# Detecting Specific Learning Disabilities

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Abstract—A child needs education to mold how it sees and learns the world. We have to cater their needs and help them learn, but 1 in 10 children suffer from a learning disability and 1 in 20 people are affected all over the world. Children suffering from a learning disability might face difficulties with reading, writing or mathematics but they excel in other areas of interests. It is in the interest of the society and especially the parents to identify the problem early in the development of the child and steer him/her towards a preferred field. The lack of proper detection and assistance in the earlier stages of development of the child will pertain to him/her being in a constant state of distress and mentally vulnerable. They might lose their sense of self worth and blame themselves for their situation.The model being proposed is a Web-based tool incorporating machine learning techniques (Decision trees) for predicting whether children (8-10 years) are at a risk of having Specific Learning Disability by showing the areas of learning disability on the basis of the clinical information and research.

## I. Introduction

Specific Learning Disability (SLD) describes specific kinds of problems related to learning, causing a person to have trouble learning and using certain skills like reading, writing, listening, speaking, reasoning, and doing math. Dyslexia difficulties in reading.
Dysgraphia difficulties in writing.
Dyscalculia difficulties in understanding concepts of mathe-matics.

These conditions where patterns of scholastic skills acquisition are disturbed from an early stage of development occur despite absence of brain trauma and in spite of availability of adequate opportunities to learn. Children suffering from SLD are gen-erally of average or above average intelligence who might fail to attain an appropriate level of education as a result. They might face considerable difficulty in one academic area while coping, or even stand out in: other areas of academic or sports or arts. Epidemiological research reveals that 3-6% of school age children are most likely to suffer from a learning disability. In the Indian context, prevalence rates are estimated to range between 9-39%.[2]

The lack of proper detection and assistance in the earlier stages of development of the child will pertain to him/her being in a constant state of distress and mentally vulnerable. They might lose their sense of self worth and blame themselves for their situation. The tool that is being developed helps in detecting whether the child is at a risk of having specific learning disability or not. Thus, the parents/teachers could take the adequate measures in helping the child overcome this disability and making sure he/she is not left out from other children.

### A. Addressing SLD in Children

From the follow up assessments done by experts while vetting for SLD in Classes I to VII in schools of 10 Panchayats in Kerala , discovered that 16% of the school children have Learning Disability (LD). Lack of early detection of SLD and lack of progressive application of appropriate assistive techniques might lead to conduct issues, reluctance to go to school, frequent change of schools, over reliance on tuition centres, and culminate in several stress related disorders in children.[4] Parents lack the awareness and teachers might not be trained to identify and assist students suffering from these inconveniences. Currently professional help and tedious techniques involving manual approaches are required to detect and correct the issue.

### B. Problem Description

Children with SLD, although generally of (above) average intelligence might fall short to meet a suitable degree of educational achievement as a consequence of learning difficulties, the obstacle to effective learning being an element of their developmental composition. They might face considerable difficulty in one academic area while coping, or even stand out in: other areas of academic or sports or arts. Epidemiological research reveals that 3-6% of school age children are most likely to suffer from a learning disability. In the Indian context, prevalence rates are estimated to range between 9-39%.

In India, poor exposure of many such children to education, understanding and language makes the diagnosis challenging. Due to the multilingual social environment, children are made to learn to study through means other than their mother tongue. This makes diagnosis and estimation of prevalence of a Learning Disorder such as Dyslexia very difficult. Factors such as age of admission in school, preschool exposure and literacy support present in individual homes in the school



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years can compound the issue.

The current education system is rather ill-suited for children with SLD as it overpoweringly emphasize on knowing over learning, theory over application. Since the child learns differently, this difference interferes with his/her capability to understand the curriculum or exhibit skills and knowledge; getting the child labeled as dull or weak. Parents might lack awareness and teachers might not be trained to identify the issue. Thus, non-recognition of the issue might lead to conduct issues, reluctance to go to school, frequent change of schools, over reliance on tuition centres, and culminate in several stress related disorders in children.

From the follow up assessments done by experts while vetting for SLD in Classes I to VII in schools of 10 Panchayats in Kerala , discovered that 16% of the school children have LD. Recent scientific discoveries regarding LD have thrilling implications for helping children, but how quickly are they being applied into suitable interventions for students with LD, mainly in the education system is a cause for concern.

