2. Literature Survey

From last two decades, there is significant growth in the domain of e-learning systems, so that the learners can access the learning resources anytime from anywhere. But majority of these e-learning systems do not cater to the requirements of cognitively disabled students. There is a significant number of students with learning disabilities who require assistance and support in their learning. We start with an overview of Learning Disability (LD), its various manifestations and origins, and then investigate the impact of Information and Communication Technology (ICT) on the learning outcomes for those LD students. The chapter ends with evaluation of various e-learning systems with a view to evolving a proposal for our work.

2.1 Learning Disability

The definition of LD has varied over time, across jurisdictions and among disciplines. In 2002, the Ministry of Education adopted the following definition of learning disabilities. "Learning Disabilities refer to a number of conditions that might disturb the acquisition, organization, retention, understanding or use of verbal or nonverbal information. These disorders disturb learning in individuals who otherwise establish at least normal abilities essential for rational. As such, learning disabilities are distinct from global intellectual disabilities" [MOE, 2002]. LD varies in severity and may obstruct the achievement and use of one or more of the following:

- oral language (e.g., listening, speaking, understanding)
- reading (e.g., decoding, phonetic knowledge, word recognition, comprehension)
- written language (e.g., spelling and written expression)
- mathematics (e.g., computation, problem solving)

LD may also involve problems with organizational assistances, social awareness, social collaboration and perception. LD is usually lifetime. It varies across individual’s lifetime, depending on the communication between the demands of the surroundings and the individual’s strengths and needs. Due to individual differences, no single description or profile can represent all individuals with LD, not even one individual over a course of time. Since LD occurs along a spectrum of severity, people can experience mild to significant impacts.

[Lerner, 2000] states that LD are caused by differences in how a person’s brain works and how it processes information. Children with LD are not “dumb” or “lazy”.
Their brains just process information differently. Students with LD usually have average to above average intelligence and potential, and while they may demonstrate unexpected underachievement compared to their abilities, they can experience academic success and lead happy, successful lives. Early identification and intervention, appropriate adaptations and support are keys to success. If a student’s performance is assessed in the absence of appropriate adaptations, the assessment may not accurately measure the student’s knowledge.

There is no “cure” for learning disabilities [Dudley-Marling, 2004]. Success for a student with LD does not mean the disorder disappears. They are life-long. However, children with LD can be high achievers and can be taught ways to get around the learning disability. With the right help, children with LD can and do learn successfully.

2.1.1 Types of Learning Disabilities

LD is a broad term. There are many different kinds of LD. According to [NICHY, 2004], LD falls into various categories based on the four phases of information processing used in learning: input, integration, storage, and output.

a) Input

In this stage, visual and auditory senses are used to perceive the information. For example, it causes problem in distinguishing the figure, place and size of items. Sometimes it is problematic to screen out competing noises in order to emphasise on one of them, such as the sound of the teacher's voice.

b) Integration

In this stage, input is interpreted, categorized or placed in a sequence. For example, students with difficulties in this stage may be incapable to tell a story in the correct order, incapable to memorize classifications such as the days of the week, tables etc.

c) Storage

In this stage, there is problem with short-term memory, or with long-term memory. Most memory problems occur in the region of short-term memory, which can make it hard to learn new things and may require more repetitions than is usual.

d) Output

In this stage, information originates from brain either through words or through muscle activity. Difficulties with words can create difficulties with verbal language, for
example, answering a query on request. Difficulties with muscle activities can cause problems with gross and fine motor skills.

Based on [Smith, 2007; Jane D. Steelman, 2008; Nemeth A, 2006; Mark Nova, 2012; Polly Dalton’s, 2006; Nigel Beacham, 2003], we categorized LD into three main types which is explained below. Students affected by LD may have more than one kind. Each of these categories includes a number of more specific disorders as shown in figure 1.1 and these are explained in sections below:

**a) Speech and Language Disorder**

Speech and language problems are often the earliest indicators of a learning disability. People with developmental speech and language disorders have difficulty producing speech sounds, using spoken language to communicate, or understanding what other people say. Depending on the problem, the specific diagnosis may be one of the following disorders:

- **Articulation disorder:** Students with this disorder may have trouble controlling their rate of speech. Or they may lag behind classmates in learning to make speech sounds. For example, A 6-year old who still says “wippon” instead of “ripon” and “thnake” for “snake.”

