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Detecting the Severity and the Type of Learning Disability with Pattern Extraction Using Machine Learning

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ABSTRACT

Learning Disabilities is that an individual does not possess the ability to communicate, read, the accuracy of word decoding, fluent word-recognition, memorize or is unable to concentrate. In this paper, we are going to discuss what learning disability means and some of its types and the technique used to determine the severity of the learning disability and to extract patterns and evaluate them to overcome the challenges faced by them in their daily life.

Keywords:—*Learning disabilities; Dyslexia; Dysgraphia; Memory; Machine Learning algorithm; Computer based Screening.*

I. INTRODUCTION

A. What is Learning Disability ?

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 what people don't realize 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[12]. The most common varieties of learning disabilities are reading, speaking, word encoding and memorization.[1] 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.[1] These learning disabilities are not caused by lack of motivation, it is not a visual problem ,it is not a problem of laziness[10] ,it cannot be outgrown and nor is it a problem of intelligence, it is just that there is not enough awareness among us to help the children cope up with the difficulties they face. If you are reading this paper on a windows product, thank Bill Gates who is dyslexic. If you are reading this paper on an iPhone thank Steve Jobs who was also dyslexic and if you are reading this with the assistance of light thank the man who once came back from the school with a note on his
shirt that read that he was too stupid to learn and that boy was Thomas Edison.

B. Origin of Learning Disability

Learning incapacity is a neurological issue that influences the cerebrum's capacity to get, procedure, store, and react to data. The learning incapacity is used to describe an unexplained phenomenon that an individual faces a lot of difficulties even in grasping basic academic skills. These skills play an important role in success for the school, work and to cope up with daily life. Learning Disability doesn't represent a solitary issue. It is a term that brings attention to a number of disorders. [1,4]

C. Signs and Symptoms of Learning Disability in various Age Groups

Different types of learning disability symptoms at different age are as follows :

Age	Symptoms
Pre-School	• May speak later than most children • Difficulty in pronouncing of simple words • Slow speed in naming objects and colors • Difficulty in learning the alphabet, numbers, days of the week • May have trouble in basic concepts such as size,shape and

	color • Poor memory for following day-to-day activities • May have trouble linking letters and sound
5-9 years Age group	• Confused while reading basic words • Easily Distracted • Problems To cope with the skills of the grade level • Problems with reading words from sentences and paragraphs • Have trouble telling time • Gets confused with several instructions at once • Problem in formation of short and long words • Difficulty in remembering the things practically done by them

It is not necessary that all children will go through the same type of learning disability.
The Common Learning Disabilities covered in this paper are Dyslexia, Memory and some parts of Dysgraphia.[11]

D. ***Common Types of Learning Disabilities.***

The table below demonstrates the prevalent kinds of learning disabilities facing corresponding difficulties and issues.[1,3].

Types	Difficulty	Issues
Dyslexia	Reading	• Struggle in reading • Skip lines and omits words • Reads slowly and guesses words
Dysgraphia	Spelling	• Poor spelling • Organization of ideas • Poor punctuation and capitalization
Memory	Working Memory	• draw conclusions • solve problems • make connections

There may be a possibility that a child suffers from more than one disability. For example, a child suffering from dyslexia might also suffer from dysgraphia as well but a child suffering from dysgraphia might not suffer from dyslexia.[16,18]

II. LITERATURE REVIEW

A] ***YUSR*** was published in 2014 by Taileb, M., Al-saggaf, R., & Al-ghamdi, A. 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 questionnaires were 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.[5]

B] 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.[6]

C] iLearnRW was published in 2014 by Rello, L., Bayarri, C., Otal, Y., & Pielot, M. It is a software system developed for Dyslexic children struggling with Reading, Writing and Behaviour. They used the student module and a lesson planner method. The base language used was English. Evaluation and method both are experimental. Major use of machine learning parameters can be used like Recall, precision Accuracy and F-measure to find the correctness of an algorithm.[7]

III. PROPOSED SYSTEM

The process comprises of two stages:

1. Input
2. Project Flow

Input : Two mandatory inputs are required in order to begin with the learning module.

