

# Improving Learning Abilities Using Interactive Assistive Technology: A Survey Based Study For Down Syndrome Students

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**Abstract-** Assistive Technology supports disabilities in education to increase the learning ratio. Students with Intellectual disabilities have equal rights to study in general learning environments with normal peers. Down syndrome is a genetic cause and sub-category of intellectual disability. Students with Down Syndrome delay in cognitive ability due to delayed reaction by their brain. Such habits cause delays in fulfilling tasks than their normal classmates. The research aim is to bring a Human-Computer Interaction strategy to bridge the reading-writing issues faced by Down Syndrome Students with Assistive Technology support. We have used mixed methodology, wherein an online survey is processed across Pakistan to evaluate the type of computing technology used by Down Syndrome Students and to identify the problems faced by Down Syndrome Students in the reading-writing process. A practical approach was carried out to identify usability patterns with desktop, portable devices, and smartphones. A proposed Interactive Learning Model addresses the issue and suggests assistive technology solutions and services provide a way to use gadgets and solve learning problems. The results show that the students with Down Syndrome face problems in reading, writing, and solving exercises. Interactive technology scrutinizes questionnaires and provides smart solutions in the classroom to address reading and writing using assistive technology-based reading and writing and touch-to-speak technology to develop language skills and express their thoughts, communication control, and decrease frustration. Tough-type-read-spell-oriented custom software to improve reading and spelling skills and to provide a paperless advantage.

**Keywords:** Down Syndrome Students (DSS), Assistive Technology (AT), Interactive Learning Model (ILM), Human-Computer Interaction (HCI)

## INTRODUCTION

Increasing attention has been drawn by the researchers in the Human-Computer Interaction (HCI) community towards the development and design of accessible computer applications for developmental and cognitive impairment individuals [1]. The progress and change in the field of computer science have facilitated and influenced mankind in almost every sphere of life. Information Technology through its accessibility

has empowered education as well.

Children with Down syndrome have special educational needs. Particularly, such individuals mature slowly, and their deficiency is determined by biological characteristics, their learning outcomes are either slower or faster and depend on the educational approaches to intrude in their cognitive development [2]. Assistive technology examines a range of techniques to support such children in teaching and their learning [3].

Individuals with Down syndrome face difficulty in communication and are unable to speak in their primary language.

To help overcome this obstacle technology-enabled alternative and augmentative communication features use the textual symbol and graphic representation to provide symbol-enabled human-to-human, human-to-machine communication [4].

### A. Down Syndrome People

Down syndrome or trisomy 21 is a genetic cause of developmental incapability around the globe. The World Health Organization (WHO) records cases of Down syndrome. The ratio of these cases is 1-2 amongst every 1000 live births around the world [5]. The possibility of trisomy 21 is openly related to maternal age [6]. People with Down syndrome possess a neuro-cognitive position and neurobehavioral profile. These behaviors have resemblances to Intellectual Disability behaviors. Children and adults with Down syndrome are diagnosed by their different emotional and behavioral outlooks. Down syndrome was firstly identified by John Langdon Down in 1866 [7]. Physical development and achievement of landmarks generally become much slower as compared to normal children. The average delay in landmark development happens approximately after two or three months, which may increase to one or two years for movements that normally come earlier [8].

### B. Technology-based learning

Assistive technology is the devices, equipment, process, services, adaptation, and systems that support and facilitate their usability by students with Down syndrome [9]. The devices that support people with Down syndrome to perform everyday tasks that seem difficult otherwise. Assistive technology engages them in routine activities to make them social and independent. People with Down syndrome require the extra support of parents and teachers. To get the best

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results, there is also a need for developing the skills and capabilities of the family and teachers enabling them to learn the usability of assistive technology [9]. Technology-based learning offers an opportunity for teachers to access new teaching strategies and the usage of technology to motivate Down syndrome students in the learning process [10].

#### LITERATURE REVIEW

Detailed research is addressed so far related to technology-based learning of Down syndrome. The focus has been only on using computers, handheld devices, and specific applications to enhance educational environments. There are more other publications that exactly describe further technology which can be accessed to address the assistive technology-based learning of Down syndrome students.

In 2017, Jafrah Alammari, Fatima Al-Haiku, and Kawther investigated the impacts of Assistive technology on Down syndrome students in the Kingdom of Bahrain. The research was focused to examine the current circumstances concerning the adoption of assistive technology in the learning processes in schools. They conducted a survey that resulted in AT enabling learners with DS more social and communication improvement, independence, and performance. They sought training of AT to parents of Down syndrome students their teachers and specialists to enhance their capabilities and skills [10].

