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Enhancing mental skills for better Reading-writing abilities using Interactive assistive Technology: A survey-based study for Down Syndrome Students

Muhammad Irfan Leghari[a]*, Syed Asif Ali

Institute of Business Administration, Karachi, Sindh, Pakistan
Sindh Madressatul Islam University, Hasrat Mohani Road, Karachi, Sindh, Pakistan

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Abstract

The aim of present study is to bring Human-Computer Interaction strategy to bridge the reading-writing issues faced by intellectual disabled Down Syndrome Students with the support of Interactive Technology. We have used mixed methodology, wherein an online survey is processed across the Pakistan to evaluate medium of computing technology accessed by Down syndrome students and to identify the problems faced in reading-writing. A practical approach carried out to observe the mental strengths and thinking potential through hands-on practice with desktop, portable devices, smart phones, and specific applications. A proposed Interactive Learning Model compensate the barriers faced in reading-writing through using assistive technology services and applications. The results show that the assistive technology and relative services enhance the thinking and decision-making abilities. Interactive technology and smart solutions provide a continuously support with touch-to-speak technology to develop language skills and expressing their thoughts, communication control and decrease frustration. Tough-type-read-spell oriented custom software to improve reading and spelling skills and to provide paperless advantage.

Keywords: Down syndrome Students (DSS), Interactive assistive Technology (IAT), Interactive Learning Model (ILM), Human-Computer Interaction (HCI)

Introduction

Increasing attention has been drawn by the researchers in 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 has 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 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 primary language. To help overcome this obstacle technology enabled alternative and augmentative communication features use textual symbol and graphic representation to provide symbol-enabled human-to-human, human-to-machine communication [4].

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]. Possibility of trisomy 21 is openly related to maternal

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Corresponding author
mirfanleghari@gmail.com

People with Down syndrome possess neuro-cognitive position and neurobehavioral-profile. These behaviours have resemblances to Intellectual Disability behaviours. Children and adults with Down syndrome are diagnosed by their different emotional and behavioural outlooks. Down syndrome was firstly identified by John Langdon Down in1866 [7]. Physical development and achievement of landmarks generally becomes much slower as comparable to normal children. Average delay in landmark development happens approximately after two or three months, which may increase to one or two years for movements which normally comes earlier [8].

Technolgoy based learning

The assistive technology are the devices, equipment, process, services, adaptation, and system 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 extra support of parents and teachers. To get best results, there is also need for developing the skills and capabilities of the family and teachers enabling to learn the usability of assistive technology [9]. Technology based learning offers an opportunity for teachers to access new teaching strategies and usage of technology motivate Down syndrome students in learning process [10].

A detailed research is addressed so far related to technological based learning of Down syndrome. The focus has been only in using computers, handheld devices, and specific applications to enhance education 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, Jaflah Alammary, Fatima Al-Haiki and Kawther investigated into the impacts of Assistive technology on Down syndrome students in Kingdom of Bahrain. Research was focused to examine the current circumstances concerning the adoption of assistive technology in the learning processes in schools. They conducted survey which resulted AT enable 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 the capabilities and skills [10].

In 2017, Gomez and Torrado found that iPads-iOS devices a supportive learning device for learners with cognitive disabilities. The study justified with a survey conducted amongst number of students with developmental disabilities, for accessing up to a time duration and found all satisfied [13]. In 2014, Areej Alfaraj and Ahmed Bawa explored into 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 of Down syndrome children. And to find out the teachers experience about 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 for providing assistive technology with necessary hardware and Arabic software [11].

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

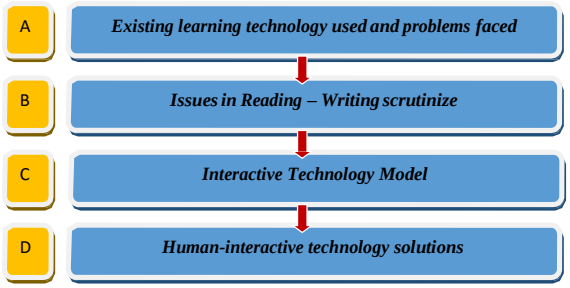
In 2013, Fern and Rodr highlighted Picaa, a mobile device related platform designed to assist people with learning disabilities for academic purpose. Picaa used the touch screen iOS features, ubiquitous to the Internet to provide four different kinds of functionalities, association, and visual exploration of content, puzzles and sorting activities. Features included authoring tool and activities to provide educational contents on user's device. Picaa supported activities of perception, memory, and attention [16]. A research study incorporated 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 development of human learning which is essential for optimal

solutions[16]. In 2010, Syed Asif Ali presented proposed research model for conversion of Heterogeneous education system to Homogeneous Education System (HeES) to provide 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 keyboard to discuss queries. Using speech recognition, language was detected and translated into understandable format. Model proved to HeES conversion and confer equal opportunities to disabled persons in normal schools [17].

