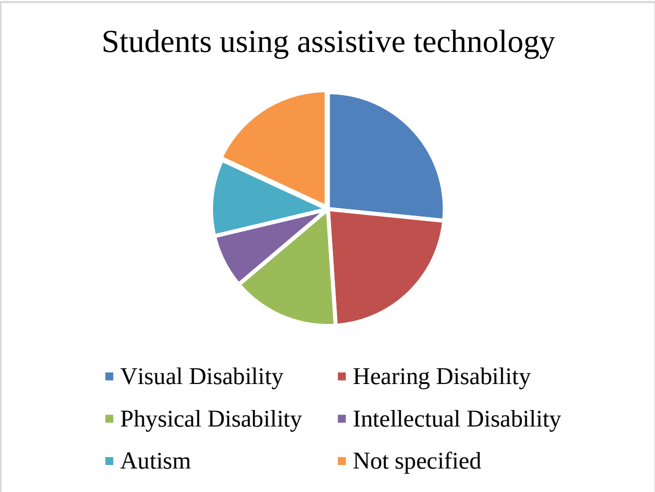

Fig.2 Students using Assistive Technologies

III. PROPOSED SYSTEM MODEL

A. Block Diagram

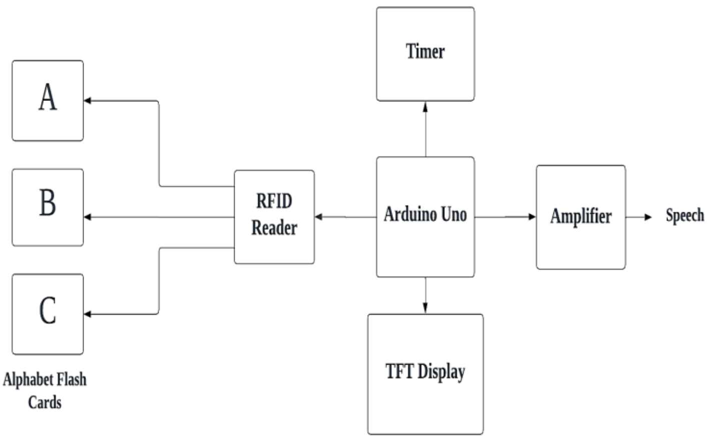

Fig.3 Proposed system block diagram

This system contains the following hardware components:

- **Arduino-Uno:** Wherever it connects with the Arduino development setting, the Arduino board is connected to a computer via USB (IDE). Within the IDE, the user writes the Arduino code, which is then uploaded to the microcontroller, which executes the code and integrates with inputs and outputs.
- **RFID Tags:** RFID tags are a kind of following system that uses frequency to look, identify, track, and communicate with things and other people. RFID tags are unit sensible labels which will store a variety of knowledge from serial numbers, to a brief description, and even pages of knowledge.
- **RFID Reader:** RFID (Radio Frequency Identification) readers are electronic devices that use radio waves to communicate wirelessly with RFID tags or transponders. The reader is made up of a transmitter and a receiver, which send and receive signals between the two RFID tags.
- **Amplifier:** An electronic equipment is an associate degree device that will increase the voltage, current, or power of a proof. Amplifiers are utilised in wireless communications and broadcasting, and in audio instrumentality of all types.
- **TFT Display:** TFT SPI touch screen and Quad SPI TFT (Serial Peripheral Interface) is a synchronous serial data transfer protocol that connects two or more serial devices in full-duplex mode.

IV. METHODOLOGY

The design and interconnection between the various components of the circuit is shown in the flowchart i.e., fig. 4 given as follows:

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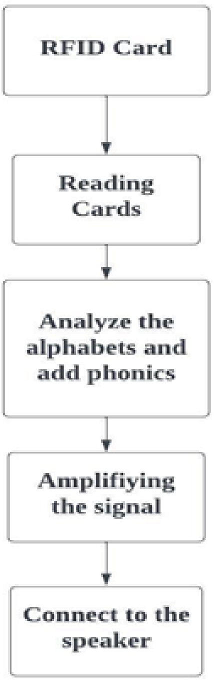


Fig. 4 Methodology Flowchart

In Figure 3, RFID cards have been programmed with unique phonics corresponding to the alphabet marked on each card. This was accomplished using the Audacity application, an open-source software tool that permits the recording and editing of audio tracks. The phonics were embedded as a unique ID on each card. When an RFID card is read by the RFID reader, the Arduino-Uno processes the data and converts the WAV file into hex code for Arduino speech, which is then played through the attached amplifier speaker as the corresponding phonics. Additionally, a TFT display has been included to allow children to practice writing the alphabet and words in a structured and concise manner.

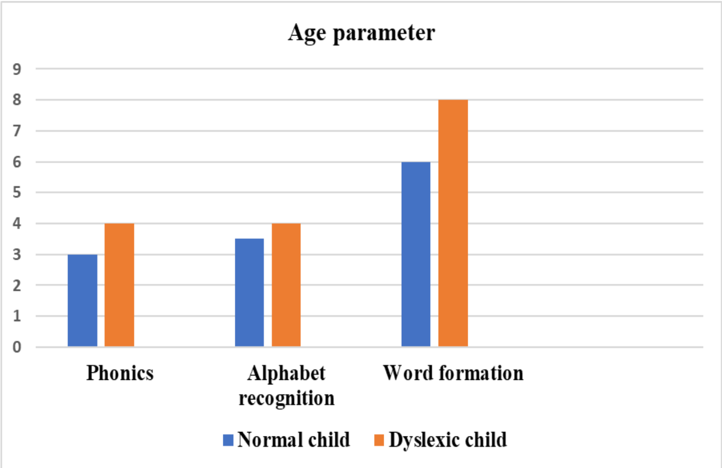
V. RESULTS AND DISCUSSION

In this prototype, we used RFID cards that were encoded with letters. We aware that dyslexic children have difficulty learning phonics, so we designed it in such a way that it is like a game for them, making them eager and curious to learn letters from cards.

