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Role of Assistive Technologies in Rehabilitation of Persons with Disabilities

Dr. R. Madhumathi* and B. Radha Krishna**

ABSTRACT

Assistive technologies usually refer to those products, devices or equipment's, which are used for improving the quality of life of Persons with Disabilities (PwDs) by improved efficiency and enhanced effectiveness. Different types of assistive technologies assist the people with disabilities by providing them with learning opportunities, capabilities and also increased potential of the disabled in different walks of life. Assistive devices and Information and Communication Technology (ICT) are playing very important role in communicating with peers, thereby promoting collaborative and social learning environment. They also help students of disabled persons in reading, writing, hearing and seeing process. Persons with disabilities have various limitations in home, school and community activities and to overcome those limitations assistive technologies are used. This paper reviews the importance of assistive technologies for Persons with Disabilities in mainstreaming; its limitations and also it discuss about future recommendations for further improvement.

Keywords: Persons with Disabilities (PwDs), Assistive Technology, Information and Communication Technologies (ICT).

INTRODUCTION

About 15% of the world's population lives with some form of disability, of whom 2-4% of the population experience significant difficulties in functioning (WHO, 2013). In India, disabled population has increased by 22.4% between 2001 and 2011. The number of disabled, which was 2.19 crore in 2001, rose to 2.68 crore in 2011; out of it 1.5 crore males and 1.18 crore females (The Times of India, Dec 29, 2013). In many low-income and middle-income countries, only 5%-15% of people who require assistive devices and technologies have access to them. Production is low and often of limited quality. In India also, a limited access of Assistive Technologies (AT) for persons with disabilities and costs of AT's also not affordable.

Assistive technology "refers to a broad range of devices, services, strategies and practices that are conceived and applied to ameliorate the problems faced by individuals who have disabilities" (Cook & Hussey, 2002). Assistive technology can make life easier for persons of all ages who may need help carrying out their daily activities through home modification and adaptation.

Different types of assistive technologies assist the people with disabilities by providing them with learning opportunities. Now a day's assistive device or assistive technology helps a person with hearing loss or a voice, speech, or language disorder to communicate. These terms often refer

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to devices that help a person to hear and understand what is being said more clearly or to express thoughts more easily. With the development of digital and wireless technologies, more and more devices are becoming available to help people with hearing, voice, speech and language disorders communicate more meaningfully and participate more fully in their daily lives.

The aim of the paper is to review the importance of assistive technologies in mainstreaming the persons with disabilities, to find out the limitations of Assistive technologies used by persons with disabilities and to suggest recommendations for future development.

Persons with disabilities have different kinds of limitations, due to that they may not be able to use Information and Communication Technology (ICT) applications and devices with ease, as it may be used by others. If we see the difficulties which are generally faced by different types of a disabled persons say *for example*, a physically impaired user may have difficulties in using input devices, A visual impaired user may have difficulties in seeing display devices, a Hearing impaired user may have difficulties in hearing audio information, A person with learning or cognitive disability may have problem in understanding system operations. To solve the above mentioned problems, assistive technologies are used.

In this paper the researchers would like to discuss about assistive technologies used for persons with Physical impairment, Hearing Impairment, Visual Impairment and Cognitive Impairment. As we know that a person suffering from not less than 40% of any disability as certified by a medical authority is called as a Disabled person. As mentioned in **Table-1** there are different types of disabilities. The primary users of assistive technology are congenital disabled persons (CP, VI, HI, MR), Acquired disabled persons (Trauma, Amputation, Spinal cord or Brain damage) Persons suffering with Progressive neurological conditions (Multiple sclerosis, Muscular dystrophy) and people suffering with some temporary conditions like burns, surgery and Accidents.

The varied assistive technologies for people with disabilities are used, which range from simple devices to complex systems integrating multiple technologies. There are different categories of assistive technologies which includes seating & positioning, Mobility and powered mobility, prosthesis, Rehabilitation Robotics, Alternative and Augmentative Communication (AAC), Adapted computer Access, Environmental control, Electronic pointing devices, Devices to assist listening and seeing, Visual Aids, Aids to daily living and Integration of technology in to Home, School, Community and place of employment. Let us discuss the different types of assistive technologies, how it will be useful for persons with disabilities.

