Chapter 6: Assistive Technology & Adaptive software tools

Even IGNOU has its share of students who need Assistive Technology and Adaptive software tools. The focus of this chapter is on disability and technology to assist people with disability. After introduction we will discuss types of disabilities, modified and improved pedagogies, modality & medium, assistive technology, common vendors that make these aids, software feature that aid these learners, support for their family and journals in this area. This is followed by sections on User Interface (UI), smart classrooms & laboratories, educational rights and adaptive software tools etc. for disabled students.

6.1 Introduction

Inclusive education is to include those students in the mainstream, who are likely to be left behind because of their special needs. In order to do this, a teacher is trained and taught to handle individual differences in Education and Special Education courses. Special Education courses deal with the detailed methodology, training and use of special aids. A trained teacher should be able to recognize, different types of students, including weak, general or gifted and help them accordingly, utilizing the available resources.

A student may be weak because of – it may be due to health problems, aging & physical or mental disabilities. There may be various other reasons due to which a teacher can face problems while she teaches a diverse class. Like, some students have emotional, social or financial problems. Female students, pupil from remote area, lower strata of society need support from teacher, family and peers. There are differences in attitudes, ambitions, interest & aptitudes of the students. They have varied morals, beliefs, opinions and family background. Every child is a special and unique entity. There are differences in their learning behaviour, environment and heredity [26]. In this chapter the area of focus is Assistive Technology concerning education.

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6.2 Disabilities

Disability is an impairment that may be physical, cognitive, mental, sensory, emotional, developmental, or some combination of these [16]. A disability may be present from birth, or occur during a person's lifetime due to aging, injury or disease. A table of various types of disabilities is given in Table 3 below:

<table>
<thead>
<tr>
<th>Physical Disability</th>
<th>Sensory Disability</th>
<th>Intellectual Disability</th>
<th>Mental &amp; Emotional Disabilities</th>
<th>Developmental Disability</th>
<th>Nonvisible Disability</th>
</tr>
</thead>
</table>

Table 3: Types of Disabilities

Disability can lead to long term impairment, social and economic disadvantages, denial of rights and limited opportunities to play an equal part in the life of community [104].

6.2.1 Effect of Season of Birth on Disability

Living beings are affected by their surrounding and genes they carry from their parents. Learning is one such affect. Learning is change in behaviour. What one perceives is what one learns. ‘Season of birth’ is one factor that affects nature and psychology of a person and hence determines attitude and learning [26]. Disability can be correlated with such factors as shown in the data analysis based study below. Sections after introduction are titled as analysis of the data, gender analysis and discussions. The idea Season of Birth comes from Educational Psychology domain. Educational Psychology can help us understand a learner
better and it includes many other tools including assessment. Human behaviour and psychology is a complex subject and is studied under various departments and disciplines. In this chapter, we are studying effect of factors leading to disability in students; particularly we observed correlations between Season of Birth (SOB) and disability. This study is similar to studies conducted in references where a relationship was established between mental health and SOB [105, 106]. Disability is a condition of body or mind, other than normal or general. Disabled people have special needs. Disability may be by birth or due to some disease/accident later in life. There are many types of disabilities, broadly – physical or mental [107] . This paper is a data analysis conducted on SOB of physically disabled people, who are actually students of IGNOU. This data is for two semesters/cycles of the year 2009 from SRD of IGNOU in the form of enrolment data files.

**Analysis of the data**

From the enrolment data of the students, month of birth has been extracted out of date of birth column while data transformation using simple statistical functions. During data cleaning phase, records with empty fields are rejected[72, 91].

![Month of Birth](image)

**Figure 51: Graph showing distribution of month of birth for disabled students**

Figure 51 has been plotted using combined data of two of cycles. As noted on studies previously, summer born child can have bad nature [107] whereas winter born child might
show a higher IQ (Intelligent Quotient). This curve in Figure 51 has a bell shape or an extreme in monsoon. This is a normal distribution. Many biological phenomenon exhibit normal distributions [99]. This graph can thus be broken into two to three normal distributions.