- **Expressive language disorder:** Students with this disorder have problems expressing themselves in speech. For example, a four year old who speaks only in two word phrases and a six year old who can’t answer simple questions.

![Figure 2.1 Types of LD](image-url)
iii. **Receptive language disorder:** Students with this disorder have trouble understanding certain aspects of speech. It's as if their brains are set to a different frequency and the reception is poor. For example, a four year-old who doesn't respond to his name, a 6-year-old who hands you a mat when you asked for a bat.

**b) Academic Skills Disorder**

Students with academic skills disorders struggle a lot in area of reading, writing and arithmetic skills. The diagnoses in this category include:

i. **Dyslexia- Reading Disorder** [Louisa Moats, 2012, Classroom Suite 4, 2011; Derrel, 1997]: Students with this disorder have following problems:
   - Difficulties in encoding and decoding words
   - Too slow in word recognition and text reading.
   - Mispronunciation of long, unfamiliar, or complicated words
   - Tend to forget which line was read and repeat the same line again.
   - Make many mistakes when reading aloud, and repeat and pause often.
   - Tend to reverse letters, words and experience difficulty with position in space.
   - Difficulty in learning the names of letters and their associated sounds
   - Strong hearing capabilities.
   - Good memorizing power.
   - Learn by experience, not from being told.
   - Respond well to learning with the "big picture" or overview of everything. 

Apart from their problems, these students have various types of strengths as listed below: *(Note: LD children are no different from other children in terms of their strength.)*

Various assistive solutions are available for the said problems, which are listed below:

- Screen readers.
- Smart word prediction techniques.
- Usage of mnemonic
- Use of graphical representation then text
- Make use of multimedia course content to make them understand

ii. **Dysgraphia-Writing Disorder** [Helen,2004; Judith, 2006]: Students with this disorder may have following problems:
• Slow in writing.
• May have very messy handwriting.
• Unable to write letters or words consistently.
• Inability to stay on the line.
• Spelling mistakes.
• Writing is random mixture of upper and lowercase letters.
• Plenty of deletion – either scratch it or erase it

Apart from their problems, these students have various types of strengths as listed below:
• Do not have primary developmental motor disorder
• Good memorizing power.
• Like to solve puzzle.
• Remember landmarks rather than directions.
• Eager to embrace new ideas

Various assistive solutions are available for the said problems, which are listed below:
• Voice to Text Software.
• Customizable line generator.
• Audible spell checker.
• Use of Onscreen Keyboard, portable keyboard, PDA

iii. **Dyscalculia – Arithmetic Disorder**[Jeri Fischer, 2007; ACLD, 1986]:
Students with this disorder have following problems:
• May confuse math symbols and misread numbers.
• Difficulty understanding simple number concepts.
• Misplacing and misreading decimal point.
• Difficulty in doing money transactions.

Various assistive solutions are available for the said problems, which are listed below:
• Use of onscreen math calculator.
• Use multisensory methods to help learners count accurately.

c) **Other Learning Disorders**

Students with this disorder include certain coordination disorders and learning handicaps. The diagnoses in this category include:
i. **Nonverbal learning disability:** Students with this disorder often show motor clumsiness, weak visual spatial skills, problematic social relations, difficulty with math, and weak organizational skills. For example, a 4-year-old who have problem in writing, running, jumping etc. because the brain is unable to communicate with the necessary limbs to complete the desired task properly.

ii. **Attention disorder:** A behavioral condition called Attention Deficit Hyperactivity Disorder (ADHD) is often associated with LD because students with ADHD have a hard time focusing enough to learn and are often easily distracted. For example, a 3-year-old who has ADHD acts impulsively, running into traffic, toppling desks, blurt out answers, interrupt and can't sit still.

### 2.1.2 Causes of LD

No one’s exactly sure what causes the various types of LD. Most LD do not stem from a single, specific area of the brain, but from the various brain regions. Some of the known causes are the following [Dudley Marling, 2004]:

**a) Errors in Foetal Brain Development**

Throughout pregnancy, the brain development is vulnerable to disorders. If the disruption occurs early, the foetus may die, or the baby may be born with debilities. If the disorder occurs later, when the cells are becoming focused and moving into place, it may cause learning disorders.

**b) Genetic Factors**

The fact that LD tend to run in relatives specifies that there may be a hereditary connection. For example, a child who lack some of the skills needed for reading, such as hearing the separate sounds of words, are likely to have a parent with a related problem.