1. SEATING & POSITIONING

Any support that helps a person with a physical disability remains in a good wedges and straps. A child has physical challenges ranging from slight to severe; this automatic task can have a significant impact of their daily functioning. Seating at work station/school requires adopted wheel chairs address the features like elevating seat devices, tilt, recline and evaluating leg rests.

Desk organizers or clips on holders for pencils Easy-in-and-out storage folders can be strapped to the desk or chair to keep home work and notes located in one area; laptop, computer can be positioned on wheel chair or table by securing it with Velcro or by using mounting systems, which help to keep the device permanently positioned or adjustable to the needs of special child in school setting. Wisconsin Assistive Technology Initiative (WATI) decision making guide helps to identify students' abilities & difficulties, environmental conditions and tasks they have to do (Karen j, *etal*, 2009).

There are some modifications to standard seat or desk like Non slip surfaces, seat cushions, Foot support, changing the angle of writing support, Chair with arms, Additional stabilizes like rolled towels, blocks can also be used as needed to assist in positioning.

2. MOBILITY AND POWERED MOBILITY

Technology can facilitate participation by indirectly (via treatment or therapy) or directly (via physical assistance) enhancing and individual's mobility such that mobility capacity meets or exceeds the demand of the environment. Indirect or therapeutic technologies enhance mobility by reducing impairments at the body structure /function level by helping the body in repairing or redressing the body structure impairment, or by supporting rehabilitation of the impaired body function. Baclofen pumps are an example of an indirect approach because they facilitate mobility by allowing a person to control his or her spasticity. Equipment that allows a person with a physical or visual disability to move independently and safely through the community. This includes wheelchairs, walkers and adapted bicycles. Power wheelchairs are traditionally operated by a joystick and one or more switches which change the function that is being controlled by joystick. These functions include wheel chair movement, seat tilt, backrest recline, footrest elevation and seat elevation. Many authors have begun to address the unique needs of using powered mobility with students and very young children. The consensus is that powered mobility should be considered as an option even for, if not especially for, young children (Deitz, Swinth & White, 2002); (Durkin, 2002); (Escobar, Leslie, & Wright-Ott, 2002); (Bundonis, 2003); (Hardy, 2004); and (Meyer, 2008).

3. PROSTHESIS

The replacement of a missing bodily part with an artificial substitute an artificial part such as a limb, eye, or tooth. Prosthetic development challenges include replacing both the efferent nervous system (*i.e.*, Movement) and the afferent nervous system (*i.e.*, sensory feedback). Adequate prosthetic limb control will be achieved when both efferent and afferent system are adequately replaced.

4. REHABILITATION ROBOTICS

Rehabilitation Robotics has been defined a special branch of robotics which focuses on machines that can be used to help people recover from severe physical trauma or assist them in activities of daily living. Robotic therapy devices are another example of indirect approach because they allow people to reduce impairment through repetitive movement training.

An example for robotics exoskeletons is Knee-ankle-foot orthosis that can assist people with leg weakness in achieving normal joint kinematics during walking. Attention is now increasing towards assistive technology applications of robotic exoskeletons in which the exoskeleton is designed to promote functional activities in the home & community.

5. AUGMENTATIVE/ALTERNATIVE COMMUNICATION (AAC)

It includes all forms of communication (other than speech) that are used to express thoughts, needs, wants and ideas. AAC supports a child who cannot speak, or whose speech is not understood by others, to communicate. This includes picture boards, voice output communication devices, communication software and computers. According to Hersch (1994) and others, "For individuals with deficits in self initiation, a device which can call itself to the person's attention will be better able to facilitate activity performance". However, while a standard alarm wristwatch or timer will provide an audible cue, it will not provide information about the task to be performed. An alarm wristwatch can be combined with a written list so that whenever the watch alarm sounds the person refers to the list for information. However, this latter intervention requires that the client

both associate the watch alarm with the need to refer to the list and remember to use (and carry) both the watch and the list.