1. Parents/ Teacher Feedback about the student using the Web Application.
2. Student's Quiz to determine the initial level and compare it with the final level.

Project Flow : A dynamic and an adaptive learning platform shall be prepared for students with learning disability. The Parents/Teachers feedback is mainly classified into three subtopics naming spelling memory and reading spelling. Questionnaire consists of some key features which will help us analyse the basic reading academic skills reading fluency, decoding, virtual memory, visual memory, audio memories spelling and similar basic analysis.
Next will be the students quiz where the student will be taking a quiz on three categories spelling memory and reading. This quiz will consist of the same key features

that we will be evaluating from the Parent/Teacher questionnaire and will be overlapping with the answers of the students. Here the basic level determination of the students will be taken using an algorithm which will help us overlap both the feedback and quiz. An existing data set will help us to train the machine learning model in order to develop accuracy in its result. Using this data we will train the model and one the level is determined the student can start with the learning module in order to improve his pace of learning.

The main focus is students studying in standard 1 to standard 4th for MHSB there will be a separate quiz for students from standard 1, Standard 2, standard 3 and standard 4.The level of difficulty will increase with increase in the standard of the student will be given by the parents while registering for the course.

IV. TECHNOLOGIES FOR DETERMINING THE PATTERNS AND SEVERITY OF LEARNING DISABILITIES

A. *Approach Diagram :*

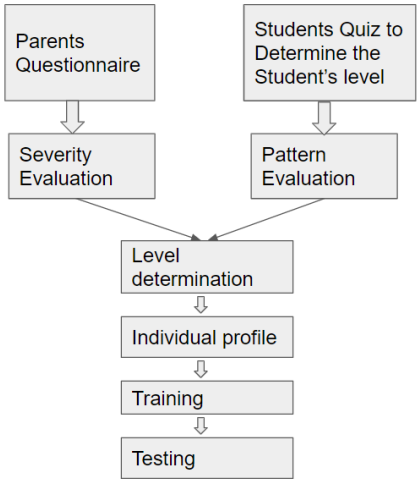


Fig. A

B. *Technologies Used:*

At the Parents Questionnaire and Students Quiz level individually we are applying the decision tree Algorithm.

To understand the level of the student better as per his Reading, Memory and Spelling capabilities we used the Random Forest Method for a clear understanding of where the student stands according to his existing knowledge base.

C. *Algorithms Used* :

1. Decision Tree : Decision tree is a type of classification algorithm which comes under supervised learning technique.It is a graphical representation to all the possible solutions to a decision. Decisions are based on some conditions For eg : A task is , should I go to a restaurant or Buy a hamburger for that we need to create a decision tree starting with the root node and check I am hungry ? If you are not hungry then go back to sleep and if you are hungry and have ₹25 then u will decide to go to a restaurant and if you don't have ₹25 and hungry then you will go buy a hamburger..[9]

2. Logistic Regression: Logistic regression is used to predict the outcome of categorical dependent variables. So the outcome should be discrete or categorical. It produces results in a binary format. For example 0 or 1, true or false, yes or no, high and low. A Logistic regression curve is a 'S' sigmoid curve which converts any value between -infinity to +infinity to discrete value/binary format. In Logistic regression threshold value indicates the probability of winning=1 or losing =0 for eg: If the data point value in the curve is 0.8 so here we check if the value is less than the threshold value or not. Let's say if the value is more than the threshold value it should give us winning case i. e value =1 and if the value is less than the threshold value it should give us losing case i. e value =0. So using threshold value it converts it into binary format.[13]

3. Random Forest: Random forest is another type of classification algorithm. It builds multiple decision trees and merges them together to get more accurate and stable predictions. Most of the time random forest is trained with the bagging method . The bagging method is based on the idea that the combination of the learning model increases the overall results, if you are combining the learning from models and then clubbing it together what it will do it will increase the overall result. If the size of your dataset is huge then in that case one single decision tree would lead to an overfit model same way a single person might have its own perspective on the complete population as the population is huge. However if we implement the boarding system and ask different individuals to interpret the data then we would be able to cover the pattern in a much meticulous way. So in random forest we divide a huge training dataset in N samples and create a decision tree for each sample and then take the vote of out of every decision of each sample decision tree and club to get the random decision.[15]

