

Perspectives for Dyslexia and the existing Learning Technologies: Review

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Abstract

Dyslexia is a child's inability to read, spell, write and memorize. Dyslexia is not a disease; Dyslexia challenges the child to understand and cope up with his grade level. The child is not able to decode the words to read and nor encode the words for spelling easily, reads slowly with many mistakes. Hence for kids dealing with Dyslexia faces a lot of challenges in their daily life and it is even more difficult to cope up without having any kind of assistance or technological help. The perspective of Dyslexia is different for everyone, as we have mentioned the mindset of teacher and parents differ too. Just like the perspective Dyslexia is also different for everyone. Some children are not able to cope up at all while some overcome it. A child while suffering from Dyslexia will be able to overcome it and lead a successful life with proper efforts and people supporting him. In this paper we review the daily problems faced by the children suffering from dyslexia, and also we try to understand the perspective of the people close to them like their Parents, Teachers and Doctors and try to understand their daily life struggle the children face and what actions are taken by the people close to them and how technologies were working hard and playing important role to provide assistance to them.

Keywords: *Learning Disability, Dyslexia, Memory, Spelling, Teachers Perspective for LD, Parents Perspective LD*

1. Introduction

Learning Disability happens, in any event, one of every 10 individuals, putting over 700 million youngsters and grown-ups worldwide in danger of the long-lasting absence of education and social rejection. Learning Disability consists of many types of learning issues. Children with learning disabilities face many challenges. Over the years they are called many things, some are also called lazy, and what people don't realize is that they are not lazy; they are one of the most determined people in the world. Sometimes they are even called disabled but they are just differently-able it is us who are ordinary in a very common way. The most common varieties of learning disabilities are reading, speaking, word encoding and memorization. Learning Disability happens in kids with all insight levels. Every now and again, they have better than expected capacity. The frequency in guys and females is roughly equivalent. It is discovered everywhere throughout the world and in all financial and ethnic gatherings. Notwithstanding, kids who go to ineffectual schools, regularly in high neediness zones, are bound to experience perusing disappointment as a result of the absence of legitimate guidance.

2. Methodology

We reviewed the topics including Dyslexia, Dysgraphia and memory from various sources we searched over the internet, referred multiple IEEE papers and also conducted a survey in order to build our review paper thoroughly. The uniterms used were Dyslexia, Dysgraphia and memory respectively. Various research papers from different publications, journals were reviewed. The process of learning and pace of pick up from a dyslexic student's perspective and technological assistance applications were studied.

3. Results and discussions ^[1-20]

Following all points are summarized from all the referred papers with some informative websites [1-20] and we just review the problems with used techniques.

3.1 Understanding the Learning process for a Dyslexic Student

a. The Learning Process of Reading

Reading is defined as a process which includes word recognition and identifying the word in order to explicate the given text. Reading is a process which involves thinking. It ensures that the reader uses what they have already known also called prior knowledge. Findings from Neuroscience say that during the learning process the physical structure of the brain undergoes changes, in other terms it alters the functional organization of the brain. Learning is a process, in which each individual gains new knowledge or alters the knowledge, during this nervous system and behaviour of an individual undergoes certain changes which vary how an individual thinks and acts. ^[15]