Daily planner software can help organize daily and monthly activities. Computer tutorials give training that can be repeated many times. People with cognitive disabilities need software that is multi-sensor, that can be personalized, that reinforces and that can motivate. It needs to provide a predictable routine.

People who have problems remembering a sequence of tasks can also use audio tapes. A task can be broken down into its component steps and an audio recording can be created outlining these steps. This recording can be used to guide the person through work and can be repeated until the task is done. There are also large button switches that can be used to guide individual tasks or to prompt a person about when to complete each step of the job. Some Assistive Technology (AT) interventions seek to provide support with planning and problem solving as well as memory. The Planning and Execution Assistant and Training System (PEAT, Attention Control Systems Inc, Mountain View CA) uses artificial intelligence to automatically generate daily plans and re-plans in response to unexpected events.

A pager can be used to remind a person to be attentive to the task at hand and when to move on to the next task. Computer-based pagers can be used to assist individuals by relaying reminders from a computer to a commercial paging carrier that, in turn, relays the message to the person in school, at work, or in the community. These devices can reduce the need for a job coach by giving the person reminders as well as providing direction and guidance. *For example*, a device could be set to send a message saying "time to clean up" and 10 minutes later saying "go to the bus." This works well for someone who cannot remember all the steps in their tasks at work.

The IQ Voice Organizer and Data Link Watch are two examples of memory aids designed for and marketed to the mainstream population, rather than specifically for people with cognitive disabilities. Scheduling and reminder software is also available for standard palmtop computers, such as those running the palm (Palm Inc, Mipitas, CA) and windows CE (Microsoft, Redmond, WA) operating systems. These devices may be more readily available than devices designed for people with disabilities. Other devices, such as ISAAC (Cogent System, Inc.), Cell Minder (Institute for Cognitive Prosthetics, Bala Cynwyd, PA) and the Planning and Execution Assistant and Training System (PEAT, Attention Control Systems Inc, Mountain View, CA) have been designed specifically for individuals with cognitive disabilities. They provide more support for people who would have difficulty independently entering their schedules into more complex devices and are designed with physical and sensory limitations in mind.

6. COMPUTER-BASED INSTRUCTION

Software to help students with learning difficulties in reading, writing, math and other subject areas. The computer allows variation of the appearance of text. Once text is committed to paper and ink, its appearance is permanent. Computers offer options such as changing text size and contrast (Keates, 2000). Computers also allow a user to change the color of the text and / or the background, similar to the practice of lacing colored screens over text to increase readability (Wilkins & Lewis, 1999). In addition to changing the appearance of printed text, computers can augment visible text using speech, so that a person with good verbal skills and aural information processing can acquire the information without the need to process printed text (Higgins & Raskind, 1997; Raskind & Higgins, 1995).

Speech synthesis software can provide speech output to match text on the computer screen in a word processor or on the computer desktop. Text from books or worksheets can be scanned into the computer and read using optical character recognition software and many books are now available directly in electronic formats. In addition to using speech output as an alternative to text, it is possible to use auditory feedback while viewing the printed text. This software can therefore act as a reading assistant; the person reads most of the text, but has the computer speak unrecognizable words. MacArthur 1998 studied the use of speech synthesis and word prediction for students with learning disabilities. He noticed that four of five students, percentage of legible words increased from 55% to 85% during the baseline phase to 90-100% during the treatment phase and the percentage of correctly spelled words increased from 42% to 75% to 90 to 100%. Computers also offer alternatives for text production. Some people have difficulty with handwriting due to motor coordination difficulties, or have more difficulty comprehending handwritten text compared to printed text. A keyboard can provide assistance for these individuals, since typing may be easier than handwriting. Typing is also helpful because all letters are visible on the keyboard, compensating for letter recollection difficulties. The position of the characters on the keyboard can also be used to aid recognition; if the person can remember the position of the letter he or she wants on the keyboard, he or she does not need to recall the letter's shape (Gregor & Newell, 2000).

