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RESEARCH ARTICLE

Framework for an Interactive Tool to Screen Specific Learning Disability in Primary School Children using Machine Learning

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ABSTRACT

Specific Learning disabilities is a medical disorder that includes difficulties in reading, spellings, following instructions, understanding, comprehending, writing. 10% of Primary school children have difficulties in learning varying from negligible to significant. Students with SLD suffer Less self-esteem. Diagnosing their difficulties and assisting them has become a tedious job. This article outlines web based framework to diagnose SLD using machine learning .To easy the process and make the diagnosis automated a web based frame work is proposed. "My lab" app designed to check their learning ability .This Web app is designed based on GLAD "Grade level assessment Device" which is an assessment tool to acess the students learning difficulties. "My Lab" is used to determine the learning difficulties in language processing-Dyslexia, arithmetic -dyscalculia and dysgraphia writing difficulties. The app collects the data as voice clipping, images, quiz score and based on glad scoring data set are generated and using CNN and ML algorithms like SVM,KNN and classifies students as negligible , mild or significant SLD.

Keywords: Specific Learning disability, Glad, Dyslexia, dyscalculia, dysgraphia , CNN, KNN, SVM .

INTRODUCTION

In recent years, specific learning disabilities have been considered to represent a diverse set of diseases that influence the learning and capabilities of a person [1]. Early SLD detection and intervention were identified as essential in the reduction and improvement of the cumulative detrimental effects [2]. Here is an overview of SLD with its key characteristics [3].

- It shows substantial problems in gaining and utilising abilities in reading, understanding, writing, mathematics or mathematical thinking [3].
- It is basically observed as a neurodevelopmental issue [1].
- It is a lifelong state with specific impairments which manifest in a person's lifetime different manifestations.
- It is not caused by inadequate education, cultural, linguistic differences, or poor motivation, but these factors might influence the severity and effects of learning disability.
- It cannot be considered as Low intellectual capacity, sensory impairment, neurological or motor disorders, or severe emotional disruption.

The terms "disability" and disorder are being used interchangeably in Literature, in an educational context the term "disabled" is used often possible for eligibility to receive accommodation and special arrangements from various educational Boards. SLD is also referred to as a Specific Learning Disability [4].

Back Ground

The primary objective to determine whether a kid has an SLD is to give adequate, helpful and corrective programmes so that the child can operate in his or her environment efficiently. Approximately 5 to 15% of school-age children have learning disabilities. 80% of people with learning problems are believed to suffer from reading difficulty (commonly referred to as dyslexia). SLD is important for early identification since it impacts all fields of functioning, intellectual, emotional or social comportments [3].

SLD can be broadly classified as Dyslexia, Dysgraphia, and Dyscalculia

Dyslexia is an expression referring to reading difficulties. Dyslexia people have problems linking letters to sound they perceive on a age. Students with dyslexia find it difficult to read fluently and need more effort to read compared to their peers [3] Learning difficulties begin even before learning to read, when kids find it difficult to divide words into syllables and recognise words that rhyme. Kindergarten-age children may not be able to recognise and write letters as well as their peers. Kids with Dyslexia might also have trouble with spellings .

Dysgraphia

Neurological disorder effecting written expression that impairs writing ability and fine motor skills. Children find it difficult in all aspects of writing such as legibility , text size, spacing between letters and words ,expression. around 5 to 20 percent of all children have some type of writing deficit like dysgraphia.[3] [5]. Dyscalculia refers to a wide range of challenges In mathematics' including deficits in understanding the meaning of numbers and trouble using mathematical principles to solve problems. Children with dysgraphia face problems like Understanding the size and connection of numbers,Counting methods , lack of proficiency in recognising numbers. finds it impossible to mentally add single digit numbers, working memory capacity limitations etc. [6]
SLD can be scaled based on the severity.

Mild: Certain learning challenges in one or two academic areas but may be compensated.

Significant: Certain learning challenges in one or two academic areas but may be compensated.

Severe: Severe learning problems affecting multiple academic areas and needing continuous specialised education [3].

Literature review

There are studies in this field, to integrate technology in diagnosing and assisting children with SLD Table no.1. Current study focusses on developing a ML model using web app "My learnab"- My learning ability web based application to collect data based on Glad "Grade level assessment Device". Early diagnosis of SLD can help children to cope better, so this model is primarily aimed for students of age group 6 to 10 years (1st standard to 4th Standard).