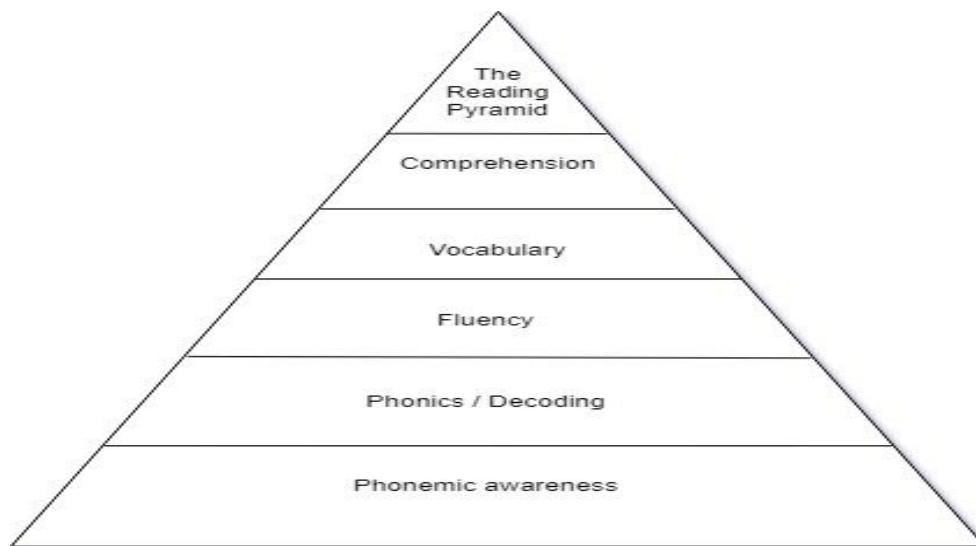


Figure.1. Summarization of Learning Process ^[1-20]

b. The Learning Process and Memory

Memory is a logical process which has the ability to store and encode the various events. Learning process and memory are interrelated, as learning is the process of achieving a vast set of skills and whereas memory ensures how the brain stores the data/information and also retrieves it. Weak memory sums up to difficulty in learning. However, there is no single/global memory which contributes to the entire memory system. There are different types of memory which develop a memory system which contains different types of information. Various types of memory are namely, procedural memory, semantic memory, episodic memory. Working memory is vital for learning it involves memorizing static data/information. Working memory involves two components namely verbal and visual-spatial short-term memory stores. Verbal short-term memory holds information that can be expressed in numbers, words, and sentences. Visual-spatial short-term memory holds images, pictures, and information about location in space. ^[18]

c. The learning Process of Spelling

Many researches show that the process to learn spelling involves understanding the relationship between reading and spelling. Reading and spelling depends on the foundation of representation of the same word. Fluency of reading is built strong when the spelling of a word is known prior. In fact, Ehri and Snowling found that the ability to read words “by sight” (i.e. automatically) rests on the ability to map letters and letter combinations to sounds. ^[16]

3.2 Neurological Aspect of Learning Disability

In terms of neurologist aspects of dyslexia, the people suffering from development dyslexia have a complex deficit of impaired reading procurement, although they have sufficient sensorial and neurological conditions, as well as normal IQ and education opportunities. Despite getting the fruitful results of suspecting genes of dyslexia, the underlying origin pathway for it has not yet been understood. imaging–genetics integration has been attempted by a few scholars to find the underlying biological aspect of dyslexia but the outputs are not significant to describe the

complexity of the reading circuit. Up to 5 to 12 % of the population finds reading extremely difficult. From the magnetic resonance imaging (MRI) that has been studied, it gives us insight into various functional, morphological and structural brain abnormalities. Also, functional MRI was considered to know how the brain reacts when at rest and during any specific task given. The test was conducted on two groups, one group of children that were found dyslexic and another pre-reading child who was at risk of dyslexia. The pathway of how brain circuits work in both groups indicate an early risk of dyslexia in pre-reading children. This kind of detection can help pre-reading children who are at risk of dyslexia an early aid for potential academic remedy.^[17]

3.3 Problems Associated with Dyslexia

Table.1: Problems associated with Dyslexia ^[1-20]

PHASE	Problems Associated
Before School	<ol style="list-style-type: none"> 1) Slow in learning new words 2) Difficulty in forming words 3) Confusion in naming letters, colors and numbers 4) Difficulty in remembering Nursery Rhymes
School Age	<ol style="list-style-type: none"> 1) Problem coping up with Grade level 2) Not able to pronounce unfamiliar word 3) Difficulty in Reading 4) Difficulty in Spelling 5) Difficulty in memorizing 6) Takes long time in completing simple task
Teen Age	<ol style="list-style-type: none"> 1) Difficulty in summarizing a particular event 2) Face problem in delivering the desired message to others 3) Problem solving simple and complex math problems 4) Problem coping up with grade level 5) Not able to speak or read loud with confidence 6) Problem staying on one particular topic

In above table, we have gathered the problems associated in specific age group and we can surely want to mention that teacher, parent and doctor are major entity of the any dyslexic child's life as they are channelizing the energy of child as per the child need. But somehow the communication gap or understanding the need of child gap or unawareness of child interest, etc. surely impact on remediation.

