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APPLICATION OF MACHINE LEARNING TECHNIQUES FOR IMPROVING LEARNING DISABILITIES

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ABSTRACT

Learning disorders such as dysgraphia, dyslexia, dyspraxia, and others obstruct academic progress while also having long-term implications that extend beyond academic time. It is well acknowledged that this type of disability affects between 5% and 10% of the overall population. Children must complete a battery of tests in order to be assessed for such disabilities in early life. These assessments are scored by human professionals, who determine if the youngsters require special education strategies depending on their results. The evaluation can be time-consuming, costly, and emotionally draining. Dyslexia is a learning disability marked by a lack of reading and/or writing skills, as well as difficulties with fast word identifying and spelling. Dyslexics have a hard time reading and understanding words and letters. Different methodologies are used in research to distinguish dyslexics from non-dyslexics, such as machine learning, image processing, studying cerebrum behaviour through brain science, and pondering the variations in life systems of mind. E-learning technologies have been increasingly important in higher education in recent years, particularly in improving learning experiences for those with learning disabilities. However, many professionals involved in the creation and deployment of e-learning tools fail to consider the needs of dyslexic pupils. In this research, a comprehensive literature review is conducted on machine learning algorithms for dyslexia prediction and e-learning for learning and cognitive disorders.

Key words: Learning Disabilities, Student Performance, Dyslexia, Machine Learning, Deep Learning, E-Learning

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1. INTRODUCTION

In recent years, there has been a growing focus on the role that technology may play in improving teaching and learning experiences. The web, in particular, has become a common instructional technology in the homeroom setting [1]. E-learning has become a crucial apparatus for improving students' knowledge, understanding, and abilities. Although current technologies have improved teachers' abilities to deliver educational programmes, students with disabilities are frequently overlooked in the development and arrangement of these apparatuses, and, as a result, they do not benefit from the same learning experiences as those without disabilities. This is especially true for students who suffer from dyslexia. According to Beacham and Alty1,1 the majority of e-learning materials were created with non-dyslexic learners' needs and abilities at the top of the priority list. They guarantee that as a result, they will be "powerless to provide accessibility and convenience for all learners [2]." They claim that, in their current form, e-learning materials act as a hindrance rather than a guide to dyslexic students' learning because the resources don't take into account the students' unique learning styles and, as a result, present students with dyslexia with additional challenges and disadvantages.

2. BACKGROUND STUDY OF LEARNING DISABILITY

"Learning Disabilities" (or learning disorders) [3] is an umbrella word that encompasses a number of different problems, such as dyslexia, dyspraxia, dysgraphia, and so on. The American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders [4] (often known as DSM-5) provides a comprehensive overview. Learning disorders are thought to be characterised by subtle and regionally distributed variations in mind-body systems, according to several research. Overall, they should not be confused with learning difficulties that may be caused by visual, hearing, or motor impairments, as well as social challenges.

Over the last two decades, researchers have been working hard to understand the neural underpinnings of learning disabilities. Despite significant progress in a variety of study domains, the causes of learning difficulties remain unknown. These learning impairments can also be explored from a variety of additional perspectives, like as

- Their frequency is determined by the family and the order.
- Alternative operational definitions of "learning impairments" and their impact.

Nonetheless, we might agree with some who believe that, despite the fact that the exact nature of dyslexia is unknown, it is possible to identify dyslexia with great reliability. We believe that this is also true for other learning problems. Despite a lack of understanding of the origins, the side effects are often well-defined and characterised in the DSM–5 as Developmental Coordination Disorders. To cut to the chase:

- Dyslexia is a type of learning disability that affects a person's ability to read.
- Motor dysgraphia is a learning disability that affects a person's ability to write.

Motor dysgraphia could also be a sign of a developmental coordination disorder (DCD), such as dyspraxia [5]. These problems persist as people become older, but they can be managed with the right education. It's not a simple Yes or No situation, and the symptoms might range from mild to severe. It is widely acknowledged that roughly 10% of the population has (to some extent) a learning impairment. For example, Duke University or the DSM-5 can be consulted. It's common knowledge that any combination of the diseases listed in the DSM-5 can lead to academic failure. Nonetheless, given the right educational technique, a child with learning disabilities can learn the same skills as a typical youngster. These youngsters frequently receive government assistance in a variety of forms (specific teaching lessons, extra educational cost, extra time for exams, specific staff helping during the homeroom, etc.). To qualify for such assistance, you must submit a certificate from an acknowledged professional who is responsible

for evaluating the child. It's possible that the evaluation will be lengthy, expensive, and emotionally draining. Furthermore, due to the restricted number of accredited pathologists, this process may take a long period. Many people, especially those who are most targeted, are unable to complete an examination because of this scenario. This searches for evaluations (or pre-assessments) of critical importance that are rapid, effective, and widely available. In most cases, our methodology provides a viable solution to this problem.