In 2017, Gomez and Torrado found that iPads-iOS devices are supportive learning devices for learners with cognitive disabilities. The study justified with a survey conducted amongst a number of students with developmental disabilities, for accessing up to time duration and found all satisfied [13].

In 2014, Areej Alfaraj and Ahmed Bawa explored their research on the use of technology to support the learning of children with Down Syndrome in Saudi Arabia. They employed a survey questionnaire to seek the technology being used in existing educational institutions for Down syndrome children. And to find out the teacher's experience about the benefits of technology being accessed and the challenges faced by students. 20 findings from two schools were accessed which concluded that mostly used technology are iPad, computers, projectors. Teachers suggested providing assistive technology with necessary hardware and Arabic software [11].

In 2014, Amal F.A Mahmoud proposed Intelligent Tutoring System (ITS) for Down syndrome for computer-based instructions in educational institutes. Using Early Intervention Program (EIP) as a tool to improve overall children development of DS. For this purpose, the ITS framework was developed to help parents of DS to monitor the skills of DS children and apply to intervene services to DS to evaluate their progress [14].

In 2014, Ahmad, W. F. W., proposed Rapid Application Development (RAD) as a custom application to provide easy interfaces. It was constructed using Eclipse Android development. The tools developed were used to support DS children with moderate level IQ. A survey was carried out amongst three candidates to use the interface of the application. Data showed satisfactory and successful use of application [15].

In 2013, Fern and Rodr highlighted Picaa, a mobile device-related platform designed to assist people with learning disabilities for academic purposes. Picaa used the touch screen iOS features, ubiquitous to the Internet to provide four different kinds of functionalities, association, visual exploration of content, puzzles, and sorting activities. Features included authoring tools and activities to provide educational content on the user's device. Pica supported activities of perception, memory, and attention [16].

A research study incorporated a proposal of bringing Universal Design for Learning, utilizable also as assistive technologies for the people with learning disabilities. To individualize the technologies, text-to-speech and spellchecking built-in word processing features were used in taking common structures advantage XML semantic tagging in Websites, it was made cognitive and linguistic-oriented to support the development of human learning which is essential for optimal solutions [16].

In 2010, Syed Asif Ali presented a proposed research model for the conversion of the Heterogeneous education system to a Homogeneous Education System (HeES) to provide a feasible platform for visually impaired and hearing-impaired persons relying on artificial intelligence and information technology tools of speech recognition and mathematics. The techniques used were speech-to-text conversion, pattern matching, and text-to-speech conversion. Deaf people use the keyboard to discuss queries. Using speech recognition, language was detected and translated into an understandable format. The model proved to HeES conversion and confer equal opportunities to disabled persons in normal schools [17].

#### *A. Working Archetypical*

Before we implement Assistive Technology in the normal classroom. We are required to get an idea about how Down syndrome students react and behave. Knowing the behavior and mental issues in learning leads towards the requirement and shape of required assistive technology to face the challenges of DSS. An online survey was conducted from parents of DSS to find out the behavioral and communication position of DSS. Once the data is obtained the problem facing in learning is found. Assistive technology will be used to deal with the deficiency.

DSS possess a distinct mental level. Thinking level differs from their physical age group. Mental age levels are the present learning capabilities and power of learning they possess. Artificial Intelligence Neuroimaging Artificial Neural Network (ANN) approach to detect the mental age level to identify study level. Finally, we suggest a model for the inclusion of the Assistive technology curriculum (ATC) within a normal class environment.

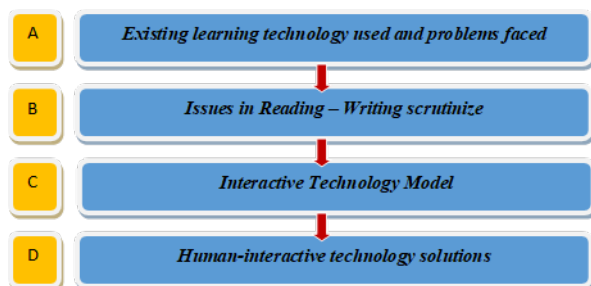


Fig. 1. Human-Computer interactive strategy

## METHODOLOGY

We have used mixed methodology, wherein an online survey is processed across Facebook groups to evaluate what technology down syndrome students are using and barriers faced during learning. Besides, a case survey based on 3 DS students was conducted. The quantitative method of a proposed Interactive Learning Model (ILM) was used to review measurable data related to down syndrome, analyze down syndrome work products, identify strategies that improve or enhance learning and develop and modify the learning strategies.