System Architecture

The architecture of a system is a conceptual description of the design, content, structure, and behaviour. The current frame work architecture consist of three levels in the development this prognosis tool, [15] the overall architectures is given below fig 1.This mainly consists of three levels in the first level a web app interactive app is developed based on GLAD assessment tool. In the second level acquired data from the app is pre-processed and in final stage ML model is applied for classification of students abilities as negligible mild and significant, and the results are evaluated [16]. Level 1: This phase is the user interface, where the app navigation screen first checks the authentication of the user for new users first need to register and a help guide is provided along with a disclaimer. If user a registered user then it checks for admin login or parent/teacher (who wants to take the assessment of the child).For assessment first step is to enter all the necessary data of the child. Then user can choose the assessment module Dyslexia , dyscalculia or dysgraphia,. Based on the age and class the child is studying respective quizzes are displayed. The user interface activity is depicted in the fig 2. Admin module of the app provides facility for the admin to update worksheets.

Dyslexia

This module has various testing activities as shown below for comprehension, identifying objects etc.And spellings are tested by dictating the age specific words [17]. Text is displayed on the screen child has to read it and then it is accessed [18] [19]. fig.4. Dycalculia is a math quiz module, where various arithmatic parameters are tested few samples are given below [20]. It inclueds identifying numbers, matching numbers with quantities, comparing quantities , based on their age, concepts on addition, subtraction, multiplication are also tested.

Dyagraphia

Students are given words or few lines of test based on their age and class , they have to write and scan the text [2] Then image is scanned and based on the parameters such as writing size, alignment, skewness in writing, insufficient space in between words, broken links between letters, inconsistent height between letters with and without an extension, ambiguous letters, unstable track [21] [22] . Values for the above features are extracted as per BHK Method (Beknopte Beoordelings methode voor Kinderhand). And tabulated for processing and analysis as given in table II.

Level 2 :Identifying and handling the missing values the app is designed in such a way that the child will be able to proceed only after completing each and every question, this allows to reduce missing values. Based on the Score sheet of Glad the categorical values are evaluated based on point scale. Based on the scoring specification of GLAD feature extraction is done. Dividing the dataset is the next stage in machine learning data pre-processing. Each Machine Learning model dataset must be divided into two independent sets - a Training data and test data [23].

Level 3: Final stage is the predicting stage where NLP is used to evaluate audio responses as per the GLAD grading. Similarly the images are converted to text using OCR [24]. then and CNN with appropriate ML algorithms such as KNN, SVM [25] are applied for classifying children as negligible or mild or significant learning difficulties in the specific areas as dyslexia, dysgraphia and dyscalculia [22].

CONCLUSIONS AND FUTURE WORK

This work aims to provide a framework that helps in Screening SLD in preprimary school children through a Web app "My Lab". This framework integrating web application for test assessment which uses machine learning algorithms for assessing the severity of learning difficulty in English, Math and Handwriting difficulties can be extended for diagnosis. The app is designed in a colorful and interactive manner to make it more interesting for kids. It also has multimodal mechanisms to support student interaction. Admin login option gives scope of adding more assessment modules for diagnosis and assessment. This app can be enhanced for vernacular Indian languages in futur

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Table.1: Comparative study on various SLD Apps

Title / Application Name	Comparison of various apps for supporting SLD		
	Main findings	Methodology	Limitations
DYS-I-CAN [7]	a smartphone application that supports dyslexic people with real world reading and writing problems.This example will display and read text like alphabets and numbers. Furthermore, a machine learning method is required to improve the educational efficacy of a dyslexic youngster.	Neural Machine Translation algorithm	This application mainly helps in Learning ,does not diagnose the learning difficulties of the child . Scope: English ,math , Communication
Kalcal :[8]	This is an Iranian mobile app that works with Persian-language devices. The Wechsler Test and the most recent updates to Persian mathematics textbooks for students in grades 7 through 12 were taken into consideration when designing and implementing the research approach for mobile applications.	Wechsler test	Difficulties in math in persian language. Scope: Dyscalculia
Pudubu : [9]	To distinguish between dyslexic and non-dyslexicYoung children, a various tests of	Machine learning, CNN,SVM	Pudubu is mainly developed inview of Sinhalelanguage . Scope:

	pronunciation is used in dyslexia screening. A single Sinhala letter is shown as the initial stage, and the difficulty level is steadily increased up to two-letter words. Children with letter dysgraphia are screened and given two Sinhala letters to write with a comparable amount of tries. CNN built the model to determine whether or not the written letters of children were right using 5000 photos of non-dysgraphic youngsters between the ages of six and seven. Dot Counting and Number Comparison are two tests used for dyscalculia assessment.		Dyslexia,Dyscalculia,Letter dysgraphia
ALEXZA :[10]	The present system is interactive and user-centric since it takes into account the user's preferred methods of learning. This system's layered architecture, which includes layers for the learning management system, application server, presentation, adaption, and database, enables many functionality. .	Optical Character Recognition, Text-to-Speech with Voice Controls and Navigations, Machine Learning, Smart AI Assist.	Alexza is mainly helps in reading Scope: Reading difficulties
Mobile App to Support People with Dyslexia and Dysgraphia.[11]	This research was done to find out the students diagnosed with dysgraphia by using an expert system which uses Forward Chaining. This system recognises the speech pronunciation and compare with a ML model using voice data sets.	Speech recognition, Image processing ML	Scope: Dyslexia and dysgraphia