3. BACKGROUND STUDY OF MACHINE LEARNING

Machine Learning is a technique for ingesting and recognising new patterns of information from large amounts of data. It enables researchers and information professionals to recognise the strategies and plans that will be devised with ease. To create strategies for clustering, regression, and classification based on useful data concealed in massive data sources. Directed and unsupervised learning are the two types of machine learning computations. Supervised learning is a machine learning action that uses examples to infer a capacity from data whose class labels are already known. Unsupervised learning [6] is a job that infers a capacity from data with unknown class labels. Machine learning is a growing trend in healthcare that aids medical professionals in better investigating, anticipating, and treating patients. There are a variety of machine learning models available, each of which does prediction in a unique way. One of the most difficult and time-consuming tasks is choosing a suitable machine learning computation.

Machine learning [34] is a type of computerised reasoning that learns and recognises new patterns from massive amounts of data. It enables data scientists and analysts to successfully identify potential possibilities and build strategies/techniques to improve customer satisfaction by exploiting important data hidden in massive data sets. Machine learning is a new trend in health care that aids medical professionals in better analysing, preventing, and treating patients. There are numerous machine learning models available, each of which formulates prediction in a unique way. Because there are so many to pick from, selecting the right machine learning calculation is crucial. There are two types of machine learning calculations: supervised and unsupervised learning. Supervised learning will rely on information that has already been trained and whose class category is known. By learning the similarities in the given information, unsupervised learning categorises the given information whose class category is unknown. Support vector machines (SVM), Neural Networks, Decision Trees, Bayesian Classifiers, k-means clustering, and Logistic Regression are the most often used machine learning algorithms. A support vector machine is a type of classifier that uses a kernel for pattern analysis, sorting raw data, grouping, and classification. It generates a model that can assign a new dataset to a specific class based on a series of preparation examples. It is a nonparametric supervised learning method for information with a variety of characteristics [7]. Neural networks mimic the mind's ability to comprehend information and generate various predictions based on that knowledge. Counterfeit Neural Networks are made up of three layers, such as input, hidden, and yield. The crude features are in the info layer, the deeply linked neurons are in the hidden layer, and the prediction is in the yield layer [8]. The neurons are fine-tuned until a precise prediction is obtained. It identifies its applications in speech and object identification, natural language processing, and image segmentation. Decision trees are a sort of supervised learning that employs directed charts to represent decision-making using a predictive modelling strategy. The goal of this methodology is to learn a decision tree from provided data. Random Forest is a collection of thousands of decision trees that has been utilised in a variety of applications. K-means clustering is an unsupervised learning method for identifying distinct groups of data based on their similarities [35]. It works with data for which the class labels are unknown. The number K in the name alludes to the number of distinct gatherings that have been created. It is discovered that it is used in a variety of business applications. Measurements are used in logistic

regression [36]. When there is a probability of only two yields and they are extremely reliant on explanatory variables, this machine learning calculation is straightforward and performs best. Given a collection of observable factors, it calculates the most likely outcome.

4. LITERATURE REVIEW

Malav, Anuraj, and Neelu J. Ahuja [9] assessed a variety of machine learning interventions in various types of teaching learning systems, given as a descriptive study, and made recommendations based on the findings. Further, the possibility of these systems being relevant for supporting the learning of individuals with disabilities has been explored and evidentially advocated machine learning calculations hold tremendous potential in terms of enriching the systems, encouraging the learning of people with special needs by providing versatility and adoptive learning experiences learning effectiveness, and this idea has been further extended to a recommendation for people with an incapacity, essentially with the deemed design alternatives.

Khan *et al.*, [10] presented a diagnosis and classification system based on machine learning. The diagnostic module of the system is a pre-screening tool that may be used by specialists, trained users, and parents to detect dyslexia's negative effects. The second module is classification, which divides the children into two groups: non-dyslexics and dyslexics with doubts. A third module is a tool for researchers to analyse data.

El Hammoumi, Oussama, *et al* [11] This research focuses on external appearance identification using convolutional neural networks and its use in e-learning systems by introducing a new approach that includes three main steps: preprocessing, feature extraction, and classification.

Chitra, K., and R. Umamaheswari [12] On a learner-centric perspective, developed a semantically enhanced module-based e-learning for computer science programme. Users are given a customised learning environment by categorising learners based on their proficiency. Despite all, learning problems based on e-learning necessitate a lot of investigation. As a result, this paper also developed a personalised evaluation theoretical model for learning the alphabet with learning objects for dyslexic youngsters.