### A. Data Sources

The purpose of the research study is to discover the usability and efficiency of AT. To meet this requirement, an online survey was distributed amongst parents using different social media and Facebook sources includes Pakistan Down's Syndrome Support Network (PDSSN), Karachi Down Syndrome Programme (KDSP), Down Syndrome Research and Support (DSRS), Down Syndrome Club (DSC) to identify barriers and mental strengths in using assistive technology.

### B. Participants

We invited 150 parents of Down syndrome students, in response to 150 distributions only (N=81) parents responded.

### C. Survey Instrument

The survey is developed by the corresponding author. Keeping in view the domain, the survey also contains the Urdu language, and it is narrowed on two areas as given below: -

- Personal data of the participant (Down syndrome student)
- Category of an existing institution

- Technology used for learning support
- Barriers faced in learning/technology

The seeking data of the type of learning environment do try to evaluate the mental and behavioural level of the DSS. We need to check the syndrome level whether the down syndrome student falls in the mild, moderate, or in the severe category. If the student is studying in general schooling systems, which reveals that he or she falls in the mild category.

To seek data of behavioral and learning skills status we used reading and writing or lecture understanding barriers and to seek the physical control to write and use the bag items well, and to memorize the notes.

An important area to evaluate which techniques are currently being used. Different technologies include computer, laptop, smartphone, the tablet is given in options. Particular user opts for a specific technology in accordance with their mental level. And to ensure the usability of the pattern of input-output devices, as per easiness.

### D. Procedure

Survey questionnaire sent to 150 anonymous parents over the different Facebook groups of down syndrome category September 2021. However, only 81 questionnaires were returned after filling online. This indicates that the study has a more than 50% response rate, which is satisfactory.

### E. Case-survey

To record the physical observation of the DSS while accessing different types of assistive technology. A session was conducted to inspect usability differences and behavior between desktop, portable, and touch screen devices. Students with down syndrome. Three students with dissimilar gender and age level were invited along with their parents to support in accessing the Desktop, Laptop, and smartphone. To operate the desktop machine, there was a keyboard and mouse. To operate the laptop, students used a keypad. To access the smartphone, students carry it in hand to use.



Figure 2. Different AT accessing the session

**F. Teaching strategies**

In a classroom, the lecture is conveyed using verbal instructions simultaneously demonstrate lecture on wallboard, multimedia, or smartboard. Though DS students experience hearing and cognitive issues, therefore, additional efforts in the shape of assistive technology are required to support them in the learning process. To fulfill this, the communication process is made using computers, laptops, tablets, or iPad. Assistive technology takes place for students with DS with profound and severe behavioural properties, weak reading-writing, and communication skills. Systems and devices of the DSS relate to teachers’ laptops and smartboards. Smartboard performing multi-tasks for kind of students in a normal class. It generally visualizes lectures to all students and is specifically connected to either DS students or teachers. For any query or feedback, the DS children communicate with teachers in a chat form through a tablet device connected through a wireless network with the teacher’s laptop simultaneously.

**G. Performance Assessment Tools**

Judging the performance of the Down syndrome students’ needs help of assistive technology. In a normal classroom, the teachers allow DSS extra time to respond, present support on fine motor-related assignments, offer visual cues, students break, encouragement, and praising students’ efforts.

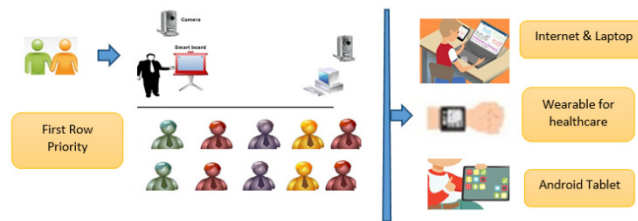


Figure 4 Assistive Technology for DSS

**Proposed Interactive learning model**

The Interactive Learning Model (ILM) emphasizes the proposed execution process that supports the Down Syndrome Students in providing a set of technology to overcome the learning barriers and deficiencies (including cognitive skills, writing skills, and tactile opportunities). The model Technology aid in the shape of Assistive devices and software applied to DS children to enhance the communication factors (including independence, performance, and socialization). Down Syndrome people have different physical ages and mental skills. In the first instance, the software tool is utilized to evaluate the mental strengths of DS people. Secondly, assistive technology (including laptop, tablet, smartwatch, personal computer, online google apps, email, calculator, windows paint, and online search engine) are presented to DS people in order to perform activities with the help of parents or teachers.