**c) Tobacco, Alcohol, and Other Drug Use**

The Mother who smokes during pregnancy may be more probable to bear reduced babies (less than 5 pounds) and tend to be at risk for a variety of problems, including learning disorders. Alcohol also may be dangerous to the foetus' developing brain as it distorts the developing neurons. Any drugs taken by the mother pass directly to the foetus and may affect the normal development of brain receptors.
d) Problems during Pregnancy or Delivery

Some complications during pregnancy or during delivery can impair brain functions and lead to LD. It can be any infection imparted from mother to the child during pregnancy or temporary cut off the oxygen from the foetus during the delivery.

2.2 Usage of ICT to Improve Education for LD

The usage of ICT in teaching-learning process is providing various opportunities for students to learn to work in this digital era. E-learning is an example of the use of these ICT-supported teaching and learning process.

In this section, we discuss the benefits of ICT and various e-learning system used by various institutions of learning. This section also throws light on the e-learning systems available in the market and its evaluation.

2.2.1 Benefits of ICT in teaching and learning process

The use of ICT in the education field is becoming significant research area for many scholars around the world. [Hannafin, 1994] conducted a study to measure the usage of ICT and students’ performance in their exams. The results were remarkable; it showed a positive impression on student’s performance, especially in English language. The main reason for that was, that it was flexible in terms of time, where students can learn according to their mood and time owned, unlike the traditional learning which is bounded with the definite timetable. According to [Tondeur et al, 2007], it was found that students consider ICT tools very helpful in completing their homework and assignments. They can also seek external help to complete their assignments and projects. [Underwood, 2009] states that there is lot of improvement in their analytical skills which includes improvements in reading comprehension, fluency etc. as well as develop various writing skills like grammar, spelling, punctuation etc. As ICT has flexibility of ‘anytime anywhere’ access, it encourages students to take self-responsibility for learning. [Lei et al, 2007] states that students get chance to showcase their work to outside audience which provides motivation to them. According to [Cassell, 2004], ICT provides just in time information for learning i.e. they seek specific information and skill when and where they need it depending upon their requirement. Due to advancement in ICT, the learning cost has significantly reduced, it saves lots of travelling time and money, even the costs of the personal computer are quite reasonable and also the cost of videoconferencing connection is also lowered making it cost
effective [Fuchs & Woesman, 2004]. From teacher’s point of view, [Ilmaki, et al, 2004] stated that teachers do not need to learn about technology; they just need to learn how to use technology in formulating their lesson strategies, organizing classroom activities, doing assessment of the students on regular basis, keeping track of progress of individual student etc. According to [Duffy and Cunningham, 1996], higher quality of lessons can be prepared with collaboration between teachers and sharing their personal experience and learning resources. [Flecknoe, 2002] states that it is easier to update learning resources exactly according to the requirements of the learner, so that the learner may learn at their own pace. Also the teacher can control the learning habits of students, and keep track of their students and can tell students what topics to learn, how long it should take to complete the topic and how many times a particular topic should be repeated [Webb & Cox, 2004]. ICT tools also provide an environment where student can work in teams and complete their projects with team members all over the world, resulting in increased global awareness and a sense of cultural identity [Lakkala et al, 2005]. From parent’s point of view, they get high quality detailed reports of their child which increase their involvement in education and hence, they are more likely to get involved in the school community [Smeets, 2005].

2.2.2 E-Learning Systems

According to [Dichanz, 2001], e-Learning is defined as “the use of new multimedia technologies and the internet to improve the quality of education”. The broad concept of E-learning was introduced 30 years before, but its actual usage began only a few years ago. Generally this complements traditional learning. It is much faster, cheaper and better compared to traditional which is expensive and time consuming [ASTD, 2001].