Rajapakse, Sampath, *et al* [13] reported the findings of a prototype mobile application that assists dyslexic users in successfully dealing with their reading issues in real life while obtaining suitable treatment. This prototype can recognise the texts in their environment and read them loudly so that the user can understand them. They will also be able to modify the chunking, looking over, and featuring of words based on their skill levels. The user will be able to comprehend difficult and complex words more readily by combining word reference support with the phonic and morphological structure of the word [37]. In addition, the study looked into the use of a machine learning approach to improve the effectiveness of learning dyslexic complex words.

Hamid, Siti Suhaila Abdul, *et al* [14] Focused on providing assistance to students with dyslexia in dealing with their difficulties by adaptively sensing their behaviour from an engagement standpoint. As a result, we use a machine learning strategy to predict student engagement with learning content using Bag of Features (BOF) image categorization. The frontal face of the 30 students was used to make the engagement forecast. In this BOF model, the authors used the Speeded-Up Robust Feature (SURF) key point descriptor and clustered the codebook using the k-Means approach. The developers then used three different types of classifiers to find the best classification result: Support Vector Machine (SVM), Nave Bayes, and K-Nearest Neighbor (k-NN).

Rello, Luz, *et al* [15] aimed to change this by detecting dyslexia early using machine learning models that predict dyslexia by analysing how people engage with an etymological

computer game the game's pieces were created using (I) an empirical etymological analysis of the errors that persons with dyslexia make, and (ii) specific dyslexia-related cognitive functions in mind: Language Skills, Working Memory, Executive Functions, and Perceptual Processes.

Chu, Hui-Chuan, *et al* [16] developed an emotion recognition method based on outer appearance with change detection. An emotion elicitation experiment was carried out to collect facial-based landmark signals in order to create emotion detection classifiers. To build classifiers to distinguish emotions, the suggested method used the sliding window technique and the support vector machine (SVM). Information Gain (IG) and Chi-square feature assessments were utilised to find hearty features for emotion identification. The efficiency of classifiers with various sliding window parameters was also investigated.

Cinquin *et al*., [17] A four-step procedure was used to conduct the systematic literature review, which included a thorough search of scientific literature databases, study selection using exclusion and consideration criteria, and literature analysis and synthesis.

Cinquin *et al*., [18] Using various machine learning approaches, image processing techniques, design assessment, and assistive equipment to support dyslexia, the research network has worked on distinguishing dyslexic from non-dyslexic people. This survey study examines several aspects of dyslexia research.

Elhammoumi, Oussama, *et al* [19] The purpose of this research is to provide a method for detecting children's learning styles that is based on their interaction with the system. An Artificial Neural Network is employed in this study to predict the learning style of children with LDs.

Atkar, Geeta Bhimrao, and J. Priyadarshini [20] The method is then coded, and the device acts as a personal trainer for dyslexic youngsters. Because the system may offer different graphics for the same phrase, the youngsters can learn more interactively and remember the words. This system is more accurate thanks to the use of machine learning techniques, and it will be taught for speech recognition and phonetics of each alphabet and word in Hindi.

Jothi Prabha, An., and R. Bhargavi [21] A prediction model that uses statistical approaches to distinguish dyslexics from non-dyslexics based on eye movement has been presented. An eye tracker is used to monitor the movements of the eyes. Obsessions, saccades, transients, and mutilations are some of the characteristics of eye movement. Using Principal Component Analysis, enhanced level characteristics are derived from the raw eye tracker data. This work suggested a Hybrid Kernel SVM-PSO based on Particle Swarm Optimization (PSO) for the prediction of dyslexia in people.

Chakraborty, Ms Vani [22] surveyed the papers in order to gain a better understanding of the work done on learning impairments and machine learning. A learning disability is not a treatable ailment. In any event, with the proper diagnosis and assistance, such youngsters can benefit from outside assistance in identifying their potential and making a suitable future career decision. Machine learning is now utilised to predict future events in a wide range of fields. Predicting learning disabilities in children, detecting the true inability and how early it may be recognised, is one of the most useful areas of machine learning application.

Dcruz et al. [23] Personalized learning is intended to assist students with disabilities. The system is divided into four sections: (I) Predicting the user's learning level. (ii) Using web mining to create multimodal learning resources. (iii) The result is linked to the user's preferences. (iv) User-specific content, demarcated by an intelligent interface.