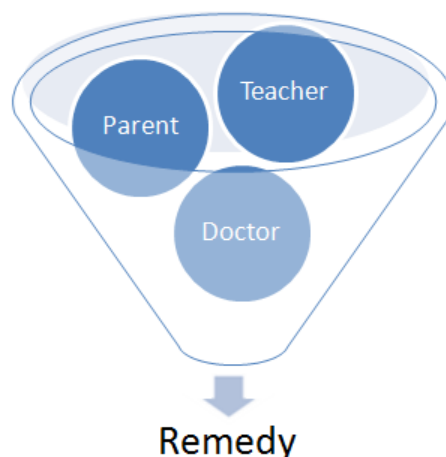


Figure 2: Traditional problem solving method

In above method, teacher contacts to parent regarding poor performance about child as disability is all about academics and suggests counsellor and counsellor suggests to contact doctor for some checkups and then doctor will take their session to evaluate the child's problem. This whole loop is conclude with the LD certificate and some suggested remedies.

a. Teacher's Perspective on Dyslexic Children

Previously researchers and professors considered dyslexia occurred due to visual deficits and that it was marked by letter and word reversals. It is now universally admitted that dyslexia is not an optical issue and that reversals are characteristic of developing readers. In an analysis of dyslexia study printed between 1960 and 2011, Lopes (2012) discovered that the top 10 most published authors of dyslexia research were physicians, psychologists, and neuropsychologists;^[4] none were teachers. Thus, when teachers, teacher educators, and other education stakeholders seek knowledge about dyslexia, they will essentially find views from researchers who typically have no direct acquaintance or experience in teaching. Professors are generally represented as lacking awareness and insight for students with dyslexia. Despite the ambiguity and conflicting state of knowledge about dyslexia, researchers who have analyzed teacher knowledge have employed close-ended surveys that include assumptions about the definition, characteristics, and treatment for dyslexia as if they are rightly understood and accepted upon. The teachers constructed complex, uniquely personal opinions about LD from multiple sources, including expert and popular lectures, life experience, and education experience. Even if our educators wanted to know more about dyslexia and help their studies more, they expressed disappointment because of a lack of information and transparency about the dyslexia identification as well as interference policies and methods in their schools and districts. It was not shocking, then, that our educators were uncertain about their capacity to work with students recognized as dyslexia, even though they felt certain to provide effective reading guidance to students with other reading difficulties. Some clear methods are there that can make the professor clear about the characteristics, origins, and identification of dyslexia, but the researchers have not yet identified a structured study program for children suffering from dyslexia. Thus, educators can gain knowledge about what exactly dyslexia is and what their symptoms are and by themselves can act upon their studies in a personalized way. Knowing what is understood and what is not yet known may give educators and mentor educators the confidence to engage in conversations that currently take place often without their input in this kind of matter.^[19]

b. Parent's Perspective on Dyslexic Children

Dyslexia could be prevented if detected at an early stage. It becomes extremely important because in case of dyslexic children, the most important role-playing people in their life are parents. How parents persevere their children is the key playing factor onto how the world will persevere with them. Early stages will be detected by the parents, in case if the child lags a command over reading by the age of 3-4 years then he could be potentially suffering from dyslexia. In this case the parents should get in touch with the teacher and take the necessary steps. Parental support can be a protective factor that may positively or negatively impact self-esteem. It is very important for parents to set realistic targets for their child, keeping in mind their condition, setting an educational expectation and academic target. After setting achievable targets for the child, his/her parents act as a wall of support for this child. More often it is seen that parents who are mentally powerful help their child achieves a lot more than those parents who fall weak after knowing about their child's condition.

Parents need to understand that it is healable in the initial stage if they reach out to the right set of people in the field. The right first person of contact should be the class teacher. Later on, proper consultation from experts can be taken to check the severity of the child. Huge time and money are invested in these procedures. There is a set of govt. Bodies which are responsible for checking the level of understanding in the child. This body conducts a 12-15-hour check-up keeping various factors in mind and provides certification which acts as legal proof of the child suffering from dyslexia.

Since a lot of time and mainly money investment is required, people from lower socioeconomic backgrounds cannot really afford these procedures. There are non-profitable organizations working closely with dyslexic children on it. Right parental support brings a feeling of being understood amongst the children and a sense of being accepted by the people around them. This will intern bring confidence and signs of improvement could be observed in their attitude towards studying and overall performance.