4. XGBoost Classifier: High-performance implementation of gradient boosted decision trees is done with the help of an XGBoost classifier which is an open-source library. The basic working of this classifier that makes it so effective yet simple for implementation is the C++ codebase along with the Python interface. [16]

V. PREPARATION OF QUESTIONNAIRE

Sr.No	Question	Options to Grade	Final Analysis
	READING		
1	Is the child able to cope up with reading according to his grade level ?	• Always • Sometimes • Rarely	Basic Reading, Academic Skills
2	Is the child able to read common printed words ?		Basic Reading
3	Is the child able to pronounce the words correctly ?		Reading Fluency
4	Is the child able to understand what he/she reads ?		Decoding
5	Is the child able to read without skipping lines and omitting letters?		Reading Fluency, Reading Rate
6	Is the child able to understand when the new paragraph is made?		Visual Memory, Decoding
7	Rate the reading of the child?		Overall Reading
	MEMORY		
8	Rate the memory of the child	• Always • Sometimes • Rarely	Overall Memory
9	Is the child able to recall the past events?		Visual Memory, Decoding
10	Is the child able to remember faces but forget the names of relatives and classmates?		Visual Memory, Decoding, Long Term Memory
11	Remember the things practically done by him, not the things seen or heard?		Audio Memory, Visual Memory
12	Is the child able to remember names but forget the faces of relatives and classmates?		Visual Memory, Audio Memory, Long Term Memory
13	Is the child able to follow higher order of thinking problems?	• Always • Sometimes • Rarely	Academic Skills
14	How is the child's semantic memory?		Decoding, Academic Memory
	Spelling		
15	Rate the spelling formation	• Always • Sometimes • Rarely	Overall Spelling
16	Is the student able to break longer words into syllables? Eg. computer = come+pooter		Decoding
17	Does the child write down the words they see/feel are right?		
18	Is the child able to differentiate the same word with different meanings?		
19	Is the child able to get the correct answer to the same question twice?		
20	Is the child able to understand the words that start with a silent letter Eg. Honest		
21	Does the child forget the content of the instruction?		

VI. IMPLEMENTATION OF QUIZ

The pictures given below are for STD 1 similar implementation is done for STD 2,3,4. The difficulty level of Quiz increases with the increase in standard

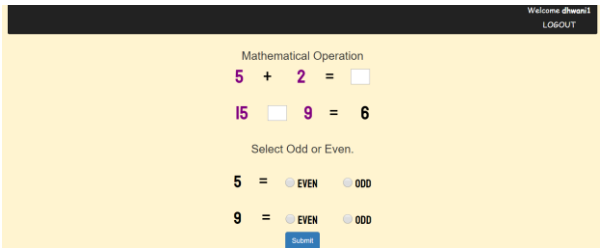


Fig. 1.1 A glimpse of the Quiz that every student will be taking before starting with the Learning Module. The above Quiz is on Mathematical Operation.

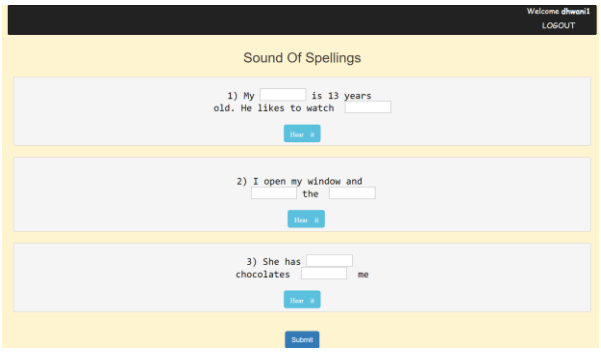


Fig. 1.2 The above quiz is on Spelling of Sound where we will be checking their ability to comprehend the words only by listening to the word with the help of the provided audio.