**Gender analysis**

Most of the students in the datasets are male. This indicates gender divide and also raises questions about female mortality rate in India. But at the same time, there are questions unanswered like, how many disabled females are born? How many of them managed to enter any kind of educational body.

![Gender distribution chart showing majority male](image)

*Figure 52: Gender distribution of disabled students showing that the majority of enrolled disabled students are male*

**Discussion**

So many similar studies about biological clocks have been done in past 2 years that now this concept has a name of its own – ‘Seasonal Biology’. Most of citable work comes from Leonid A. Gavrilov and Natalia S. Gavrilova, a Russian scientist couple working in the area of Aging and Longevity[108, 109] at Centre on Aging, NORC at the University of Chicago. SOB affects various aspects of life –longevity, moods, height[110] etc.
SOB is now studied in various parts of the world in context with Disposal Soma Theory of Aging[109] and Seasonal Affective Disorder (SAD) & Bright Light Therapy[111].

6.3 Modified pedagogy

IGNOU can help its disabled students’ by improving pedagogy in the following ways:

Teaching methods and teaching aids need to tailored and suited to the specific needs of the students. Pedagogy is science and art of education. Pedagogical studies ultimately give us teaching methods like lecture methods, demonstration method, collaboration method & group methods.

- Lecture method
  - Teacher should speak clearly
  - Students should be able to record lectures (tape recorder, Smartphone etc.)
  - Visual aids shown and explained verbally
  - Distribute hand-outs, pictures, copies of slide show

- Demonstration method
  - All 4 points above as in Lecture method
  - Use of Virtual Reality (VR) or Robotic Aids can possibly make this instruction method interesting for disabled students as well. Sample studies exist but more efforts are needed to bring them to daily use.

- Collaboration method
  - Students can debate and discuss topics using Text-to-Speech (TTS) and Speech-to-Text (STT) tools, do projects in groups by collecting data from reliable sources for analysis
  - Balance group for assistance (if needed)
- For example, use of spreadsheets on a machine with STT typewriters and calculators
  - Group controlled method
    - Students participate in the teaching process, to gain self-confidence and improve speaking and communication skills. TTS and STT tools are required.
    - Balance group for assistance (if needed)
    - Use AT / Accessibility tools available.

When these students need some help from teacher, they can use flash coloured cards which are also embossed in Braille so that blinds students can also use them (Figure 53). This idea can be used while teaching any subject using computers.

![Problem!](image)

![Problem solved!](image)

![Problem partially solved.](image)

**Figure 53: Flags for speech impaired**

Teaching methods of various subjects like sciences, mathematics, social sciences, humanities, and arts has to be altered, so as to provide more time. For example, Deaf students need video lectures supplemented with titles, captions & subtitles, text or written descriptions. Teacher should write in letters on blackboard with coloured diagrams & labelling. Use of cards with keywords shown in bold, during the lecture can also help or STT tools can be used for e-Learning. Blind students require audio descriptions, titles, captions, subtitles. Teacher may need to speak important points again and again or TTS tools can be
used for e-Learning. Students with locomotor impairment should be given artificial limbs and wheel chairs to move objects and themselves respectively. They use special input devices to use computers for typing. Mute students can be provided with TTS tools to do group activities and other communication. Teacher should be patient as these students learn to use various aids from an expert and then use them in the class or at home. Institute & offices/work place need to provide them with more space, power supply to keep, maintain & use their electronic devices.

