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Psychological Interventions for Children Having Dyscalculia and Dysgraphia

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ABSTRACT

In most schools, one may come across a distinct set of students who struggle with learning. These issues can be discovered in their acquisition of fundamental knowledge. Reading, writing, and arithmetic are examples of academic talents. The condition in which a learner struggles to acquire the fundamental abilities required for learning is known as a learning disability. This paper aims to identify interventions for these disabilities and help prevent them at an early age.

Keywords: *Dyscalculia, Learning Disabilities, Intervention, Early Intervention, Therapy, Dysgraphia.*

DYSCALCULIA

An arithmetic learning issue is called Dyscalculia. Children with dyscalculia are reported to struggle with math. Dyscalculia has gotten less attention than other learning disorders, including dyslexia, and is less well-known among the general public as a whole. However, in order to lessen the impact this learning deficit may have on a kid, early intervention and therapy are crucial.

Many of the children with learning disabilities may be found to exhibit serious learning difficulties in mathematics primarily related to mathematical calculations and mathematical reasoning. The difficulties that children face in the learning process have begun to attract serious attention. It has become a real educational handicap and a widespread issue in today's society.

Dyscalculia is the most commonly used word to describe the learning challenges and difficulties in mathematics that children with learning disabilities encounter. It is a learning problem that makes it difficult to gain the necessary arithmetic abilities to execute mathematical tasks.

SYMPTOMS

Several studies have been conducted in an attempt to uncover predictors of prospective mathematical impairment. Among the most important predictions:

Let's look at some of the arithmetic challenges that a youngster with dyscalculia may confront: -

- i. Dyscalculia is characterized by difficulties with fundamental arithmetic abilities in children. Even if this talent looks to be simple and "a piece of cake." A youngster with dyscalculia, for example, may have difficulty to answer addition, subtraction, multiplication, and dividing issues.
- ii. Children may also struggle to tell time and operate an analogue or digital watch.
- iii. Having difficulty comprehending and calculating money concepts
- iv. Difficulties coping with and understanding the logical stages necessary to solve a math problem. For example, if the arithmetic problem needs several steps of thinking and solving, the youngster will struggle to complete it.
- v. Having trouble comparing numbers to amounts, such as 4 persons.
- vi. Having trouble comparing sums, such as determining if two numbers are greater or smaller.
- vii. In addition, I'm having trouble utilizing the signs larger, less than, and equal.
- viii. Difficulty counting backwards and forwards.
- ix. Difficulty with direction and determining whether to move from left to right or right to left.
- x. Patterns and order numbers are tough to remember. What happens, for example, if the patterns are: square, triangle, square...? A youngster with dyscalculia may have difficulty following the pattern.
- xi. They have difficulty counting with their fingers.
- xii. Difficulties comprehending concepts such as place value.

CAUSES

Experts are unsure why dyscalculia occurs in the majority of instances, particularly in youngsters. There is evidence that learning impairments, such as dyscalculia, run in families. More study, however, is required to corroborate this. Experts know that persons who have dyscalculia are more likely to have abnormalities in particular parts of their brain.

These variations appear to reflect less growth and fewer connections between brain cells in particular regions. The afflicted regions are those in your brain that you employ while performing anything involving numbers and mathematics. However, doctors are unsure why these disparities occur or how they affect the symptoms of this condition.

How is dyscalculia diagnosed?

To determine if a person has Dyscalculia, educational psychologists administer a battery of tests. An assessment reveals how well a person understands and applies numbers and math concepts to solve advanced-level and everyday problems. The evaluation compares a person's expected level of performance (based on their educational history and level of remediation) to their current level of skill and understanding, noting specific strengths and weaknesses.

DYSGRAPHIA

Dysgraphia is a neurological condition that affects written expression and inhibits fine motor control. It is a learning condition that affects both children and adults. It obstructs nearly every aspect of writing, including spelling, readability, word spacing and size, and expression. Writing is impacted by a learning deficit that is brain-based. In those with ADHD, dysgraphia is common, as it is with all learning disabilities.

It is believed that 5 to 20% of all children have some form of writing disability, such as dysgraphia.1 Dysgraphia and other learning problems, such as dyslexia and dyscalculia, are frequent in children with attention deficit hyperactivity disorder (ADHD or ADD); in the United States, up to half of children with ADHD have a learning disability.

SYMPTOMS

A disability of written expression, on the other hand, may go unnoticed during the early school years while a child's writing skill develops; dysgraphia may be untreated until maturity.