3.4 Computer Based Screening for Dyslexic Students

It is used as a marking schema to detect the severity of learning disability. There are many types of learning disabilities whose characteristics coincide with each other and thus a test is taken to determine which type of learning disability an individual suffers from. The decision tree algorithm is used in this classification system. Since the decision tree is a rule-based (if-then rule) algorithm they are easier to understand and is also computationally easy as it performs classification with less computational time^[1]. It also helps to provide a clear indication of important fields for classification. It is used in this system for the sole purpose of deciding the level of dyslexia, dysgraphia, and memory in an individual. In each category, it classifies the skills of an individual and depending on that a decision is generated^[1]. Learning Disability affects Up to 10 percent of the population are affected by specific learning disabilities, such as dyslexia, dysgraphia, and memory. This system diagnoses these different types of Learning Disabilities by using some simple cognition. Following table is just example of e-learning system. It shows how system will work on disability and how it grabs the understanding level of child. Some time it requires more repetition but it will be helpful for the child.

Table.2: Use of Computer system for LD child remediation

No.	Task	Category
1	Word Count	Dyslexia
2	Correct the spelling	Dysgraphia
3	Card Comparison	Memory

- 1. Dyslexia:** Word Counting, in this task, the series of sentences are given in a particular order and some sentences and words are jumbled. The difference in speed of recognizing the words and sentences of both patterns is calculated. The cognitive functions noticed here are knowledge of the words, decoding of words, the arrangement of proper sentences, attention and visual memory.
- 2. Dysgraphia:** Correct the Spelling In this task, incorrect words will be provided to the children with a guess limit as well as words will be given with missing alphabets and children are expected to complete the words with the provided choices of the alphabets. This checks their working memory, decoding of words, and enhances their vocabulary.
- 3. Memory:** Card Comparison In this task, two cards will be drawn out of the 8 cards and children are supposed to select 2 cards look at them and then select the third card, when the third card is selected the previous two selected card are turned over and the children are supposed to think and match the third card with one of the previously selected cards. This checks their working memory and attention.

4. Reviewed models ^[1-20]

As we have referred total 20 references and we have used the all papers for summaries the existing system with its helpfulness and are as follows:

- 1. “TheCure”** was published in the year 2018. Target users are dyslexic students from English medium backgrounds facing difficulties in Reading, Handwriting. It uses the following algorithms to build a model Convolutional neural network (CNN), Automatic Speech Recognition (ASR), TensorFlow source tree, Euclidean distance K-means clustering. It gave an accuracy of Heuristic Evaluation model: reasonable substance mean of 4.52 / 5, letters acknowledgment strategy mean of 4.64/5 and reasonable multisensory approach mean of 4.4 / 5. It has quite a lot of limitations like it was highly depended upon confusing words recognition only; No audio, Limited animation.^[2]
- 2. Mobile App for reading practice & Dyslexic Diagnostics** was published in the year 2016. Target users are dyslexic students from Portuguese background facing difficulties with Reading. It uses the model based on Voice Recognition(Dragon Mobile SDK), gives an accuracy where the normal endeavor by Dyslexic was 3.46 / 5 and non-Dyslexic was 2.54 / 5 youngsters. This app was limited to students from Portuguese

background and the user read properly what the screen display but factors like surrounding noise affects the accuracy, user with a non-native accent may spell right, but it is not correctly identified but the system.^[3]