Course writers and translators need to choose words carefully i.e. stick to basic language of the subject instead of using adopted words. Provide simplest possible explanation of concepts (Occam’s razor [21]). To enable smooth reading of pdf files uploaded on egyankoash.ac.in IGNOU’s course writers adopt 1 column approach. Multicolumn approach makes text to speech tools task difficult. When such inbuilt functions come across figures, tables and special symbols errors occur and clarity is lost. Therefore course writer need to discuss these issue and adopt consistently uniform strategies – like explain every such object in side boxes or in caption for understanding. Due credit should be given to a special educator, her assistants and student volunteers who help in education and employment of a differently abled person.
Learning will be more effective if the pedagogies are modified on the above mentioned lines.

6.4 Modality and Medium

Modality is use of medium or channel for communication to express or convey information. Mode is human senses (vision, audition & haptics). Medium is text, graphic, audio or video or necessary physical devices like keyboard, mouse, microphone, speaker and screen.

Physical events are translated into symbols i.e. Perception. In Translation symbols are coded into physical events. To store, acquire and transmit these physical representations we need assistive technology (hardware & software) as medium.
6.5 Assistive Technology

Assistive Technology (AT) refers to development of those devices which can be used to enable or partially enable a disabled or differently abled person, perform daily living activities at home, outside like market, institution and workplace etc.

Most educational institutions – colleges, universities, their regional and study centres lack Assistive Technologies and aids which makes it very difficult for any needy person to study there. After such a person is given enrolment, other students have to volunteer to help her. Various life situations that such person has to face like education, transport, workplace, home, community, illness\injury and aging may require AT. It also depends on interests, motivations, type of subject, career or other goals a person wants to accomplish. Steps and resources required can be filled using AT plans as given in [112]. This manual also has a questionnaire for activities required to be done, technology selection, awareness about law & rights, funding strategies, budgeting, buying, use & maintenance which such students or employees have to fill. They need to identify their circle of support in family, friends, neighbours, community organization, college/high-school contacts, religious organizations, therapists, colleagues at work, teachers & hospitals or agencies. There are forms in [112] where a differently abled user can rate, mention importance and compare aids they are using, then ask a set of questions to the vendors. These forms are useful for family and supporting persons as well. More information can be obtained from Alliance for Technology Access (ATA) hub, an online database of vendors & products information [113]. Other such databases are:

1. AbleData [114]

2. Adaptive Device Locator System [115]

Since this research concerns physically disabled pupil who are enrolled in various courses of IGNOU, we can divide them broadly in following categories:
5. Vision impairment: to have partial or no vision. Person with this impairment can’t use mouse for input. They can’t see the screen. Correction requires magnification and colour contrast [17].

6. Hearing impairment: to have low or no hearing capability. While using computer they can’t hear audio, video, system alerts or alarms.

7. Locomotor impairment: Limited or no use of limbs, tremors, limited range of movement, speed & strength.

8. Speech impairment: difficulty in speaking or no speaking ability at all.

Assistive Technology that may be used to correct the above:

1. For visually impaired: large text i.e. screens magnifiers, text to speech i.e. screens readers / voice output, braille displays.

2. For hearing impaired: speech to text, subtitles and captions in videos, alt text (alternative text), hearing aids. Closed captioning i.e. broadcast with captions that can be seen only on a specially equipped receiver [116], Transcriptions (making a full written or typewritten copy of dictated material). ‘Show sounds’ or ‘Flash Screens’ to indicate system alert.

3. For locomotion impaired: wheel chair & ramp, artificial limbs, barrier free designs & space standards, voice input into computer, access keys, latches that are easier to reach and manipulate, switches, on screen keyboards, OS (Operating Systems) based keyboard filtering.

4. For speech impaired: text to speech (for group activities), sign language, action translators (e.g. head movements into computer commands).
6.6 Common Vendors that make aids for differently abled

There are companies and manufacturers that make and sell specially designed instruments, digital devices and their software which disabled students can use for e-Learning.