Dysgraphia symptoms, according to the National Center for Learning Disabilities (NCLD), include:

- i. Difficulty creating letter forms
- ii. A pencil grip that is tight, unnatural, or unpleasant.
- iii. Difficulty adhering to a line or remaining inside boundaries
- iv. Difficulties with sentence structure or grammatical rules while writing but not when speaking
- v. Difficulty organizing or expressing ideas on paper
- vi. Noticeable gap between oral and written comprehension of a topic

CAUSES

When dysgraphia first develops in childhood, it is mainly due to an issue with orthographic coding. This is a type of working memory that helps you to recall written words and how your hands or fingers must move in order to write those words. Dysgraphia makes it difficult for children and adults to organize and execute the writing of phrases, paragraphs, and even individual letters. It's not that you can't read, spell, or recognize letters and words. Instead, your brain is having difficulty comprehending words and writing. When dysgraphia occurs in adulthood, it is frequently the result of a stroke or another type of brain damage. Dysgraphia can be caused by damage to the brain's left parietal lobe. You have a right and left parietal lobe in the upper part of your brain.

HOW IS DYSGRAPHIA DIAGNOSED?

Diagnosis of dysgraphia frequently necessitates the collaboration of a team of specialists, including a physician and a licensed psychologist or other mental health professional specialized in working with persons with learning problems. An occupational therapist, school psychologist, or special education teacher may also be consulted to assist in making the diagnosis.

An IQ test and an evaluation of their academic performance may be part of the diagnostic procedure for youngsters. Specific schoolwork may also be scrutinized. Examples of written work or written exams performed by a doctor may be assessed for adults. Fine motor skills issues will be identified while you write. You may be asked to copy words from one source to another in order to determine if there are any language-processing issues.

INTERVENTIONS

Interventions in applied psychology are acts used to effect change in people. There are several intervention options available, each aimed at a different sort of problem. It most broadly refers to any activity designed to influence behaviour, emotional state, or sentiments. Psychological treatments have a wide range of uses, the most prevalent of which is the treatment of mental problems, most typically through psychotherapy. The ultimate objective of these therapies is to target not just symptoms but also the fundamental cause of mental problems.

If no intervention or treatment is provided, dyscalculia can have serious consequences for children. Dyscalculia, in particular, may have an impact on humans mental-health. For example, in a focus group with nine children with dyscalculia conducted by Bevan and Butterworth (2007), many negative feelings were stated in relation to the children's repeated failure in mathematics. The kids reported feeling excluded, blaming themselves for not knowing how to do a task, crying, and feeling "horrible" and "stupid." Living with dyscalculia might be tough in the long run. Difficulties range from remembering essential phone numbers and dates to paying the correct amount for paying a bill.

Dyscalculia, like other learning disorders, cannot be cured with medication To cure the problem, unique learning tactics are required. The following are the five most critical tactics to include in every dyscalculia treatment plan:

Follow core learning principles.

Learning is a multi-stage process. Before it is possible to learn future skills, certain skills must first be acquired. To be a football player, one must first acquire fundamental abilities such as passing, kicking, and tackling. To accomplish math, a youngster must first master the core skills of math, such as visual perception and visual memory. As an example, a child who mistakes the signs +, -, and may struggle with visual discrimination of forms or visual discrimination of position in space.

Reduce anxiety

It is critical to keep anxiety levels as low as possible, as anxiety can be a handicap in and of itself. Anxiety, for example, may occupy the brain's working memory space, preventing complete and effective processing of arithmetic tasks (Ashcraft et al., 2000). Anxiety of any kind triggers the production of the hormone cortisol into the bloodstream. The primary role of cortisol is to refocus the brain on the source of the worry and decide what action to take to reduce the stress. As a result, the pulse rate rises and other bodily signs of anxiety arise.

Use a multimodal approach to teaching

Information enters the brain via three major channels: visual, auditory, and Kinesthetic. Many kids with learning disabilities struggle in one or more of these areas.

As a result, teaching in a multisensory manner, using all three channels at the same time, will benefit them because their weaker channels will be bolstered by their stronger ones.

Make the most of your failures

Everyone makes errors; they are necessary for learning. Unfortunately, making mistakes in math can lead to some students giving up. However, research at Stanford University by Jo Boaler and Carol Dweck has demonstrated that synapses form in the brain when mistakes are made but not when answers are accurate. Even if a mistake is not corrected, growth will occur. The quest to find the appropriate solutions promotes growth. Changing the messages a teacher or parent sends regarding mistakes and wrong answers in mathematics is one of the most powerful movements a teacher or parent can make. Teaching children that mistakes are beneficial has a tremendous freeing effect on them.

Repetition is not a bad thing

In the 1920s and 1930s, repetition and rote learning were synonymous with poor instruction. Drill-and-practice was informed to teachers that it dulls students' creativity and that rote learning in math classrooms is anti-right brain and thus potentially illegal, since it deprives all students of the ability to realize their human potential. In educational circles, the phrase "drill and kill" is still used, which means that drilling the pupil will kill their motivation to study. Drill-and-practice, when done properly, is a consistently effective teaching strategy that should not be dismissed as "low level," and appears to be just as important to sophisticated and creative intellectual performance as it is to virtuoso violin performance (Brophy, 1986).

