1. Introduction

A disability is any on-going disorder that restricts routine activities and it may be genetic, or occur during a person’s lifespan. According to the Disability Services Act (1993) disability results in reducing the capability of the person to communicate, interact, learn or move and require continuous support [DSA, 1993].

There are many different types of disability and International Classification of Functioning Disability and Health (ICF) published by World Health Organization (WHO) has categorized disability into three dimensions (a) body level, (b) person level and (c) societal level. The (a) denotes deficiencies in body functions and structures like loss of vision or hearing, and incapability to do leg movement etc. (b) denotes limitations in doing any activity or task like eating, learning, writing, walking, brushing teeth, opening a bottle etc. and (c) denotes restriction in participation in society like playing sports, going to school etc. [WHO, 2001]. According to the Disability Services Commission (DSC), disability can be categorized into five types like (a) Physical, (b) Sensory, (c) Psychiatric, (d) Neurological and (e) Cognitive. The (a) disability involves complications related to person’s bodily functions and may be suffering from cerebral palsy, arthritis, spinal cord injury etc. The (b) disability includes injuries in hearing and vision. The (c) disability involves mood swings, depression, anxiety disorders etc. The (d) disability includes genetic disorders, brain injury, or any nerve injury. And (e) disabilities include problems related with communicating, learning, problem solving etc. [DSC, 2001].

In the next section, we start our discussion with respect to the cognitive disabilities and difficulties associated to it.

1.1 Cognitive Disabilities and Learning Challenges

The word Cognition means to ‘understand the information’. It involves mental process to know the information and to handle that information [Von & Barbara, 1996]. A person with a cognitive disability will face numerous problems in doing mental task as compared to an average person. They have impairments in (a) intellectual functioning and (b) adaptive behaviour. The (a) refers to a person's ability to propose an idea, understand it, and accomplish it. And (b) refers to a person’s capacity to smear
social and real-world skills in everyday life. For e.g. eating, dressing, using money etc.[Valletutti & Dunmmett, 1992]

There are many types of Cognitive Disabilities, but we can broadly categorise in to two types, based on their diagnosis i.e. (a) Clinical Diagnosis and (b) Functional Diagnosis [Petterson et al, 2007]. The (a) include various severe conditions like Autism, Down syndrome, and Traumatic Brain Injury (TBI) etc. It may also include less severe cognitive conditions such as Learning Disabilities (LD), Attention Deficit Disorder (ADD) etc. And (b) focuses on abilities and challenges rather than treatment point of view. The most common challenges which they face are categorized as follows [Gallagher, 1998]:

a) Memory Deficits

Memory refers to the ability of a person to recollect what they have learned over time. A person with cognitive disabilities will have problems with their short term and long term memory. It may be difficult for them to retrieve the content from the memory, process it and store it or even remember the problem or error before they can address it.

b) Problem Solving Deficits

A person with cognitive disabilities lack the ability to solve any problem, they easily give up whenever some problem occurs and face difficult time whenever such problem arises.

c) Attention deficits

People with cognitive disabilities get easily distracted as they have short attention span and have tough time in learning any new things as they are very inattentive.

d) Learning Deficits

Some people with cognitive disabilities may have difficulties learning new things as they are not able to read and understand the text.

Cognitive Disabilities is the most common type of development disorder which has effect on various skill set of child which includes social, emotional, communication and academic skill sets. According to Centre of Disease Control (CDC), the cognitive disabilities are classified based on various levels of severity, based on the score of IQ test which measures individual’s intellectual capability to succeed in the school which are as follows [CDC, 2013]:

a) Mild Cognitive Disabilities – IQ score between 50-70
b) Moderate Cognitive Disabilities – IQ score between 35-55
c) Severe Cognitive Disabilities – IQ score between 20-40
d) Profound Cognitive Disabilities—IQ score Below 20

Thus, we see that child with cognitive disabilities have an IQ score below 70 and in order to participate in any academic activity, the child should have strong learning skills. Weakness in cognitive skills is the root cause of academic failures and they may have to face various learning challenges like:

a) Poor reading and spelling,

b) Difficulty in retaining information and learning simple routines.

c) Face problem in understanding the sarcasm, slang, metaphor etc.

d) Difficult to understand mathematical expression or equation.

e) Take long time to do simple calculations, homework assignments.

f) Have trouble in processing visual information.

1.2 Impact of Cognitive Disabilities in the field of Education

Students with severe cognitive disabilities category include students with moderate to profound levels of cognitive disabilities. These students will not be able to cognitively catch up with their class mates in terms of intellect and educational performance. They comprehend very few things and learn at a very low pace as compared to average intellectual student. And with the growing age, the gap between cognitive and educational performance widens. They require various levels of individualized help and special education depending upon the severity of cognitive disabilities [Levine, 1994]. Whereas in case of less severe category like Learning Disabilities (LD), student can manage to reach their educational potential if they get right kind of instruction, high level of guidance and technological support.