Adaptive e-Learning System.[12]	A multi-layered architecture includes the display layer, adaptation layer, learning system management layer, application server layer and database layer. The adaptation layer gives a more intelligent and adaptive system functioning - the major aim of this study.	Multi-Layer Architecture involving presentation , adaptation, LMS,Application server layer and DB	More generic system
Multiplatform Games for Dyslexia Identification in Preschoolers[13]	A series of online games were designed to develop multiplayer versions for mobile platforms and the Web in one effort. They are also intended for their target users to be both suitably demanding and entertaining and effective for assisiting reading and language processing skills	RIA(Rich internet application)LAMP HTML 5	This mainly focuses on Dyslexia and games to help English learning.
Dyslexia Baca [14]	This mobile app is developed for young children to identify and distingush letters. Dyslexia Baca' is a multi-sensor based Malay-speech learning ecosystem. In terms of substance and attitude, Baca is nicely designed. Multimedia goods and general stuff such as fascinating and easy to use. attractive	ADDIE ,text graphics , animation and videos	It mainly focus on identifying similar alphabets and memorizing them. This app is for children of age group 6-8years
Framework for Intervention and Assistance in University Students with Dyslexia[15]	It provides a learning management system for university students with learning difficulties, it includes cognitive assessment give provides a platform for assisting	Multilevel architecture 1)Tools for assessment and intervention 2)get Reading Profiles and personal details 3)get an adaptive engine that selects and provides	It is aimed for university students with reading and cognitive isuues

	tasks in specific cognitive deflicts.	analysis and recommendations for learning 4)developing an interactive model	

Table. 2: Features for handwriting analysis

S. No	Feature	Parameter
1.	Alignment.	P1
2.	Skewed writing.	P2
3.	Insufficient spacing between the words	P3
4.	i dots and t bars	P4
5.	Irregular size of the letters.	P5
6.	Reverse alphabets/ atypical letters	P6
7.	Ambiguous letters.	P7
8.	Striking of words / traced letters.	P8
9.	Unstable track	P9
10.		P10

Fig.1: Overall system architecture

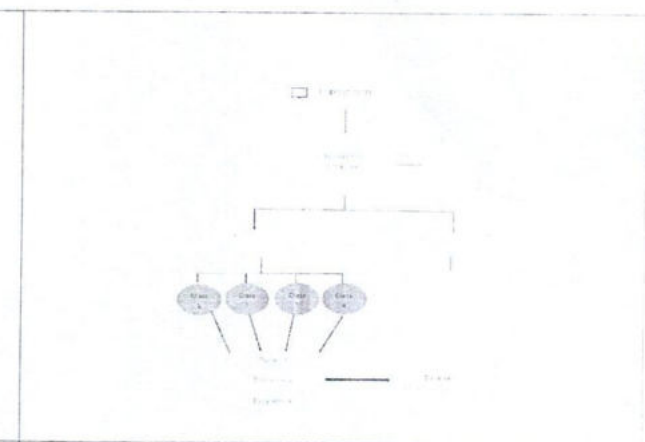

Fig.2: Unser interface activity diagram

Fig.3: Sample Worksheets for dyslexia

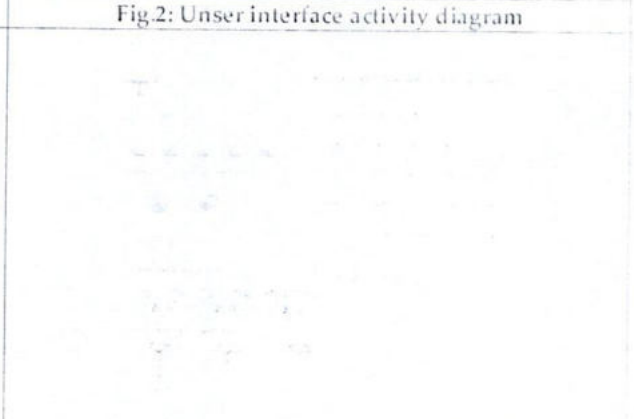

Fig.4: Sample Dyscalculia worksheets

Fig. 5: Writing Samples

Fig. 6: level 2 Process diagram

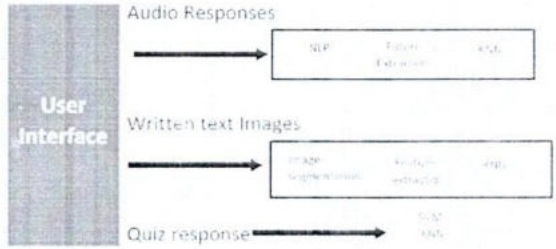

Fig. 7: Level 3 architecture.