The field of learning disabilities is scattered across a number of academic and professional disciplines, with each group focused on different aspects and few formal communication channels between them, leading to disagreements and difference in priorities. Much of the research and intervention in SLD is being done by private organizations and the NGOs, but the communication channels between these organizations and the state educational authorities are limited. There is also a split between personnel in the health and educational fields (government or private).

## II. Existing models

### A. Dyslexia Screening Test- Junior (DST-J)

Dyslexia Screening Test covers primary and secondary school-aged children in two separate evaluations: DST - Junior and DST Secondary. The DST-J[1] employs many subtests to offer an abstract of strengths and weaknesses which is useful to mold the suitable support approach. Due to recent theoretical developments in research concerning dyslexia , a possibility of identifying both slow learners and potential children with dyslexia at age of 5 or 6 years was suggested. This is helpful for assisting the children by reading aid. The DST-J is intended for early identification of children who are at risk of being dyslexic so that they can be given extra attention at school. The DST-J replaced the best selling DST by reflecting changes in theory and practice since its preliminary release by amending additional subtests, confirmation studies and case histories and scoring software. The DST-J consists of the following subtests:

1) Rapid Naming: Test to measure how swiftly children can name out loud objects, pictures, colors, or symbols (letters or digits).
2) Bead Threading: Measure of fine motor skills and in-volves threading small, brightly colored beads...
3) One Minute Reading:Number of words read correctly in one minute from a group of words.
4) Postural Stability: Checks the stability of the posture of the child.
5) Phonemic Segmentation:The words given are to be bro-ken down to individual sounds.
6) Two Minute Spelling: From a group of single words the child is asked to write down the maximum in two minutes.
7) Backwards Digit Span: Child is made to listen to strings of numbers in the reverse order and is asked to replicate the same.
8) Nonsense Passage Reading: Provides a passage with real and nonsense words only the nonsense words are scored after the child is made to make sense from the passage.
9) One Minute Writing:To write down a sentence or pas-sage in one minute.
10) Verbal Fluency:To generate words beginning with a stimulus letter.
11) Rhyme : To find words that rhyme.
12) Vocabulary : To detect substitute words.

### B. Test of Word Reading Efficiency-Second Edition(TOWRE-2)

The Test of Word Reading Efficiency-Second Edition (TOWRE-2)[3] is a evaluation of an individuals ability to pronounce printed words (Sight Word Efficiency) and phonemically regular non-words (Phonemic Decoding Efficiency) accurately and fluently. Because it can be conducted very quickly, the test provides an efficient means of monitoring the growth of two kinds of word reading skill that are vital in the development of overall reading ability.

The test contains two subtests with each having four alternate forms (A-D). The Sight Word Efficiency (SWE) subtest measures the number of real words printed in vertical lists that an individual can correctly comprehend within 45 seconds. Likewise, the Phonemic Decoding Efficiency (PDE) subtest measures the number of pronounceable non-words presented in vertical lists that an individual can correctly decode within 45 seconds. The four forms of each subtest are of equivalent intricacy, and depending on the intentions of the evaluation any form of the subtest can be selected. If only one form of each test is used, the test can be administered in roughly 5 minutes, including time for instructions and practice items. The TOWRE-2 was implemented on over 1,700 individuals ranging in age from 6 to 24 years and residing in 12 states and Washington, DC. Over 700 children in the testing sample attended primary school (to age 10), where the TOWRE-2 is expected to have its widest use[3]. The average alternate forms reliability coefficients (content sampling) for the subtests exceed .90. The average test/retest (time sampling) coefficients for the same form exceed .90. The average test/retest (time sampling) coefficients for different forms of the subtests are .87. The magnitude of the coefficients accounted from all the reliability studies showed little measurement error in the TOWRE-2. The numerous reliability and validity studies presented in the manual provide the examiner with strong evidence concerning

the strengths and limitations of the scores provided by the test.

The current edition of the TOWRE has been extensively used for three different purposes:

1) Early identification. The TOWRE-2 can be used in identifying children who needs more intensive or precise instruction in word reading skills in the early years ,to make sufficient growth in learning to read.
2) Diagnosis of reading disabilities: The test is also being widely used as part of a string of tests for diagnosis of specific reading disabilities in older children and adults. The TOWRE-2 can be used either as a substitute for or as an add-on to standard diagnostic tests of context-free word reading ability currently in use.
3) Research: Since its publication in 1999, the TOWRE has been extensively used in research as a swift and trustworthy assessment of word-level reading skills in both large and small research populations.