For individuals who have difficulty typing as well as writing, speech recognition is an option for the entry in the computer. People who have good verbal skills can compose material directly through speech and the computer will take on the task of translating the words into printed text to expand upon available technologies, (Gregor and Newell, 2000) developed a highly configurable word processing environment, see word, to assist people with dyslexia in reading and composing text. See Word was developed within the context of the University of Dundee's overall research program on human-computer interaction for extraordinary users and users in extraordinary situations (Gregor, Alm, ASrnett, & Newell, 199). This software provides a variety of options related to the visual appearance of the text and of the software interface and the means for each user to customize these settings to his or her particular preferences. In addition to difficulties with visual processing and motor coordination, individuals with learning disabilities often have difficulty in organizing their thoughts for written compositions (Newcomer & Barenbaum, 1991). Computer software can aid in this organizational process by helping the user create concept maps. Concept mapping is the process of categorizing information into a graphic form, known as a "concept map" or "semantic network". This visual representation of information can then be used to organize concepts and provide a basis for the structure of written text. Concept mapping has been shown to support more organized and detailed written texts (Ruddell & Boyle, 1989; Zipprich, 1995). Software such as Inspiration (Inspiration Software Inc, Portland, OR) provides a means to easily create and edit concept maps.

7. ACCESS AND ENVIRONMENTAL CONTROLS:

Devices that allow increased control of the environment or that open up access to things in the environment. This includes electronic controls like switches, special keyboards or mice and remote controls etc. a standard keyboard and mouse configuration is not suitable for everyone and there are plenty of alternatives available to suit users varying needs and abilities, there are various computer applications available for persons with Disabilities like Keyboards with lowercase keys. Keyboards with large keys, Keyboards with fewer and larger keys than a standard keyboard, Keyboards with fewer but multifunctional keys, which are used with companion software, Large

print keyboards with high contrast colors, Large print adhesive keyboard stickers in high contrast colors, Foot mouse, wherein the mouse is operated by the users' feet rather than their hands. And alternative input devices replicate the functionality of a keyboard and mouse. The most widely known examples of accessible mainstream products cited by proponents of universal or accessible design and other gadgets that were designed to be attractive and generally useful and to be easily used by people with limited hand strength or dexterity (Muller, 2000). A wide range of devices are available to help people get around the community, like ramps, automatic door openers and Braille signs etc.

8. ELECTRONIC POINTING DEVICES

Electronic pointing devices provide a way for people to control the cursor on-screen without having to use their hands. There are a wide range of devices that use different techniques and technologies for users to control their computers, such as: Ultrasound, Infrared beams, Eye movement tracking, Nerve signals and Brain waves.

(a) Switch access

Switch access refers to the range of switches that respond to specific actions used to activate them, such as sip-and-puff, pushing, pulling, pressing, blinking or squeezing, as well as the software that is used to facilitate these activations and, in some instances, enhance them. Switches can be used to access a range of computing functionality without the need for a keyboard or mouse. Many people will use one or more switches, depending on their abilities.

(b) Rods and sticks

There are different types of rods and sticks, some are worn on the head, held in the mouth or strapped to the chin. They are all designed to enable people to press keys on a keyboard.

(c) Joysticks

Joysticks are used to replicate the functionality of a mouse and people primarily use their hands, feet or chins to control the cursor on-screen.

(d) Trackball

Trackballs are used to replicate the functionality of a mouse. They have a movable ball contained in a flat base and are manipulated by hand to move the cursor on-screen.

(e) Touch screens

Touch screens allow people to select or activate the functions of their computer through touch, rather than by using a mouse or keyboard. The advent of the iPad and other tablet devices in mainstream technology can be used instead of AT specific touch screens. However, AT specific touch screens differ in that they are either built into or added onto the computer monitor and are not used as standalone devices.