3. **ALE(Adaptive E-learning)** was published recently in 2019. Target users involved students diagnosed with Dyslexia and Dysgraphia using base language as English. The model used was a Rule-Based System using PHP, HTML, XML, WAMP Server in the development of a web based system. They studied 100 people using 16000 .wav (audio file). Found out the accuracy after 70,000 record sound files of different voices those who don't suffer from dyslexia got percentage level that lies between 80-90 while those who suffer from dyslexia got percentage level that lies between 30-40. This model was limited to a Rule-Based System and was not found to be very flexible. It was web based so it restricted a lot of students who wished to use tablets and smart devices as a platform.^[4]
4. **Mylexic** was published in 2009. Focused mainly on Dyslexic and Autism students struggling with Reading, Spelling and Writing with base language as Malay originated from Malaysia. They used Dual coding Theory, Scaffolding, Teaching Strategy. They reached out to students using a Courseware (CD). Their learning module mainly focused on Alphabets, Syllables and Words. Though it used the dual coding theory the model was very static and did not provide an accurate statistical interface on the development of the student.^[5]
5. **Dyslexia Baca** was published in 2013. It focuses mainly on dyslexic students facing difficulty with alphabet recognition but having a strong command on Malay. They used a Multisensory Approach and included the memory theory. They came up with a mobile application which focused mainly on confusing alphabets. The application was not platform independent and was not compatible with any web browser. It used a limited Letter Recognition pattern and the level of the letters was also extremely simple.^[6]
6. **IASD** was published in 2013. It is a standard one software system for children/adults with dyslexia facing difficulties with Phonology, Reading, Writing. The model is built on Machine Learning (HMM), Game Visualization principles. The data was gathered using pre/post test experimentation on the target users. This app mainly focused on the Syllables, Rime, Phoneme, Reading and Writing. The base of the model is not very clear in terms of the approach and structure used.^[7]
7. **YUSR** was published in 2014. It is a software developed for the dyslexic children struggling with Phonic, Reading and Spelling. The model uses Machine Learning, Vision and Speech recognition as its key components. Multiple students were considered during the interview and questionnaire was given to evaluate the weak areas. This software was developed in the Arabic Language. It lagged in its accuracy of voice recognition but works really well with Alphabets, Words, Sentence Framing and similar formation of words. Example: Bad, Cad, Mad.^[8]
8. **DysEggxia** was published in the year 2014 by Rello & Bayarri. They worked closely with dyslexic children to develop a mobile application which would help dyslexic children learn spellings in a more interactive and fun method. It used a Gamification method to provide games using the error-based method. Key languages of development mainly focused on the Spanish and English Languages.^[9]
9. **E-Talk** was published in 2014 with the intention to promote Phonological Awareness on Communication Training. The target is to assist people facing articulation disorder with the help of a talking pen. The learning module included Phoneme, Tone awareness as you slide the pen over the book it guides you and reads out the sentences and images for you. It was a proper device and was limited to the book that came along with it. It only works in the mandarin language.^[10]
10. **Jolly Mate** was published in 2007 with an intent to help students in the early stage of their dyslexia. This was a classroom experiment which was performed under observation using a Digital Notepad. The approach was a multisensory approach and used machine learning(K-NN & NN model). The base language was english and focused mainly on Phonic and writing. The learning module included visual of six

letters at a time and writing letters. This experiment was limited to the digital notepad provided by the company Jolly Mate^[11]

5. Last note on review

All Traditional methods without e-learning technologies are trying to resolve the problem of child But problem can't resolve with some remedies or some counselling sessions. Child requires repetition as per his/her understanding. So, as mentioned in above point, parent, teacher and doctor plays vital role.

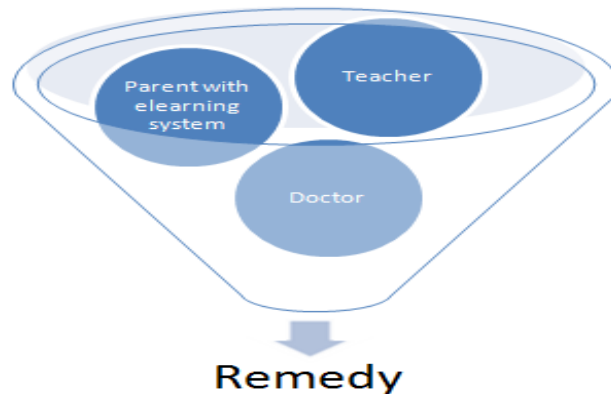


Figure 3. Technology use for assistance

But conveying the message as per child need or understanding is again generate pattern. As a parent same thing repetition will be possible as they want to overcome their own child problem but as a teacher, every time repeat completed task to connect the ½ children from class will consume time as well as other children energy as they have already make themselves ready for new task. Here our technology plays vital role where child can continue their regular schooling and will join some elearning system which will give repetition as per their need. As it is tough as every child has own pace of understanding. Machine learning will help here a lot. We can take the online session as per their syllabus and take a small test. He can access any task any time with multiple attempts. It will create the learning path of the child and we can analyse the learning pattern too.

6. Conclusion

A learning disability is neither a disease nor an indication of the laziness of the children. It is a neurological disorder. The dyslexic brain is actually larger and typically much more creative than the average. Children with a learning disability will still have problems with academic skills like reading, spelling, memorization, writing, neat handwriting, writing speed, etc and as previously mentioned a disorder cannot be cured completely. Learning disability severity can be little decrease with proper efforts with parents and teachers who never give up on them and with proper support, guidance and the right technology will help children can achieve great success in school/college and be successful in life.

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