<table>
<thead>
<tr>
<th>Alternate Input</th>
<th>Interface Devices</th>
<th>Keyboard Additions</th>
<th>Processing Aids</th>
<th>Misc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miniature Keyboards, Chording Keyboards, Miniature Keyboards, On-Screen Keyboards</td>
<td>Multiple-Switch Interfaces</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Manufacturers and Vendors that make aids

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IntelliTools [119]</td>
<td>TASH [120]</td>
<td>IBM</td>
</tr>
<tr>
<td>Prentke Romich Company [121]</td>
<td>AbleNet [122]</td>
<td>Epson</td>
</tr>
<tr>
<td>Carolina Computer Access Centre (CCAC)</td>
<td>ABBYY</td>
<td>Corel</td>
</tr>
<tr>
<td>WesTest Engineering Corporation [123]</td>
<td>Don Johnston</td>
<td>HP</td>
</tr>
</tbody>
</table>

Some such *hardware aids* are given below in Table 5 and Table 6.
### Alternate Output

<table>
<thead>
<tr>
<th><strong>Word Processors</strong></th>
<th><strong>Braille</strong></th>
<th><strong>Screen Magnification Software</strong></th>
<th><strong>Wireless</strong></th>
<th><strong>Assistive Technology for the Deaf and Hard of Hearing</strong></th>
<th><strong>Misc.</strong></th>
</tr>
</thead>
</table>

### Table 6: Aids for Output

#### 6.7 Software Features

Auditory Cues includes verbal prompts & instructions. They are computer generated & require a speech synthesiser. Visual Cues are written instructions in a box that appears on screen. They are not printed in the final output. Easy-To-Read Screens provide clear, uncluttered pictures that reduce distractions. Simple and legible text with options of large characters, changeable style, font & spacing is presented. Single column can be read easily. Instructional Choices allow parents & teacher to control content & lesson presentation by adding customized spelling lists, vocabulary lists or mathematics problems. Students’ progress can be recorded and tracked. The difficulty level, vocabulary, sound, timing, speed, amount of text & graphics is adjustable. Graphics can be understood by those who can’t read. They make education interesting or motivating. Use of colours and friendly images personalizes students’ allotted disk space & profile to support reading for those who can see.
Built-In Utilities like spell checkers, zoom options, dictionaries, thesaurus, macros, grammar checkers can be integrated and installed with word processors, spreadsheets & databases. It reduces system conflicts. Built-In Access Methods allow users to elect options they want. Like which input device to use – joystick, alternative keyboard or touch screen. For this method of asking input from user is changed as per the device. Clear Documentation or Manuals with clear diagrams, illustrations and demos in large print, braille, on audio cassettes must be supplied with assistive devices. Labels used in programs must be logical and consistent to increase readability. On-Screen Instructions like help balloons and prompts can be used to guide the user through the program. They can be turned off after practice.

Mouse Alternatives like certain keyboard combinations can replace mouse functions for those who are unable to use a mouse. Modified Cursors like flashing squares, a hand, a pencil a pointed figure, thick crosshairs, thicker I-beam, or larger arrow or animated figure like a snake to indicate current pointer location on the screen.

Figure 56: Extra-large and dark mouse pointers (Mouse properties in Control Panel)
Creation of Custom Programs like Overlay Maker [119] or Speaking Dynamically [125] enable user to build their own tools that work with assistive or augmentative devices.

6.8 Support for supporters

Technology consultations and assessments can be provided by institutions, employers and aid manufacturers by conducting AT workshops, training, presentations, and tours. Special arrangements for exploration opportunities in model lab require finance, space and skilled personnel. A lending library of software, assistive devices, books, and videotapes at specialized resource centres can be opened [126]. Programs can be run on-going school, corporate, and community programs. Computer recycling programs help generate free or cheaper devices & material. Those who don’t have enough information of requirements, products, law and health care can read about it or attend workshops in a concerned institutions.