(f) On-screen keyboards

On-screen keyboards display an image of a keyboard on-screen, allowing people to access it using a standard mouse or a variety of electronic pointing devices.

9. DEVICES TO ASSIST LISTENING AND SEEING

Supports that help a person who is either deaf or has a hearing loss. This includes hearing aids, amplifiers, captions on TV and typing telephones. Tele Typewriter (TTYs) are small telephone devices with keyboards and visual display and are designed for people with hearing and speech disabilities; however, they have also been used by other people with memory problems to keep track of conversations. Tele Typewriter (TTYs) have delayed reaction time and can provide a printed display of the telephone conversation. The printer model allows the user to print and keep a copy of the conversation to review later if necessary.

10. VISUAL AIDS

Supports that give a student with visual difficulties access to information. This includes large-Print Books, Books on tape, Magnifiers, Talking Computer software and Brailers.

11. AIDS TO DAILY LIVING

Special tools for daily activities, like brushing teeth, dressing or eating. This includes adapted utensils, plates and cups, non-skid surfaces and specially designed toilet seats and shower stalls. Early work on memory aids investigated the application of commonplace technologies, such as clocks and calendars (Harris, 1978) or timers and digital watches (Jones & Adams, 1979, Klein & Fowler, 1981, Wilson, 1984). Many products developed to give easy access to Persons with Disabilities. Among them electronic gadgets including remainder products like coffee maker, Iron box, LPG stove, electronic faucets (turn the water on when they sense a person hands in the sink and turn the water off when the hands are removed). And splashing sounds can be absorbed by placing sense of any item which falls on the floor.

Phones with speed dial can reduce the need to remember numbers. Some phones, such as the Clarity P-400, have large speed dial buttons that have spaces for symbols or photos that represent telephone numbers. This feature is useful for people who cannot read well or who have memory problems.

Personal Data Assistants (PDAs) and other similar hand-held devices have a touch screen that helps a person to input, save and retrieve notes. They can also be used to store phone numbers, dates and daily reminders. PDAs also have a calendar that displays the entire month. One can use the cursor to move from day-to-day or month to month. PDAs offer a portable solution for keeping appointments, reminders and contact information for family and friends close at hand.

Location devices are available to help people to find item, they have lost. *For example*, key chains which to signal where they are, we can attach key chains to something that get lost all the time., such as T.V. remote, pair of glasses etc. Item is lost just whistle or clap then alarm will beep.

Global position systems are available that can track an individual were about. There are comforting aids, Environment fire and smoke alarms, phones and pager, etc., will help especially persons with cognitive impairments.

12. ASSISTIVE TECHNOLOGIES FOR MULTIPLE DISABILITIES

(Persons with Physical impairment, Hearing impairment and visual impairment)

Window-Eyes: Is one of the most established and powerful screen reader tools available today. This tool gives total control over what you hear and how you hear it. It also provides enhanced Braille support. Window-eyes provides key application converts components of the windows operating

system into synthesized speech, allowing for complete and total access to windows based computer systems to the visually impaired. Window-Eyes integrated into windows provide seamless instant access to the operating system without having to learn a complicated set of keystrokes.

JAWS: Are a powerful accessibility solution for visually impaired, that reads information on computer screen using synthesized speech. It provides many useful commands that make it easier to use programs, edit documents and read Web pages. With a refreshable Braille display, JAWS can also provide Braille output in addition to, or instead of, speech. JAWS can be customized as per individual needs and preferences.

Tobii Eye Tracking System: Is a specialized eye tracking and eye control technology. This technology makes it possible for computer to know exactly where users are looking. Tobii's eye tracking technology work on principles of advanced image processing of a person's face, by using eyes and reflections in the eyes of near-infrared reference lights to accurately estimates the 3D position in space of each eye. It finds the precise target to which each eye gaze is directed towards. It is a fully automatic eye tracking technology with high tracking accuracy and tolerance of head-motion.