Figure 5. Interactive Learning Model

**RESULTS AND DISCUSSION**

The impact of the applied assistive technology analyses how the performance of the DSS is enhanced using technology. Down syndrome children extensively face learning difficulties that lead to delay in development in various factors of life. They usually learn and grow gradually than other children. Down syndromes learn better with illustrated things.

We conducted an online survey to examine existing technology access to help in reading and writing and to evaluate barriers currently faced by the DS students. In response out of 500 distributions only (N=70) parents of Down syndrome students responded. The survey was conducted on a national level only. Resources of social media were also approached in

getting survey data. Various Down syndrome Facebook groups including Pakistan Down’s Syndrome Support Network (PDSSN), Karachi Down Syndrome Programme (KDSP), Down Syndrome Research and Support (DSRS), and Down Syndrome Club (DSC) were used.

The feedback of different data is represented, 60% male and 39.4% female Down syndrome students participated in the survey. Students are enrolled in different grades depending on the mild-moderate level of mental age, students are enrolled from class on to 8th class. The average age was recorded from 6 to 16 years. The results of the learning environment are reproduced as under:

- 33.3% DSS are enrolled in inclusive education
- 27.3% DSS are enrolled in the special education system
- 18.2% DSS are studying at home
- 18.2% of DSS are enrolled in the normal schooling system
- 1% of DSS are learning at Rehabilitation centres

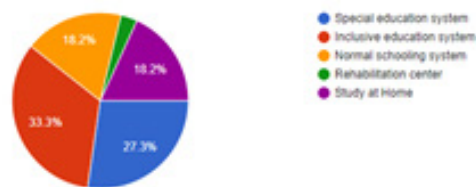


Figure 6. Learning environments

Down syndrome students faced different issues during learning. The higher difficulty ratio is reading (50%) and writing (50%). Technical issues they face are slow typing (42.1%) and mouse moving and handling (42.1%).

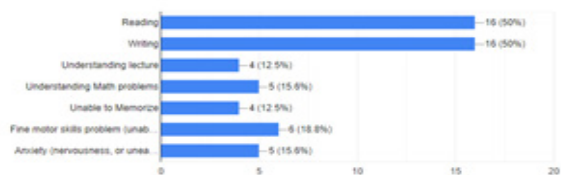
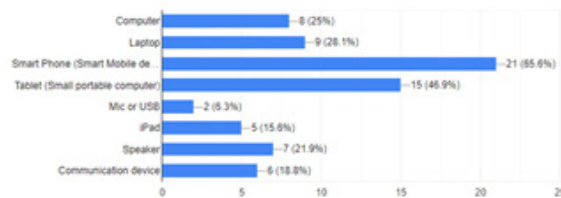


Figure 7. Learning environments

Different interactive technology is adopted by the DS students for academic and general learning purposes, 65.6% are using smartphones as given below in figure # 8.



Figure#8: Interactive technology

The results from a live session were conducted, wherein 3 students with Down syndrome of age level and gender participated and used a Desktop computer, laptop, and smart device. The results of usability difference between desktop, portable, and touch screen devices is given in table # ....

Table 1. Software For Special Need

	Age & gender	Technology using and Issues facing	M e n t a l strengths observed
P1	year – 8 Male	Desktop computer  Reading-writing, mouse moving	Modest
P2	year – 10 Female	Laptop: Slow Typing	Mild
P3	year - 10 Male	Smartphone	Mild

CONCLUSION

The adaptability of assistive technology gives control to the students with Down syndrome to their learning. In general, technology breaks the barriers faced by disabilities and provides productivity in learning. Software services and gadgets facilitate them to initiate and face difficulties in studies. Assistive learning is believed as a useful tool that helps in improving the academic and social skills of Down syndrome students. Assistive technology-based classroom provides various learning opportunities with different adoptive equipment connected between DSS and teacher with communication boards, handheld devices, and special keyboard. The built-in accessibility provides applications to learn mathematics and perform logical assignments. DSS feel comfortable sending feedback and query for discussion with the teacher. Interactive technology enhances study skills and brainstorming.

A technology-based curriculum is highly supported for learners with intellectual disabilities, which may be trained with audit books, portable keyboard, tape recorder, calculator, magnifier, and computers. These tools provide a practical

approach in solving exercises.

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