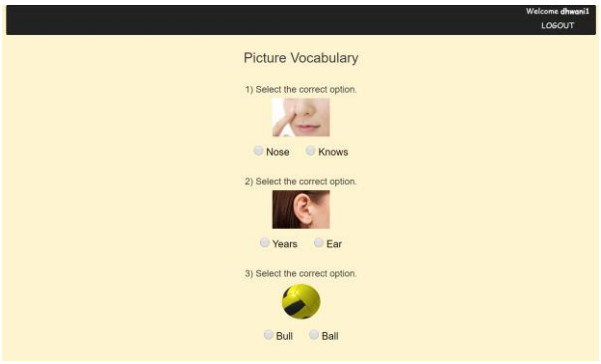


Fig. 1.3 The above Quiz will determine the students ability to decode the meaning of the word and match it to the pictures given above.Here the student has to pick a word which defines the picture.

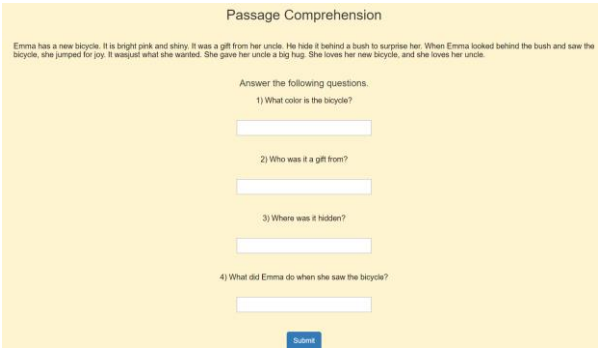


Fig. 1.4 The student will read the above passage and fill in the answer to the comprehension. Here Logical Reasoning will be tested.

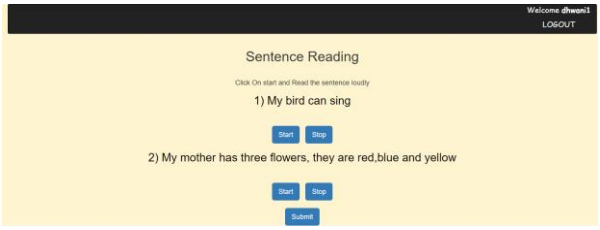


Fig. 1.5 The student will read the above given sentence using the start stop buttons with the help of the microphone. Hear the reading skills and pronunciation will be evaluated.

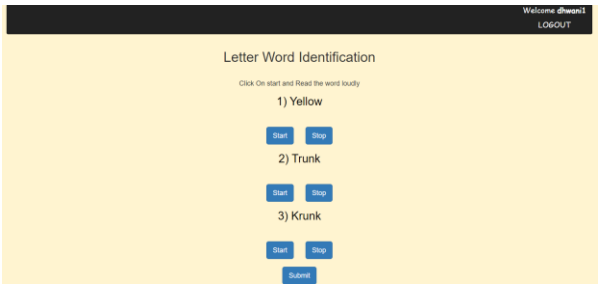


Fig. 1.6 The student will be given some word, it could either be nonsense word or word with a meaning. The student is expected to pronounce it either way. Here the letter word identification skill is evaluated.