I Communicator: Is an assistive tool for the people with hearing impairments. It assists in dependent communication for persons who are deaf or hard-of-hearing. It translates contents in real-time, like speech to Text, Speech/Text to Video Sign-Language and Speech/Text to Computer to computer generate voice. Content one translated can be used by the user for obtaining definition, synonyms and antonyms, with the help of inbuilt dictionary in the system.

Head-Mouse extreme: Is an innovation solution for wireless head-pointing on personal computer, Macintosh system and Alternative and Augmentative Communication (AAC) devices. The Head-Mouse extreme replaces the standard computer mouse for people who cannot use or have limited use of their hands when controlling a computer or augmentative communication device. The Head-Mouse translates natural movements of a user's head into directly proportional movements of the computer mouse pointer. The Head-Mouse has a wireless optical sensor which tracks a tiny disposable target that is conveniently placed on the user's forehead, glasses, hat etc. It works just like a computer mouse, with the mouse pointer being moved by the motion of the users head. It is very useful for disabled suffering with arthritis, spinal cord injury as well.

Math Daisy: Is an application developed for making math accessible to the student with disabilities. It enables us to save documents in the DAISY Digital Talking Book format with accessible math. The students can use Math Player-enabled DAISY player software to read classroom materials in the manner that suits to the disabled learners.

Text Help System: Provides literacy software solutions. This software is developed to help struggling readers and writers, those with literacy difficulties, learning disabilities such as dyslexia, mild visual impairments and also those for whom English is a second language. It helps to improve users reading, writing and research skills at school, in the workplace and at home.

LIMITATIONS IN USING ICT FOR DISABLED

- Lack of specialized disabled friendly teacher training.
- Limited flexibility in training options for people with disability.
- Limited availability of specialized disabled friendly hardware and software resources, due to business constrains.
- Lack of formal involvement of the government organizations and support structure for AT/ICT for disabled.
- Attitude barriers towards people with disability.

- Lack of appropriate disabled friendly policies and their implementation.
- Limitation of finances in developing ATs.

RECOMMENDATION FOR IMPROVEMENT

Below are some recommendations which we strongly believe that, if taken care of, while suggesting, planning, using, developing tools, applications and infrastructure for people with disability, will have impact in imparting assistive teaching and learning;

- Age type of disability, functional limitations of the individual need to be consider while developing ATs'
- Improvement of networking facilities to allow more effective co-operation between institutions and telecentres to assist all types of disabled people using online network.
- Adoption of standard software to the needs of learners with intellectual impairment.
- Creation of virtual environment for supporting different types of disabled learners.
- Customization of workspace setup to fit a wheel chair.
- Development of user-friendly multiple types of user interfaces for the same devise/application for facilitating different types of disables, to increase the ability to use the services.
- Making of people with disabilities as part of the decision making and planning effort alongside disability experts in projects related to disabled users.
- Making tools used by disabled, to create, check and validate educational content, in such a way so that it should be accessible for teachers and system administrators with disabilities.
- Providing consistency in the layout of keypads at least for blind learners.
- Enabling hearing impaired person with access to audio output with proper volume control.
- Advocating and supporting of more open source applications development for people with disabilities.

CONCLUSION

Assistive devices cover a wide range of "devices or systems that individuals to perform tasks they would otherwise be unable to do or increase the ease and safety with which tasks can be performed and range from low-tech devices, such as pictorial communication boards or adapted eating utensils, to high-tech devices, such as adapted software and voice output devices with speech synthesis. In summary, by enabling a person to perform desired tasks, it is possible that assistive technologies may provide a sense of competence and reconnection to the community. By accommodating a person's weaknesses and supporting his or her strengths, assistive technologies can reduce psychosocial stressors, thus leading to renewed confidence, self-efficacy and self-esteem.