Working Archetypical

Before we implement Assistive Technology in the normal classroom. We required to get idea about how Down syndrome student react and behave. Knowing the behaviour and mental issues in learning leads towards the requirement and shape of required assistive technology to face the challenges of DSS. Online survey conducted from parents of DSS to find out the behavioural 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 distinct mental level. Thinking level differs from their physical age group. Mental age levels are the present learning capabilities and power of learning possess. Artificial Intelligence Neuroimaging Artificial Neural Network (ANN) approach to detect the mental age level to identify study level. Finally, we suggest model for inclusion of the Assistive technology-curriculum (ATC)



within a normal class environment.

Figure 1. Human-Computer interactive strategy

Materials and Methods

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

Data Sources

Purpose of the research study is to discover the usability and efficiency of interactive technologies for enhancing the mental skills. To meet this requirement, different sources approached from case survey, 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.

Participants

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

Survey Instrument

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

- Personal data of the participant (Down syndrome student)
- Category of existing institution
- Technology used for learning support
- Barriers faced in learning / technology

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

The important area to evaluate which technology are currently being used. Different technologies include computer, laptop, smart phone, tablet are given in options. Particular user opts specific technology in accordance to mental level. And to ensure usability of pattern of input output devices, as per easiness.

Procedure

Survey questionnaire sent to 150 anonymous parents over the different Facebook groups of Down syndrome category September 2021.

However, only 81 questionnaire returned after filling online. This indicates that study has more than 50% response rate, which is satisfactory.

Figure 2. Different AT accessing session

Case-survey

To analyse the reveal of potential on technology usability, a physical session carried out to judge how Down syndrome students can improve the mental skills and reading-writing skills with direct accessing different types of the interactive technology. A session conducted to inspect usability difference and behaviour between desktop, portable and touch screen devices. 10 students with dissimilar gender and age level invited along with their parents to support in accessing the Desktop, Laptop, and smart phone. To operate desktop machine, there was a keyboard and mouse. To operate the laptop, student used keypad. To access the smart phone, student carry it in hand to use.

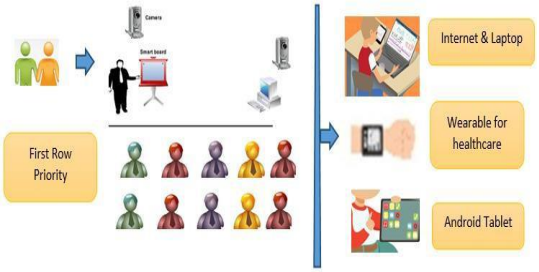


Figure # 3 Assistive Technology for DSS

Teaching strategies

In a classroom, the lecture is conveyed using verbal instructions simultaneously demonstrate lecture on wall board, multimedia or smart board. Though, DS students experience hearing and cognitive issues, therefore, additional efforts in

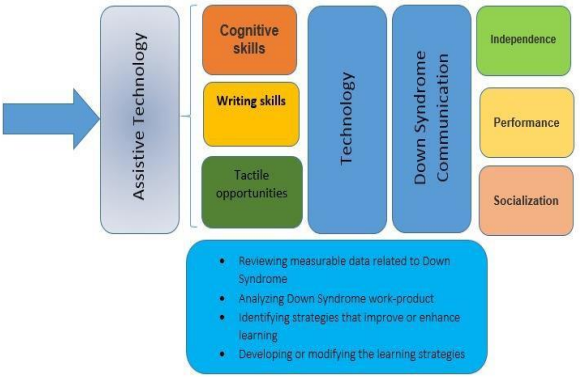


Figure 4. Interactive Learning Model

shape of assistive technology are required to support them in learning process.