E-learning systems are categorized based on the modes of learning which is explained as follows:

a) Content management systems (CMS)

CMS are data sources that contain content authoring and aggregation tools, with an aim to simplify the design and management of online content [Roberston, 2002]. It stores and allocates the right content to the right learner at the right time. The main purpose of CMS is to provide the ability for numerous users with different levels of
permission to access and manage the content [Boiko, 2004]. Managing content means to design, archive, edit, publish and collaborate report, website content, data and information. The most widely used CMS in the market are WordPress, Drupal, Joomla, ExpressEngine, TextPattern etc. [Glen Stansberry, 2009]

b) Learning Management System (LMS)

LMS is a software application that automates the administration, tracking, and reporting of training events [Zhang et al, 2004]. LMS provides a common platform for both teachers and students [Anido et al, 2001]. LMS give teachers the opportunity to deliver the entire course which includes the following features [Lewis & MacEntee, 2005]:

- Providing different tools to run and manage an e-learning course
- Provide course content in a variety of media – including text and multimedia.
- Developing all learning activities and materials in a course
- Options for discussion forums, file sharing, management of assignments, lesson plans, syllabus, chat, etc.
- Monitor and manage communication between learners.
- Record assessment and provide feedback to the students

LMS also provides following opportunity to the students community as well:

- Students can perform their self-evaluations.
- Access chat rooms, discussion forum and whiteboard.
- Sharing of project ideas with peer groups.
- Interacting with teachers using synchronous or asynchronous mode.
- Completing and submitting of various assignments at any point of time.
- Can check their grade and progress status reports.

Many LMSs are available on the market; the most widely used open source LMS are Moodle, Sakai, Chamilo, Atutor, LRN etc.

c) Learning Content Management System (LCMS)
A LCMS combines the administrative capabilities of a traditional LMS with the content creation and storing features of a CMS. It is a multi-user environment where learners can create, store, reuse, manage and deliver digital content from centralized data storage [Jurubesco, 2008]. LMS and LCMS are both concerned with content. But if content has to be created then LCMS is the best option [Jacobsen, 2002]. The primary role of LCMS is to accomplish the development of learning products and provide a learning content object repository that can be accessed by other authors. It also has course authoring capability and provides various collaboration tools to create and administer tests and quizzes [Robbins, 2002].

d) Massive Open Online Courses (MOOCS)

MOOC is an online education system which aims at a large-scale interactive participation of users and open access with the help of web [Masters & Ken, 2011]. MOOC was first introduced in 2008 and its more one of the most popular mode of learning in the field of distance education. MOOCs use Web-based tools and environments to provide education irrespective of number of target audiences, their topographical limitations and time zones [Laura, 2012]. There are many advantages of MOOC over existing e-learning system including [John, 2012]:

- MOOCs are free, where students do not have pay any fees for taking up the courses.
- MOOCs are semi synchronous in nature, similar to course that is delivered on campus according to their timetable.
- With MOOCs, lectures are also planned in a very different way. The faculty member delivers his lecture maximum for 15 minutes rather than 45 or 60 minute lecture as normally delivered in a traditional classroom.
- MOOCs get their students from all around the globe. So accessibility of the courses are on international scale.

There are many global MOOC providers like Standford Online, Udacity, Udemy, Academic Earth, Future Learn etc.

e) Personal Learning Environment (PLE)

PLE are learner centric systems that help learners to set their own learning objectives, accomplish it and communicate with others in the process of learning [Ebner & Tarahi,
The tasks supported by LCMS are designed to accommodate various learning situations and to support huge number of students and teachers. Whereas PLE organizes and adapts according to the individual learning preferences and process, it will seek information resources based on the known past study of the learner and present according to the learner’s learning style [Dabbagh, 2012]. It may incorporates many Web 2.0 technologies like Facebook, Twitter, blogs, RSS, wikis etc. around the independent learner. There are many advantages of using PLEs in education but the two most important are learners gaining the ability to use the above mentioned Web 2.0 technologies and the using of PLE to peak the student interest [Van, 2006].

2.2.3 E-Learning Systems & LD

E-learning can promote the inclusion of students with various disabilities [DiIorio, 2006]. It has great potential to help both existing students with disabilities in their studies and also facilitate a more equitable representation of this group of people in higher education. In order for this potential to be realized the eLearning platforms need to be as accessible as possible for students with a range of different impairments. Today, more than one fifth of disabled e-Learners require voice or speech recognition software to communicate with computers and 28% require other technology to assist with the physical manipulation of information [Cooper, M., 2006]. Also there are many online courses which are not designed with accessibility in mind [Roberts et.al, 2011]. This means that students who do not disclose that they have a disability maybe disadvantaged. It also means that when students do request accommodation to access the learning environment it requires a process of design-redesign to accommodate the students, adding additional costs. As [Seale, 2013] observed non-disabled students are viewed in the context of what they can do with technology, whereas students with a disability are viewed in terms of what they cannot do. This study focused on on-campus students, once students are online the nature and number of what can be considered invisible disabilities grows. [Crittenden, 2011] found that this unwillingness explicitly to disclose a disability and request accommodation also is a feature of students studying fully online. The reduced access to information technology experienced by people with disabilities, noted above by [Dobransky & Hargittai, 2006], creates an initial barrier to this type of learning. Those people with access to technology then encounter a number of problems that have been documented by [Fichten et al, 2009]. These include the
accessibility of websites and learning management systems, the accessibility of digital audio and video content and alternatives, inflexible time limits built into online exams, the accessibility of PowerPoint presentations, and also course material in inaccessible PDF formats and the lack of access to needed adaptive technologies. [Bolger, 2009] also highlighted problems with the inaccessibility of online chat rooms, and particularly the incompatibility of screen readers with these forums for students with vision impairments.