Hamid, Siti Suhaila Abdul, *et al*. [24] advocated using frontal face detection as an alternative way for predicting student attention. The authors used a machine learning approach that used the Speed-Up Robust Features (SURF) descriptor to recognise the images' major

interest purpose and cluster them using different codebook sizes. We employed a Support Vector Machine (SVM) with two distinct kernels and Nave Bayes for the classification model.

Rezvani, *et al*., [25] targeted at creating a neurobiologically based classifier that can effectively distinguish between two groups of children, one with dyslexia and the other without. The authors employed the phase lag index to create weighted connection matrices for several frequency bands using EEG resting-state data from 29 dyslexics and 15 regular readers in grade 3. (PLI). We created weighted connectedness charts using the connectivity matrices. A Support Vector Machine (SVM) and a typical K Nearest Neighbors (KNN) classifier were used to compute several nearby network measures, and 37 False Discovery Rate (FDR) corrected features were chosen as contributions to a Support Vector Machine (SVM) and a typical K Nearest Neighbors (KNN) classifier.

Kaisar, Shahriar [26] This examines recent commitments to identifying dyslexia using machine learning approaches and identifies future research options. Researchers have proposed a variety of ways to detect developmental dyslexia, including game-based procedures, reading and composing assessments, facial image capture and analysis, eye tracking, Magnetic reasoning imaging (MRI), and EEG examinations.

Chakraborty *et al*., [27] The earlier dyslexia is detected and supported in education and preparation, the more its harmful impacts can be mitigated, according to research. As a result, creating a powerful and precise screening approach to detect dyslexia at an early age would be critical.

Knoop-van Campen *et al*., [28] The study of both the learning process and the learning results in students with and without dyslexia can shed light on this topic and assist determine if the redundancy effect, as described in the Cognitive Theory of Multimedia Learning, has any imperatives. To summarise, the addition of sound appears to impair the nature of knowledge and results in less effective learning across the two groups.

Trivedi, Mr Viraj, *et al* [29] Discussed what learning incapacity is and some of its varieties, as well as the technique for determining the severity of learning incapacity, extracting patterns, and evaluating them in order to overcome the problems they confront in life.

Low, Spencer [30] Models that predict RD discovery in a large population of children were developed using resting state functional MRI (rsfMRI) data combined with multivariate pattern analysis (MVPA). BOLD (blood oxygen level dependent) signals are used in rsfMRI to offer information on functional enactment and connectivity between neighbouring and nonlocal mental regions. Patterns of temporal connection that differentiate between RD and non-RD children were found and the precision of the model was assessed using MVPA, specifically support vector machines (SVMs) and random forest classifiers.

Usman, Opeyemi Lateef, and Ravie Chandren Muniyandi [31] developed an approach for securely classifying dyslexia biomarkers based on a deep learning model and the residue number system (RNS). Before classification with a cascaded deep convolutional neural network, a special modulus set of RNS was used to develop a pixel-bitstream encoder that encrypts the 7-piece twofold value of each pixel present in the preparation and testing mind magnetic resonance imaging (MRI) dataset (neuroimaging dataset) (CNN).

Fellman, Daniel, *et al* [32] The purpose of this study was to see how unique characteristics in online activities influenced visuospatial and verbal WM performance. Working memory (WM), defined as the ability to keep up with and alter approaching information before it decays, is an important feature of all types of learning that is understudied in e-learning.

Martinez-Murcia, Francisco J., *et al* [33] The goal of this study is to see if these disparities exist, and if so, how they relate to children's performance on various linguistic and cognitive tasks commonly used to diagnose dyslexia. A denoising autoencoder (DAE) was trained to

learn a low-dimensional representation of the connectivity matrices, and temporal and spectral inter-channel EEG connectivity were computed for this purpose.

5. RESEARCH FUTURE DIRECTION

Because the signs and symptoms of learning difficulties fluctuate depending on the language used, language-based classification must be taken into account. Several soft figure approaches now in use have lower precision levels that can be improved [38]. In many cases, not all parts of the brain are examined when using image databases of the cerebrum for dyslexia prediction. They only looked at one part of the brain to predict dyslexia, which is ineffective because dyslexia can develop in multiple parts of the brain. Dyslexics might benefit from a variety of assistive gadgets that can help them improve their reading and writing abilities. Dyslexia is also a difficult condition to predict early and accurately. The utilisation of machine learning approaches, image processing, and assistive equipment for the prediction/assistance of dyslexia has been described in this paper [39 & 40]. The majority of machine learning calculations used to predict dyslexia are focused on just a few dyslexia traits or side effects. Because the characteristics of dyslexia might change depending on the language, language-based classification is necessary for better prediction.

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