To fulfil this, the communication process is made using computers, laptop, Tablet or iPad. Assistive technology takes place for the student with DS with profound and severe behavioural properties, weak reading-writing and communication skills. Systems and devices of the DSS are connected with teachers' laptop and with smart board. Smart board performs multi-tasks for both kind of students in normal class. It generally visualizes lecture to all students and specifically connected to both DS students and teacher. For any query or feedback, the DS children communicate teachers in a chat form through tablet device connected through wireless network with teacher's laptop simultaneously.

Performance Assessment Tools

Analysing the performance of the Down syndrome students' is very important and needs help of interactive assistive technology. The bridge of the technology help teachers in evaluating the current learning position and status of the students. Smart technology associated between students and

Proposed Interactive learning model

The Interactive Learning Model (ILM) emphasise the proposed execution process that support 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 age and mental skills. In the first instance, software tool is utilized to evaluate the mental strengths of DS people. Secondly, assistive technology (including laptop, tablet, smart watch, 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.

Results and discussion

The accessibility impacts of interactive assistive technology evaluate how the mental ability of an intellectual disabled Down syndrome student is enhanced. Enhancing mental abilities directly approaches the solutions of the problems faced in reading-writing and in communication. 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 conducted on 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 recorded from 6 to 16 years. The results of learning environment is reproduced as under:

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

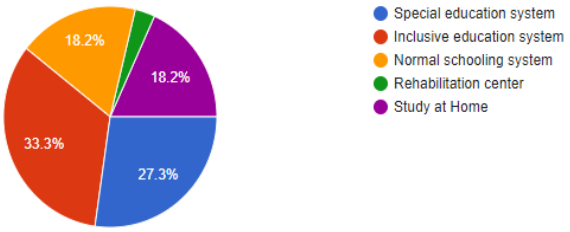


Figure 5. Learning systems

Down syndrome students faced different issues during learning. 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%).

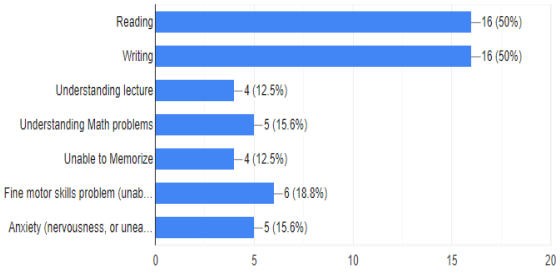


Figure 7. Learning environments

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

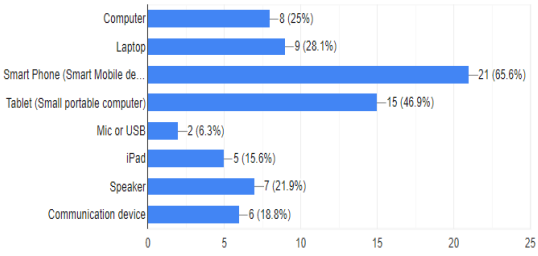


Figure 8. Interactive technology

The results from live workshop session conducted, wherein 10 students with Down syndrome of different gender and age levels participated in the live workshop session and accessed different interactive technologies i.e., Desktop computer, laptop, smart phone, and tablet. Before the technology accessibility they faced difficulty in reading and writing skills and were unable to understand the exercises. After they accessed the different devices, they found it helpful and started using the computer, laptop, and smart devices with interest. The found tablet and laptop an easy and friendly device to use. Opening the computer and accessing operating system Microsoft windows helped them to understand the technology and software. The easy accessibility of Microsoft operating system enabled them to open other utility software of game, Calculator and MS-Paint. Down syndrome individuals face reading and writing problems, to cope with the situation, specific utility of text-to-speech and Microsoft Window based applications provided support in getting help in reading. Reusing of smart interactive solutions including Table and smart phone helped them in enhancing the cognitive and mental levels.

Conclusion

Down syndrome is an intellectual disability. The major problem of this kind of individual face is lower mental skills. They delay in performing any task. But they have potential to strengthen their mental skills. The lower mental and thinking decision impacts on their learning and education. They face difficulty in reading-writing and communicating problems. We have approached Interactive Assistive Technology (IAT) to fill this gape and support Down syndrome individuals in different learning skills.

The adoptability of interactive assistive technology give control to the students with Down syndrome to their learning. In general, technology break the barriers faced by disabilities and provide productivity in learning. Software services and gadgets facilitate them to initiate and face difficulties in studies.

Assistive learning is believed as useful tool that help in improving 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 to send feedback and query for discussion with 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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