LD learners face variety of barriers while accessing via e-learning platform. There are various types of learning disabilities, and each LD learner is different from the other learner, but the delivery techniques of e-learning courses do not take into consideration all these requirements. Its aim is to make learning resources accessible to everyone rather than predict these individual needs [Brown, 1997]. [Woodfine et al., 2008] indicate that text-based synchronous events such as chats etc. which are widely used tools in education create accessibility issue for LD learners. There are huge amount of Assistive Technologies available for learning difficulties students but it is unsuccessful when e-learning applications are taken into consideration because the developers of those technologies have made generic application without considering specific type of LD [Alsobhi et al., 2014]

Some of e-learning systems that are available in the market for LD are focusing on specific problem of their educational life, For e.g. [Mounira et al., 2013] provides speech recognition software that provides assistance in Arabic reading for dyslexic children. [Gregore et. al., 2003] provide various learning activities at the word and sentence level, both in spoken and written format for dyslexic students. According to [Chera & Wood, 2003], audio-visual training increases the performance of dyslexic child in recognition of words and alphabet. [Graham et al, 2005] have based their research on young struggling writers (dysgraphia) and provides solutions to help them. [Kumar et al, 2009] incorporates math learning into interactive video, using stories, music and visual cues to help dyscalculia students relate math concepts to everyday life.

The major challenge faced by LD learners is to match their accessibility needs and academic challenges (as discussed in Section 2.1.1- b) in the existing e-learning system. So in order to overcome their needs and challenges, it is necessary for online teachers to suitably provide an assistive learning environment in which the learning material that is made available online can have far more options for accessibility than analogue content. The electronic text can be read aloud and translated to Braille; audio
files can be electronically transcribed as text. Text made available as an audio file can be listened to in different settings. Subtitles can be used to read the content of a video presentation when sound is not appropriate. Information that is less fixed to a specific format can be accessed in multiple ways and is more easily searchable. It can also provide students greater degree of flexibility to listen to lectures at their own pace of understanding and at their own set time and place. The assistive learning environment can also be defined in terms of (a) learning strategies used by these learners and (b) identify how they can be delivered through e-learning system [Lerner, 1997].(a) is dependent on an individual’s learning style preference. Based on the learning style preference, learning strategies are designed. And (b) identifies the technology that can help in the learning strategies in the form of screen amplification, changing font size, type and color of the text, text editing in form of line spacing, word spacing and alphabet spacing, provide aural and visual presentation of course material etc. [Mull & Sitlington, 2003].

Here, a teasing out of the shortcomings of these e-learning technologies has been attempted and efforts at providing an assistive learning environment to help students with LD have been made. And thus by providing this environment, all the course materials are available to the learners and based on the type of LD appropriate adaption is done to bridge the gap totally between normal students with the Learning Disability students.

2.2.4 Evaluation of E-Learning Systems

The development of e-learning system is one of the most rapidly growing areas of education. There is plenty of literature available which is specifying various tools and instruments for the evaluation of e-learning system. But from LD learner’s point of view, we are focussing on two dimensions for evaluation, viz, accessibility and usability.

The major challenge faced by LD learners is to match their accessibility needs and preference in the existing e-learning system. LMS could be the perfect solution to improve the academic performance. It consists of various features like assignments, blogs, chats, forum, emails, quiz etc. that could cause accessibility problems for LD students. Based on the evaluation criteria specified by [Cooper, 2006], [Sabine & Kinshuk, 2006], [Ben et al, 2013] various open source LMS are evaluated according to
the requirements of the LD learners. And for this evaluation purpose, following four open source LMS were taken into consideration viz. Magic Tutor, Moodle, LAMS and Sakai and the evaluation criteria is as show in the figure 2.2. Based on the evaluation, it can be concluded that the above mentioned open source LMS do not meet the accessibility requirements of LD learner.