Journals in the area of assistive technology

To read and share your experience, studies, small or big inventions & research to gain and spread knowledge there are various magazines, journals available online and in print, some of them are listed below:

1. Closing the Gap [127]
2. Exceptional Parent Magazine [128]
3. Journal of Special Education Technology [129]
5. Assistive Technology Journal [131]

More such references are available in [132].
6.9  User Interface (UI)

User Interface starts with Desktop (root). Its child elements are programs running on it such as applications. These child elements contain elements representing parts of the UI such as menus, buttons, toolbars and lists. These elements in turn can also contain sub-elements such as items in a list. Elements relations are studied while designing. Working within such models and providing options to alter appearance as per language, disability, gender, culture etc. can provide universal access and reduce workload of software development team [17].

![User Interface Tree](image)

Use of metaphors (images, acoustic or tactile) can convey what thousand words can’t. Interface modelling involves – cognitive models, task models, user models and the like.

**Smart class rooms and laboratories**

Classrooms and labs that can accommodate all types of students for learning and maintain security, privacy at the same time require teaching aids of all types installed in there. Such multimodal system must be robust and flexible at the same time. Detection and tracking of persons using advanced biometric methods (finger prints, iris patterns, voice characteristics, facial features and handwritten signatures) are fused together. Such ambience or ambient intelligence implementation demands high budget and skilled engineers. In case,
budget or resources are low, resources are shared wisely e.g. print outs are used for those who can’t hear; audio cassettes, CDs, DVDs for those who can’t see; and peers who are willing to help those who can’t speak or use limbs.

### 6.10 Educational Rights of Disabled in India

There is a need for mainstreaming of the persons with disabilities in the general education system through Inclusive education. *Sarva Shiksha Abhiyan* (SSA) i.e. The Education for All Movement launched by the Government has the goal of eight years of elementary schooling for all children including children with disabilities in the age group of 6-14 years by 2010.

“SSA provides up to Rs.1200/- per child for the inclusion of disabled children, as per specific proposal, per year. The interventions under SSA for inclusive education are identification, functional and formal assessment, appropriate educational placement, preparation of Individualized Educational Plan, provision of aids and appliances, teacher training, resource support, removal of architectural barriers, research, monitoring and evaluation and a special focus on girls with special needs. SSA ensures that every child with special needs, irrespective of the kind, category and degree of disability, is provided meaningful and quality education. Hence, SSA has adopted a zero rejection policy. This means that no child having special needs should be deprived of the right to education and taught in an environment, which is best, suited to his/her learning needs. These include special schools, EGS, AIE (Army Institute of Education) or even home-based education. 29.57 lakh have been CWSN have been identified till now in SSA. Out of this, 24.77 lakh CWSN (83.78%) have been enrolled in regular schools. The current coverage of CWSN is 26.47 lakh (89.53%). The States have shown an overall expenditure of 81.77% on CWSN inclusion related activities in 2008-09 [134].”
It is important that no section of society should feel neglected. To make everyone self-dependent & feel worthy, a sense of self-importance has to be developed. A person has to learn various skills including ‘The Three Rs’ (Reading, Writing, Arithmetic; Relate, Represent and Reason) and the institution has to follow ‘3 Rs’ of its own (Reduce, Reuse, Recycle) when it comes to utilization of resources especially in a developing country like India.

6.11 Adaptive Software tools

Currently quite a few e-Learning and online information delivery platforms are designed with a “One-size-fits-all” approach. Existing distance education system lacks interactivity and can reduce interests of students. There is a need for flexible education systems which can also provide guidance as per capacity & learning level [58].

6.11.1 Accessibility and Tracking

Use of AEH to create various views of the same material, as desired by the user. This can be done by maintaining a student enrolment database combined with user behaviour database using tools like link removal (Figure 58), stretch text (Figure 59) and course monitor (Figure 60) for all those students of the university who are using online resources. These proposed tools utilize options set by user & also track and record actions of the user, which media type is chosen most often etc. Combined database form a user model [59] or a student model: goal, previous knowledge, previous performance, background, experience, preferences, stereotypes, user-supplied preferences supplied at run time, analysis of user actions & plan recognition or inference. Providing varying views of the same content is a paradigm shift away from “write once, use once” towards a middleware system [59].
This link removal tool saves the time spent on looking for most preferred type of media by avoiding confusion. Same is the purpose of stretch text tool and it also makes the interface user friendly. Such tools adapt to the habits & needs of a user as in HCI (Human Computer Interface).