The parameters that have been selected are for the determination and evaluation of the time taken by children with signs of dyslexia to understand the phonics and basic alphabet recognition and how well they are able to identify the letters through speech i.e., how many words they are able to enunciate properly in a given time frame and lastly, the age group that the selected children belong to, etc.

The sample data set used for the evaluation and testing of the prototype is ten children (selected at random) aged 3-8 years old, consisting of fast-paced, normal-paced (normal child) and slow-paced learners (dyslexic child). The following is a comprehensive representation and analysis of test performance results in graphical and pictorial form in fig. 5, fig. 6 and fig.7 respectively:

Fig. 5 Age parameter



The x-axis denotes the evaluation parameters and the y-axis denotes the age of each child (normal and dyslexic) in the age group of 3-8 years for the bar graph i.e., Fig. 5.
Following the performance for age parameter, it was indicated that normal children aged 3 perceive phonics accurately, whereas dyslexic children aged 4 perceive phonics accurately. In terms of the next parameter, alphabet recognition, both normal and dyslexic children aged 3-4 years correctly recognised the alphabets. Finally, while normal children aged 6 years could form the given 3-4 words correctly, at the same time, the dyslexic children aged 8 years could form the same words correctly.

The x-axis denotes the number of words enunciated correctly by each child (normal and dyslexic) and the y-axis denotes the time taken (in seconds) for the bar graph i.e., Fig 6.

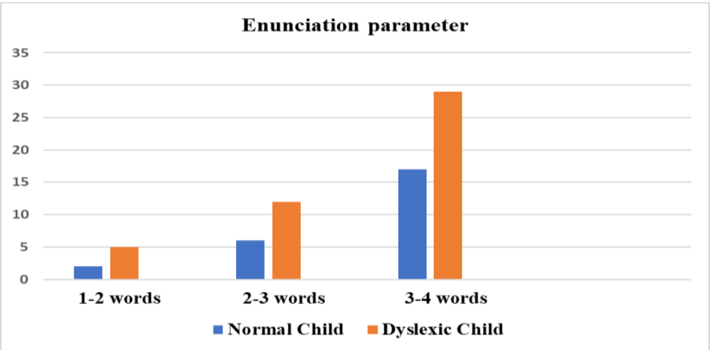


Fig. 6 Enunciation parameter

Following the performance for enunciation parameter, it was discovered that while normal children could enunciate 1-2 words in less than 3 seconds, dyslexic children could do so in 5 seconds. Similarly, normal children could pronounce 2-3 words in 5 seconds, whereas dyslexic children could do so in 10-15 seconds. Finally, normal children could enunciate 3-4 words in 15-20 seconds, while dyslexic children could do so in 25-30 seconds.

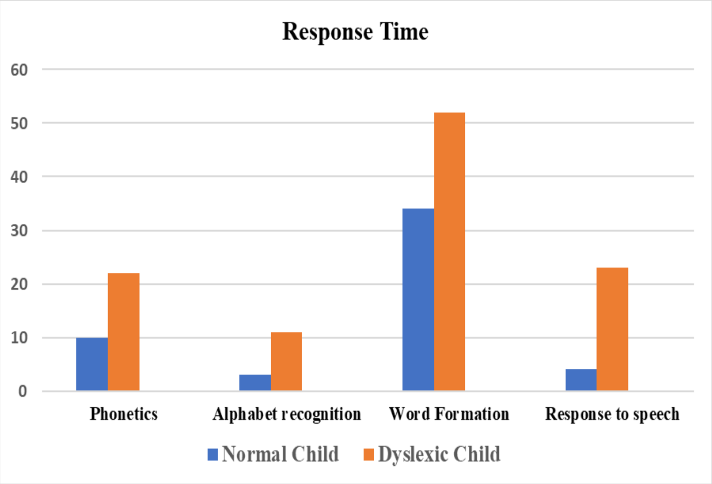


Fig. 7 Response Time

The x-axis denotes the evaluation parameters and the y-axis denotes the time taken by each child (normal and dyslexic) in seconds for the bar graphs i.e. 7.

Following the performance for response time parameter, it was observed that while normal children take an average of 10 seconds to perceive phonics/phonetics, a dyslexic child takes 22 seconds. A normal child takes an average of 3 seconds to recognise a single alphabet, whereas a dyslexic child takes an average of 10 seconds. When it comes to the next parameter, word formation, a normal child takes an average of 33 seconds to form simple 3-4 lettered words like dog, cat, kite, and so on, whereas a dyslexic child takes more than 50 seconds. Finally, a normal child takes less than 10 seconds to respond to speech produced by the prototype's amplifier, whereas a dyslexic child takes an average of 20-22 seconds.

Despite the potential benefits of ATs, their implementation is fraught with difficulties. The cost and availability of ATs, particularly in low-income settings, is one of the most significant challenges. Furthermore, a lack of training and support for teachers and students using ATs can limit their effectiveness.

The prototype is currently being improved in order to validate factors relating to the approval and use of the application by differently-abled people, as well as to highlight the main benefits and problems that it can pose as a result of its use.

VI. CONCLUSION

Hence, the children's/students' reliance on others to scan, write, and organise their work may be reduced with the assistance of helpful technology and helpful technology will facilitate troubled students. It ought to be noted that technology has considerable impact on learning on its own.

Finally, assistive technologies have the potential to improve educational outcomes and opportunities for differently abled children. However, more research on the effectiveness of ATs in various educational settings is required, as is addressing the challenges associated with their implementation.

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