VII. PATTERN EXTRACTION

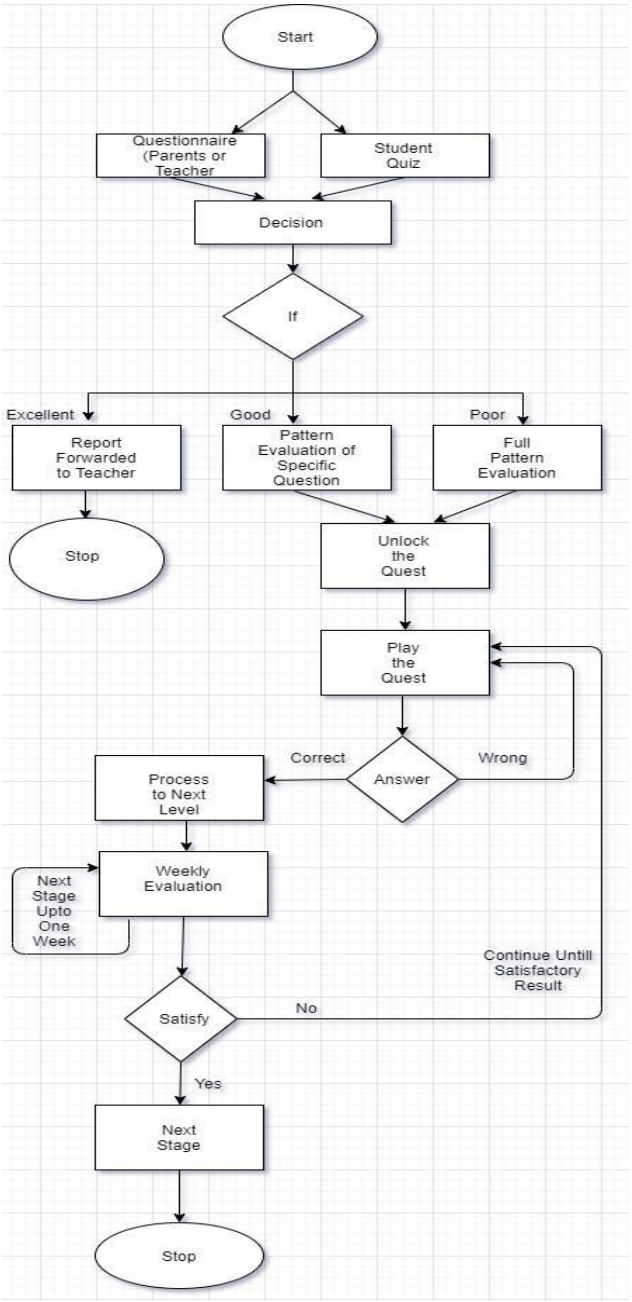
	Basic reading	Broad reading	Reading fluency	Reading rate	Decoding	Visual memory	Audio memory	Short term memory	Academic skills	Spelling
Letter-word identification	✓	✓			✓	✓		✓	✓	✓
Sentence reading	✓		✓	✓					✓	
Passage comprehension		✓		✓		✓			✓	
Mathematics operation	✓				✓	✓			✓	
Listening skills						✓	✓	✓	✓	
Picture vocabulary	✓				✓	✓			✓	✓
Sound of spelling					✓		✓		✓	✓

The Pattern Evaluation Table gives information about the various categories and seven features in which these categories fall into. The seven features are Letter-word identification, Sentence reading, Passage comprehension, Mathematics operation, Listening skills, Picture Vocabulary and Sound of spelling.

Overall, the academic skills are the prime goal. While letter-word identification involves basic reading which includes the reading of simple words/sentences, Broad reading includes reading of articles/comprehension, Decoding refers to how a student can understand a word/statement and defines it, Visual memory refers to how a student can remember things by visualizing it, Short term memory implies the capacity to remember things for a short period, academic skills and spelling. Sentence reading includes basic reading, reading frequency includes how a student can easily read a given set of a sentence, reading rate is the amount of time taken by the student to read a given sentence and academic skills.

Similarly, Passage comprehension holds broad reading, reading rate, visual memory and academic skills. Mathematics operations incorporate basic reading, decoding, visual memory, audio memory which refers to the retain power due to sound of words and how it is pronounced and academic skills. Listening skills cover visual memory, audio memory, short term memory and academic skills. Picture vocabulary comprises basic reading, decoding, visual memory, academic skills and spelling. Sound of spelling cover features like decoding, visual memory, academic skills and spelling.

VIII. SYSTEM ARCHITECTURE



IX. MODEL BUILDING

1.Data Collection - Data was collected by taking surveys of Dyslexic Students and parents' feedback.[14]

2.Data preparation - The Data collected is in raw format and so manipulation of data is done which will be suitable for processing and analysis.[14]

3.Data Input - The data verified is converted into machine readable format. we loaded the data into .csv format..[14]

4.Data Processing - The data is now exposed to various machine learning algorithms. The below table shows the algorithms that are used along with their accuracy.[14]

Model	Accuracy
Logistic Regression	0.70
Random Forest	0.60
Decision Tree	0.50
XGBClassifier	0.50