Relations in the concept ensure that the student has a study guideline to follow and clearly knows the perquisites and the predecessors for each study. If certain specific perquisites are not fulfilled, the learner will be prompted for the same by course monitor tool. This tool is in accordance with Skinnerian or Linear Approach and can be combined with Programmed Learning. A rule for this can be as below. More components can be added – interest, repetition.

If c1.access = true then set c2.allow_access = true else c2.allow_access = false

If (c1.access = true or c1.test_passed = true) then set c2.allow_access = true else c2.allow_access = false (to include assessment & evaluation options)
Concepts from various disciplines can be combined – “many to many” approach.

6.12 Ease of Access – DialAT

A one stop app for helping disabled population, all the databases mentioned in [113-115] can be connected and combined with other leading vendors. The Android application similar to Dial Kashmir [135] named 'DialAT' may contain various contacts of government and private departments as a one stop source for "essential information" on Assistive Technology. 'DialAT' can include important contacts of different departments, officials and public utilities and would be of immense help to the disabled students & workers alike.

'DialAT' will provide users detailed information like addresses, phone numbers and email ids of various local vendors. It can be even further developed as a one stop source for multi-lingual information on admission, job ads, healthcare, insurance, and then one does not need to surf through internet pages, official websites and directories.
Figure 61: Screen shot 1—An example of DialAT app function for smartphone

Figure 62: Screen shot 2—representing lists of vendors with recognizable logos
6.13 Extracurricular Activities (ECA)

There are racing wheelchairs and Prostheses [136] which enables disabled person participate in sports. There are new techniques which help such persons become active in art, music, theatre, film. But it requires team work and training.
6.14 Challenges

Misunderstandings can happen e.g. while solving math puzzles use of various types of currency or use of words adopted from other languages. It is a cultural diversity issue which can only be solved by making our tools universal and adaptive. In the long term, requirements of user can change or widen, which again may cause failure of device. An assistive program provided in a class or office has to cover a heterogeneous group of users, which again is a challenging task. Following guidelines, policies and law requires the software developers’ team to be heterogeneous. To serve people with disabilities of all ages, their families, service providers, educators, and businesses Government needs to provide grants, scholarships, subsidies. Encouragement is needed to make homes, roads and institutions friendlier. More awareness of laws, rights and facilities is required. Use of Virtual Reality (VR) Aids can possibly make this instruction method interesting for disabled students as well. Sample studies exist but more efforts are needed to bring them to daily use. Robotics and VR can also be utilized for therapeutic purposes.

6.15 Summary

This chapter achieves a part of the objectives: suggesting e- Learning software and tools & modifying the existing pedagogy methods for special education, based on societal variables studied in the database & literature review. It is important to respect end user’s preferences and requirements [133]. Mission of AT is enabling individuals with disabilities to control and direct their own lives by providing them with information about, demonstrations of, and access to assistive technology tools. Designing new applications that improve user experience and confidence can increase the use & awareness about existing AT. In one section, analysis of the data in relation with season of birth and gender has also been presented and discussed. Due to global warming, pollution and other environmental factor – disability is certainly going to increase in future. More data is required to establish such facts.
Such points once established could be used for counselling students, parents and families. Taking care of environment and promoting health programs like Anti Polio Campaign in India, can help eradicate those disabilities for which the reasons are known. The idea of Season of Birth section comes from Educational Psychology domain. Educational Psychology can help us understand a learner better and it includes many other tools including assessment.