Regular evaluation of critical reading skills is also a fundamental aspect of the popular Response to Intervention model of service delivery. Although the TOWRE-2 has not been developed to provide weekly or monthly estimations, it certainly can be used to monitor progress in growth of word-level reading skills three or four times per year.

## III. Design and Implementation

The basic idea of the projected model is to detect the SLD at an early stage and to increase the accuracy of the learning disability estimation and reduce the time consumed for it. We employ different statistical machine learning techniques to achieve these goals. The benefits of these techniques consists of: utilization of less manpower and time, the accuracy and efficiency underlying handling of missing values and redundant data. We employ data sets containing 16 attributes that reveal the signs and symptoms of SLD for the evaluation.[2] The

| Sl. No. | Attribute | Signs & Symptoms of LD |
|---|---|---|
| 1 | DR | Difficulty with Reading |
| 2 | DS | Difficulty with Spelling |
| 3 | DH | Difficulty with Handwriting |
| 4 | DWE | Difficulty with Written Expression |
| 5 | DBA | Difficulty with Basic Arithmetic skills |
| 6 | DHA | Difficulty with Higher Arithmetic skills |
| 7 | DA | Difficulty with Attention |
| 8 | ED | Easily Distracted |
| 9 | DM | Difficulty with Memory |
| 10 | LM | Lack of Motivation |
| 11 | DSS | Difficulty with Study Skills |
| 12 | DNS | Does Not like School |
| 13 | DLL | Difficulty in Learning a Language |
| 14 | DLS | Difficulty in Learning a Subject |
| 15 | STL | Slow To Learn |
| 16 | RG | Repeated a Grade |

Fig. 1. The Parameters for assessing LD[2]

data needs to be preprocessed to make it suitable for mining. The redundant data is removed, the number of attributes is diminished and the missing values are assigned during the data preprocessing.

Obtaining data set was the first major milestone we faced towards successful implementation. Interviews and sessions with experts on the field who are ready to share infor-mation about the subject were necessary. With our limited contacts and resources, we made a headway into the prototype implementation by successful discussions with the Centre for Disability Studies (CDS), Poojapura, Trivandrum on the current methodologies in use, such as the DST-J (Dyslexia Screening Test for Juniors) out of which we expect to create an interface consisting of questions for the parents and activities for the children that ultimately contributed as the input to the classification model and result in successful prediction. We have taken into consideration the ethical responsibilities associated with such an initiative as it involves sensitive information about the child and their parent along with an assessment of the child. The initiative must take into account the anonymity that we hope to deliver along with the accuracy of the prediction as it will be in the main interest of the end user.

### A. Working

The tool is divided into two modules:

Parent

Child

The parent module consists of questions that are to be answered by the parent/teacher. The answers to the questions are mapped onto the 16 attributes according to the question asked and the result is stored.A total of twenty questions are presented to the parent. In Fig.2, a question that can be

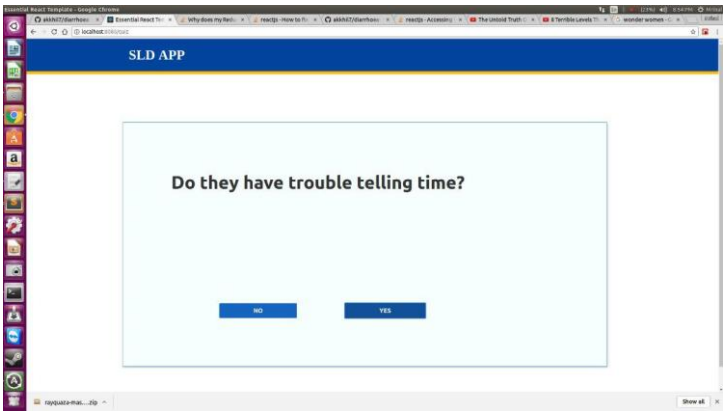


Fig. 2. An example of a question asked to the parent

only answered by the parent/teacher is shown. This answer to this question is mapped to the attribute DA with a mark of 25.