Basically students with LD lack ability to speak, listen, think, read, write, and spell or to do mathematical calculations [Bender, 2002]. And our educational system mainly stresses upon cognitive development. Due to this gap, they have to face difficult time catching up with their own deficiency and meeting the requirements of the educational system. LD learner often feel that "I can't do anything correct.", "I'm worthless.", "I have no brains.", "Everyone hates me." Due to such feelings LD learner have lots of trouble to cope with their educational life.[Daneil, 2008].These feelings cause the individual to feel frustrated, discouraged, alone or angry and have a poor self-image. Due to such feelings LD learner have lots of trouble to cope with their educational life.
LD may also manifest itself in delayed conceptual development, difficulties in expressing ideas and feelings in words, a limited ability to abstract and specify what they study, restricted attention-span, may have exertion in writing notes, pain in remembering spelling, problem in understanding jokes or idioms [Jeff, 2011]. Due to above problems, these learners are often unnoticed by their educators and peers which reduces their confidence and leads to disaster in their academic life [Jonassen, 1993].

This thesis investigates these challenges, and attempts to design and build an assistive learning framework for people with LD.

1.3 Problem Definition

The research in the field of providing assistance in learning for LD is still in infancy. In India, around 13 to 14 per cent of all school going students are suffering various types of learning disabilities and most schools do not have sufficient facilities to accommodate their learning problems. Due to which they are labelled as failures. A report by [Sadket, 2012] highlights that the awareness related to LD has started in India but it is still in the growing phase. In spite of this growing awareness, we still do not have a clear idea about such assistance to LD in e-learning environment. Policy related to this assistance for LD is still in the initial phase and cannot cater the exact needs of the LD learner. Due to lack in this development part, LD learner phase lots of problems in their regular schools [Nalanda, 2011].

Considering the barriers of LD learner and current scenario of e-learning, we decided to explore this domain of Assistive Learning for LD, trying to address the appropriate technology interventions for their problems. Our aim is to provide assistance to the LD learner by providing individually customized instruction and strategies that enable them to solve their reading problems.

1.4 Major Challenges

In realizing an Assistive Learning Environment for LD, the major issues and challenges are as follows.

a) LD learners often lack the opportunity to get trained via e-learning technology, which provide innovative ways to learn and provide comprehensive interactive access to the content which cater to their requirements and they can learn when and where they want, at their own pace. The aim is to focus on following three
dimensions of the e-learning framework: (a) Content (b) Presentation Formats and (c) Pedagogical Strategies through which teaching and learning process can be effectively achieved.

b) Content plays a very important role for LD students. Focus is to build appropriate content which can help in building appropriate presentational interventions for LD. The content has to be enriched with text, graphics, audio and video according to the requirement of the LD learners. Currently the content is designed in various formats but are not meant specifically for LD.

c) Every LD learner has its own unique learning style. So in order to improve the learning curve, the content must be presented in the format that matches the learning styles of the LD learner.

d) LD students have wide range of learning needs. They have their own unique set of strengths, weaknesses, interests, experiences and special abilities. Therefore pedagogy that is appropriate for a particular learner in a certain situation may be of little value in another situation. Thus by building pedagogical strategies appropriate for them we can customize their individual learning experience.

e) Constructing pre-packaged content for different LD requirements is not feasible, given the wide variety of LD patterns and requirements. A rich and general framework which can transform content from a standard repository to each LD student would be valuable, but challenging to design.

f) Also for any e-learning system, there are also typical challenges like delivery, which also apply to our task.

All these issues can be considered as research challenges in the realization of Assistive Learning Environment for LD, in the approach we have adopted.

1.5 Thesis Overview

The rest of the thesis is organized as follows. Chapter two explores in detail the characteristics of LD and also throws light on Information and Communication Technology (ICT) interventions for education that is relevant to our concern. It also covers various e-learning systems from the LD educational aspects point of view. In chapter three LD Student Modeling approach student is introduced, which aims at identifying their learning problems, learning styles, vocabulary and frequently updating information about students’ progress and performance. Furthermore, the LD student
model plays a crucial role of storing and updating the vital information about students which is needed in order to provide adaptivity. Chapter four outlines our approach to personalizing content for LD students, including the transformation mapping with respect to content, pedagogy and presentation. It also introduces our framework for assistive learning. Chapter five presents the design details. Chapter six presents implementation of our system. Chapter seven covers the empirical evaluation of the implemented system. Finally the thesis ends with conclusion and some direction for future work.