INTERVENTIONS FOR DYSGRAPHIA

The major intervention for dysgraphia and other learning impairments takes place in the classroom. Interventions are generally classified as follows: (I) accommodation, in which the student accesses the mainstream education curriculum with supportive or assistive resources without changing the educational content; (II) modification, in which the school adapts the student's goals and objectives as well as provides services to lessen the impact of the disability; and (III) remediation, in which the school provides specific intervention to lessen the severity of the disability. Management of dysgraphia and other learning disorders is a fluid and life-course procedure that must adjust to the most current level of impairment as the manifestations of these problems alter with shifting scholastic demands and cognitive growth.

REVIEW OF LITERATURE

- i. **Alam et al. (2023)** conducted a study to find out how art therapy affected children with learning difficulties' aggressive behaviour and sense of self. This study used a quasi-experimental (one group pretest-posttest design) methodology. The study was carried out in the Menoufia Governate's Shebin Elkom. Al Basma Association Centre and Ebny Centre for Children with Special Needs are both facilities for kids with impairments; hence they were both chosen. 60 kids who attended previously chosen centres for treatment and follow-up were chosen in a purposeful sample. After receiving art therapy, 85% of the learning disordered children showed little aggression. There was a statistically significant difference in self-esteem between before and after art therapy, and 61% of children exhibit normal self-esteem after intervention. Children with learning impairments who receive art therapy display less violent behaviour and have higher self-esteem.
- ii. **Agarwal et al. (2023)** covered the numerous types of dysgraphia and its symptoms are in this article along with machine learning models that can be used to identify dysgraphia. Disabilities in handwriting associated with dysgraphia are identified using unsupervised machine learning approaches. In order to achieve the goal, a new handwriting dataset is produced through the use of handwriting exercises, and a wide range of features are extracted to represent different handwriting characteristics. According to the results, Random forest provides the best accuracy but performs worse when correctly identifying dysgraphic samples. To address the issue of the lack of dysgraphic examples needed to train machines, one class SVM has been tested. With an increase in sample size for machine learning, the results provide good optimism for identification.
- iii. **Mitsea et al. (2023)** conducted a systematic review paper to examine the efficacy of virtual reality gaming as an intervention technique for meta-skills training among individuals with neurodevelopmental, cognitive, and learning disabilities. 26 studies satisfied the criteria for inclusion out of 1100 entries that were produced by the database search. According to the findings of this study, VRGs can help persons with special educational needs and disabilities become more motivated and acquire metacognitive skills as well as the emotional intelligence necessary for inclusion, success, living independently, and overall well-being. According to what was seen, the respondents' favourable experiences with VRGs helped them internalise motives and generate self-motivated, self-regulated, and flexible behaviours with less effort.
- iv. **Yoong (2023)** analysed a study which attempted to look into how the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) Model might be used to design and build a tool for dyscalculia students. The ADDIE Model is used in this work to systematically explain the design and development of an instrument for dyscalculia. The researcher envisioned a tool that schools could someday create that is specifically made for students with dyscalculia. The results of this study can be used as a guide for other researchers who seek to create instruments for particular learning challenges in a methodical manner. It aims to create a tool that will help the Malaysian Ministry of Education (MoE), schools, teachers, parents, and dyslexic students in elementary schools. Future researchers can build more instruments appropriate for dyscalculic students by examining the effectiveness of the current instrument.
- v. **Uket et al. (2023)** conducted a study that focused on creating, verifying, and standardising a dyscalculia test on a sample of 2340 students that were randomly selected using a multistage sampling procedure that applied various sampling techniques. He used the Test of General Reasoning Ability and work 1 of the Mathematics Achievement Test component of the 2021 National Common Entrance Examination, as well as the Dyscalculia Test introduced in this work, which was created and standardised in phases, for data gathering. The study reveals that the Dyscalculia Test items specifically target working memory, number perception, and arithmetic operations. Based on the research, he advises school administrators and counsellors to use the Dyscalculia Test to evaluate students who may be struggling with math and arithmetic in order to make the appropriate diagnosis.