![Figure 2.2: Evaluation criteria and results for measuring accessibility issue in LMS for LD](image)

A usability evaluation according to [William & Nicholas, 2006] is based on user’s satisfaction and motivation to learn. Numerous researchers have defined a list of usability evaluation factors that could be followed in order to achieve decent usability. LMS usability is a significant issue that can affect the overall acceptance and success of these platforms. [Sim et al, 2015] evaluated the usability factor of three open source LMS platforms viz, Moodle, ILIAS and Atutor. This study involves usability testing and user’s acceptance test of these LMS’s where each participant is given a task to perform on LMS and at the end of the each task, they are requested to give comments in the online survey forms. The final result then shows the usability and user acceptance of the LMS. And it was found that Moodle is most easy to use followed by Atutor and lastly was ILIAS because ILIAS is more complicated compare to the other two LMS and not accepted by the participants. According to [Aisha et al, 2015], who has done an extensive study to understand of the requirements of an e-learning tool for people with dyslexia has taken into consideration following four dimensions for usability evaluation:

(i) **Presentation** which is concerned with how to make the system more interactive by choosing icons and interaction styles, or by selecting different layout designs.

(ii) **Hypermediality** helps to represents the content in multi-modes i.e. audio, video, image etc.

(iii) **Acceptability and Accessibility** denotes the accessibility wants of users i.e. if the user will accept the system only if it is accessible to him.

(iv) **User Experience** deals with users’ feelings before, during and after using the system which plays a vital role in the success of the system. There are numerous usability
evaluations done, considering various dimension. For example, according to [Lund, 2001], usability evaluation of any e-learning system should be based on four dimensions, namely (i) Usefulness (ii) Satisfaction (iii) Ease of use and (iv) Ease of learning. [Hatzilygeroudis et al, 2007] define the usability evaluation in terms of (i) effectiveness, (ii) efficiency, (iii) safety, (iv) usefulness, (v) learnability and (vi) memorability.

The review explored only a partial literature providing a feel for the e-learning and LD students. Based on it, we see that if e-learning system has accessibility and usability problems, then it is very difficult for LD students to participate in the course enabled by that e-learning system. However, no clear solution is available as each LD student is different from Solutions chosen arbitrarily, rather than in a framework will be costly to accomplish the goal. One operational way to ease the costs of managing these is by using frameworks which can reduce redundant choices which will be discussed in detail in chapter 5.

2.3 Research Gap

There are certainly gaps in the research on how to deliver an assistive learning environment to LD learners, as each LD learner has its own accessibility needs and is faced by academic challenges. As more studies are conducted in the field, perhaps these gaps will be filled, but currently there are a number to be considered. One of the gaps in current research are studies that found that almost one-third of dyslexic students who used assistive technology to access online educational material found that this material was unreliable or inconsistent if it could be accessed at all [Kelly, 2011]. Just like any other aspect of eLearning courses [Guglielman, 2010] cautions that it needs to address both technical and pedagogical aspects of accessibility. While e-learning systems are convenient for many students, LD students face lots of problems in accessing learning material, because they require various accommodations from the teacher and institution [Debenham, 2002]. Another interesting aspect that has been left out of e-learning environment is about their accessibility and usability problems. Due to which it is very difficult for LD students to participate in the course enabled by that e-learning system. However, no clear solution is available as each LD learner is different from other [Guri Rosenblit, 2011]. So in order to overcome their needs and challenges, it is necessary for online teachers to suitably provide an assistive learning environment in which the
learning material that is made available online can have far more options for accessibility than analogue content. The goal is to address the gap in this thesis.

The thesis addresses the following research questions:

1) *How to enable customization of the learning content according to the requirement of individual LD learner?*

2) *Is there an association of achievement score (Science) between traditional method of teaching and Assistive E-Learning System (AELS)?*

In order to respond to this question the following research objectives were established:

- To build a framework for personalized learning environment for LD learners.
- To design a flexible content transformation structure including pedagogy and presentation.
- To implement an Assistive E-Learning System based on the above.
- To empirically validate the effectiveness of this system against the research questions.