X. LEARNING MODULE

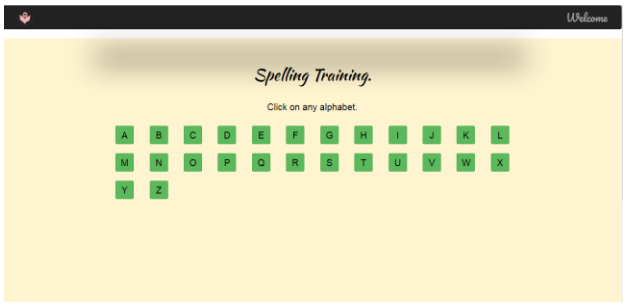


Fig. 2.1 The first module in the learning section is the spelling section. Here from the alphabets A-Z the student has to pick an alphabet.[17,18]

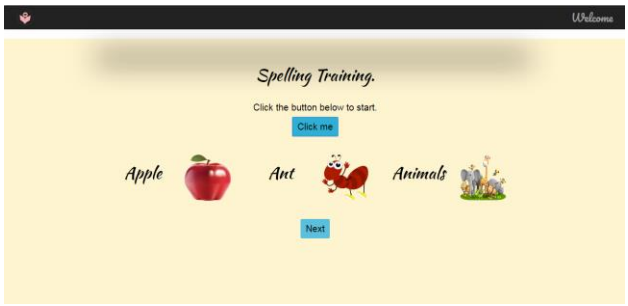
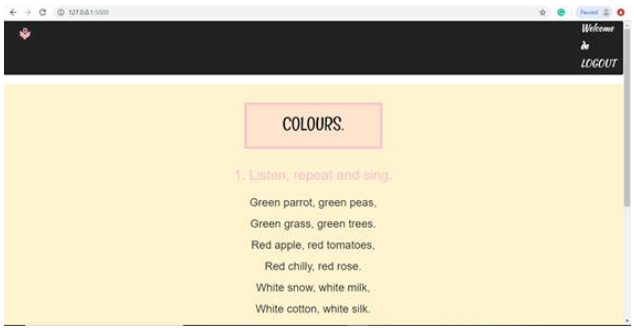


Fig. 2.2 According to the alphabet the word will be displayed along with a pictorial representation of the word. The word will be completely spelled alphabet by alphabet. Every alphabet will consist of three words.[17,18]



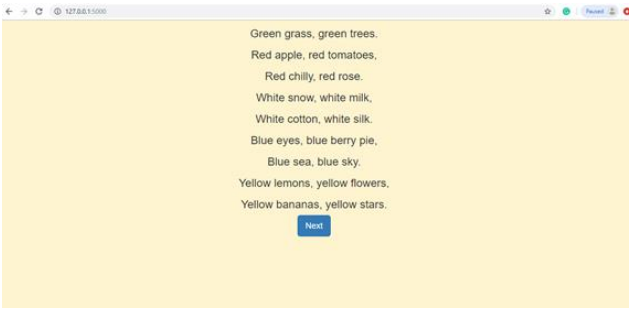


Fig. 2.3 The above picture belongs to the reading module. Here the student will click on the audio, listen to the reading by the instructor and attempt to read alongside.[17,18]