Table-1

Sr. No	Type of Impairment	Definition & Description
1	Physical impairment / Loco motor disability	Loco motor disability means disability of the bones, joints or muscles leading to substantial restriction of the movement of limbs or any form of cerebral palsy; (PwD Act, 1995) "Dysfunction of the musculoskeletal and/or neurological body systems, which affects the functional ability of a person to move or coordinate movement". In Physical impairment there are different types; they are Loss of Limbs, Cerebral Palsy, Spinal cord injury, Arthritis and stroke.

Sr. No	Type of Impairment	Definition & Description
2	Hearing Impairment	Hearing Impairment means "Loss of sixty decibels or more in the better ear in the conversational range of frequencies". It includes mild and moderate hearing (PwD Act,1995)
3	Visual Impairment	Blindness taken together with low vision represents all visual impairment. "Blindness" refers to a condition, where a person suffers with total absence of sight or visual acuity not exceeding 6/60 or 20/200 (Snellen) in the better eye with correcting lenses ;or limitation of the field of vision subtending an angle of 20 degree or worse. (PwD Act,1995)
4	Cognitive Impairment	Cognitive deficit or cognitive impairment is an inclusive term to describe any characteristic that acts as a barrier to the cognition process the term may describe deficits in global intellectual performance, such as mental retardation, learning disabilities; language disabilities and seizure disabilities. It may describe specific deficits in cognitive abilities.

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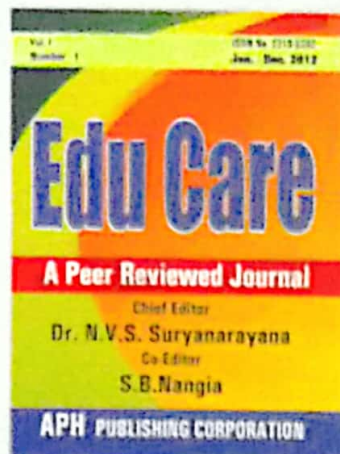
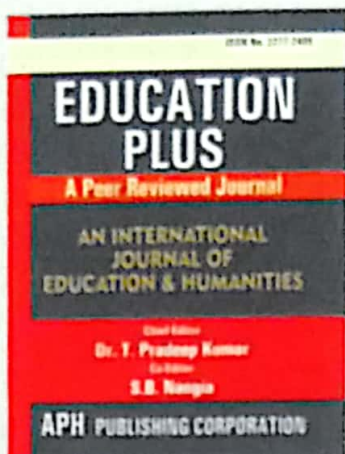
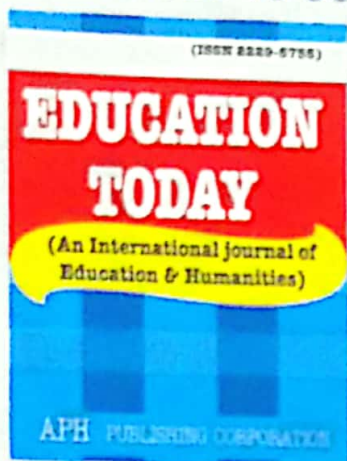
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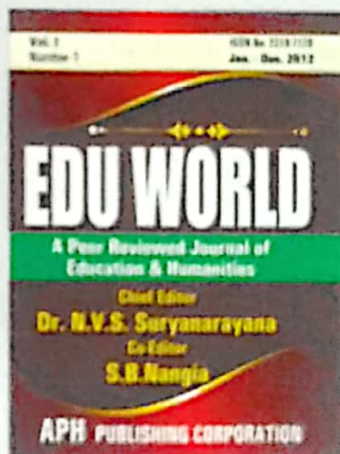
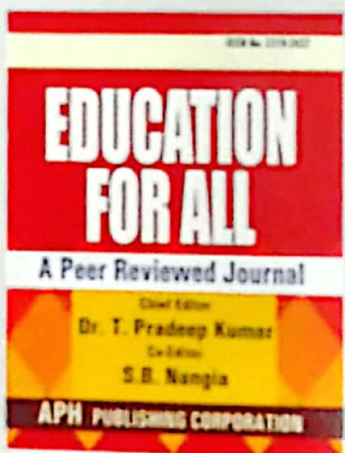
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