The child who is taking the test is presented with activities rather than questions,this guarantees to keep the interest of the child throughout the procedure.Seven activities are used

here the result of each activity is mapped on to respective attribute they are focusing on. A memory game is presented


Fig. 3. Memory based activity for the child

to the child among the activities; an example is shown in Fig.3 where 10 words are shown for a duration of one minute and disappear after it.The child is then supposed to recite the word from their memory to the parents. The parents then

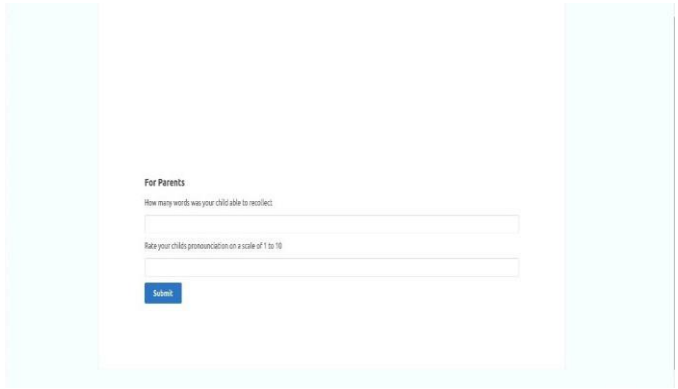


Fig. 4. Feedback to be given by the parent

must enter the feedback/how their child has fared in the activity as shown in Fig.4. Since the test is to be taken for children of age 8-12, we set the minimum number of words to be recited as four. If the child is not able to memorize more than four words the corresponding attributes DA,DM and DR and the value 20 is added to it.

After linking all the Attributes ,according to the workflow diagram we proceed to the machine learning model.

The Algorithm used here is decision trees. Decision Trees [2] (DTs) is a robust and popular tool for classification and prediction. It is a classifier in the form of a tree structure where every node is either a leaf node or a decision node with one branch and sub tree for each possible outcome of the test. The leaf node is used to suggest the value of target attribute of examples and decision nodes for specifying the tests to be carried out on a single attribute. Since classifiers do not require any domain knowledge or parameter setting, they are the suitable for probing knowledge discovery. High dimensional data can be managed by decision trees. The learning and classification steps are simple and fast. Thus it is a flow chart like structure, where the internal nodes denote a test on an

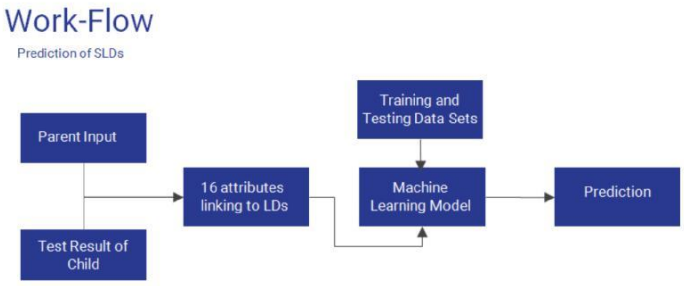


Fig. 5. Workflow for Predicting SLD

attribute, branches of the tree represent an outcome of the test and leaf nodes hold class labels. The root node is the topmost node. Thus this algorithm can be used to classify an instance by starting at the root of the tree and traversing through it until a leaf node is encountered, which provides the classification of the instance.

The final result will be the prediction along with the values of all 16 attributes.

## IV. Conclusion and Future Expansion

The basic version of the developed tool is aimed at creating awareness for the parents and teachers who might be burdening their ward with unnecessary strain by trying to reintroduce the children to an education system that has already failed them.The age gap for the tool is 8-12 years. This version will feature the tool that is developed to assess and obtain a rough prediction of whether the child is at risk of suffering from a learning disability or not by providing them a child friendly user interface with multiple functionalities. This tool will be free of cost for the parents/teachers.Frequently Asked Questions and Instructions for parents will be provided for administering the test.

For Future expansion , the tool can feature precise analytics and predictions for professionals. The test and activities for the child to require in-depth research and careful construction. The machine learning models to be backed by different classification schemes and improved accuracy of prediction of the tool. The tool will be a perfect intelligent assistant for a child consultant/psychiatrist who can diagnose accurately with thousands of data backing their expert opinions. It will ensure that the child is not falsely diagnosed while not denying proper assistance for those suffering. An advanced version of the tool can be made purchasable by the child consultants/physicians/psychiatrists.Furthermore, the tool could be expanded for children of all age groups i.e, to provide tests designed depending on the age of the child, involving information from parents/teachers for assessment.

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