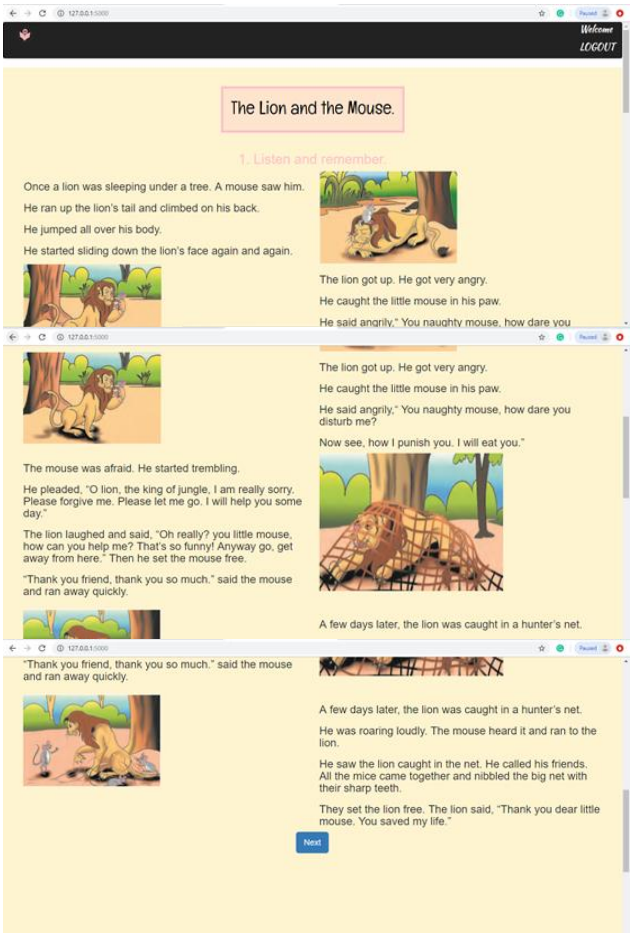


Fig. 2.4 Continuation of the above passage. The student will try and understand the story which will be read for him, with the help of images he/she can then guess the moral of the story. This will help us decode the summarization ability of the student.[17,18]

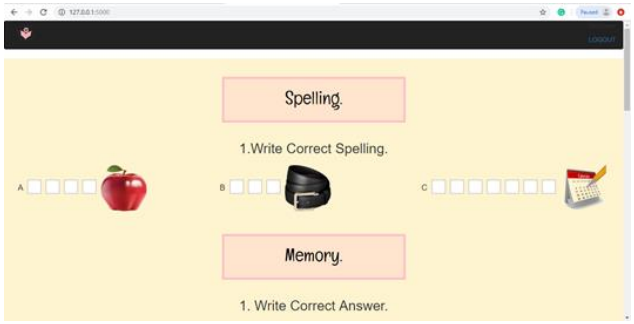


Fig. 2.5 The above quiz will be conducted at the end of the first week. This is to evaluate the progress of the student. First is the spelling evaluation where the student will be completing the missing words just by looking at the image.[17,18]

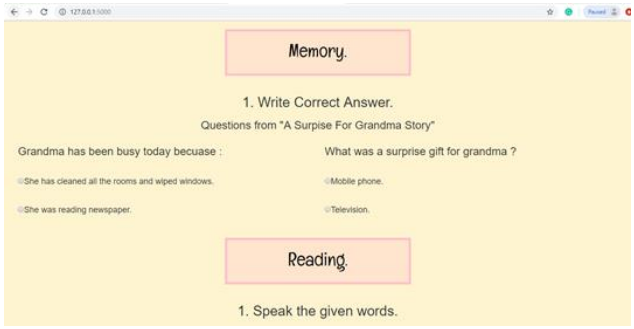


Fig. 2.6 The child has to remember how the story went about, here a few questions from the stories will be asked to test the memorization skill.[17,18]

Fig. 2.7 The student will be given a few words from the poem according to his std. Which he will have to read out aloud. This activity includes the use of a microphone. Finally we will be able to check the fluency of the student as per his grade.[17,18]

XI. RESULT

Expected Result :

Once the application is deployed we are expecting the following Results:

1. Increased the pace of Learning.
2. Able to read Fluently
3. Enhanced Long Term, Short Term Memory.
4. Widening the range of Spelling.

5. Advancement in Identification, Sentence Reading, Letter-word Identification.
6. Overall development in Reading, Spelling and Memory.
7. Augmentation on the Academic Skills.

XII. CONCLUSION

A learning disability is not a disease nor it is an indication of the laziness of the children. It is a neurological disorder. The dyslexic brain is comparatively symmetrical and typically much more creative than the average. Children with a learning disability will still have problems with reading, spelling, memorization, writing, etc and as previously mentioned a disorder cannot be cured completely. Learning disability does not come with a manual it comes with parents and teachers who never give up on them and with proper support, guidance and the right technology children can achieve great success in school/college and be successful in life.

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