- vi. **Coacci et al.** (2023) conducted a research which consisted of an integrative review of the literature, to confirm the efficacy of neuro-rehabilitative and neuro-psycho-pedagogical interventions using exercise games to improve executive function functioning in children with specific learning disorders (SLDs) between the ages of 4 and 11 and to improve academic performance. Six of the 154 quantitative experimental studies that were initially chosen for analysis were examined after meeting the inclusion criteria. Although the results cannot be generalized, the findings seem to point to the effectiveness of exergames as a neuro-rehabilitative and neuro-psycho-pedagogical intervention and to an improvement in school performance in the case of Dyslexia and Dyscalculia, which are types of SLD.
- vii. **Kamran et al.** (2023) in their study examined the three executive functions- working memory, planning/organizing, and cognitive flexibility was in an Iranian environment in relation to the impacts of a disclosure programme for expressive writing about emotions. In order to do this, 40 learning-disabled third through fifth graders were enlisted, and through a series of interviews and recognition tests, they were divided into experimental and control groups. After two months, the treatment's effects on executive functions were steady. Results concluded that disclosure initiatives can lessen the executive functioning deficits experienced by learners.
- viii. **Salisa and Meiliasari** (2023) conducted a study using a systematic literature review with the goal of identifying and synthesising the data that already existed regarding the disparities in understanding of dyscalculia, its characteristics, and the challenges that children with dyscalculia may encounter in the classroom. 23 articles were selected to compile responses to the research questions. The results show that, despite various variances in perceptions of what dyscalculia is, it is obvious that the disorder affects pupils' grasp of and ability to manipulate numerical concepts. Low mathematics achievement scores are the most notable of the many traits that dyscalculic students display.
- ix. **Fritzlar and Wild** (2022) conducted a study where parental predisposing traits, enabling resources, and perceived need were examined as factors influencing the utilisation of extracurricular support offers for children with developmental learning disorders (DLD) in accordance with the Behavioural Model of Health Care Utilisation and based on data from a self-developed online survey (N = 225 parents of third and fourth graders). Parents who claimed they did not employ extracurricular support programmes despite their child having a DLD were also questioned regarding their own justifications. Utilisation is unaffected by educational background or enabling factors (income or hours worked). Organisational (financial, time) and a lack of offers were the two primary reported barriers to utilisation, which are explored in light of concerns about educational policy.
- x. **Islam** (2022) conducted a study to examine the perspectives of English language instructors in Bangladesh who instruct at the pre-primary, primary, and secondary levels on learning impairments and possible interventions. Through in-person and online interviews with the teachers, a combination of quantitative and qualitative data was gathered. 12 teachers freely took part in the study and contributed their knowledge based on their individual experiences. Although the majority of them claimed to have heard of learning difficulties, they were unable to define the phrase or connect it to their own experiences. Regardless of their pedagogical or technological capabilities, they indicated a willingness to make accommodations for kids with any kind of disability in their classrooms.
- xi. **Husni et al.** (2022) created a prototype in an effort to aid the children's learning of writing. By comparing handwriting samples from before and after prototype-assisted intervention using the Handwriting Legibility Scale, a user-based evaluation was carried out. The evaluation's findings showed that overall legibility and reading effort were 92%, page layout and letter formation were 96%, and writing changes were 100%. In terms of readability, long-term memory, proper letter construction, assisting learning, and automatization in writing, positive results were found after examination of the data.
- xii. **Bavi et al.** (2022) conducted a quasi-experimental study with a pretest-posttest design and a control group whose purpose was to find out how balance training activities could help SLD students who struggle with dyscalculia and dysgraphia. 30 second- and third-graders with SLD in Ahvaz, Iran were included in this study 15 of whom were randomly assigned to the experimental group and the other to the control group. The control group got no treatments, whereas the experimental group underwent balance improvement activities over the course of twelve 45-minute sessions. The findings showed that balance improvement exercises helped SLD students' dyscalculia and dysgraphia (P 0.001). The findings show that balance enhancement activities can be used to increase academic achievement in SLD kids by reducing their dyscalculia and dysgraphia.
- xiii. **Kshirsagar and Nathani** (2022) conducted a study on mothers of children between the ages of 7 and 12 who met the minimum requirement of having completed the 10th grade. The subjects who met the inclusion criteria were sent a self-made validated questionnaire. Descriptive statistics were used to analyse the collected data. Only 51.66% of the individuals in this study, or 93 people, were aware of learning difficulties, according to the study's findings. The percentage of those 93 subjects who were aware of dyslexia, dyscalculia, and dysgraphia was 52.69%, 55.91%, and only 36.56%, respectively. Mothers of school-aged children are less aware of learning problems. The understanding of learning difficulties among moms is crucial since they are a child's first carer and they are the ones who play a significant role during their formative years. Lack of awareness among mothers might keep a kid from receiving early attention, worsening their condition.
- xiv. **Ayar et al.** (2021) conducted a descriptive study to investigate the social, emotional, and behavioural difficulties experienced by 278 kids with specific learning disabilities (SLDs) and to pinpoint the contributing factors by using the Strengths and Difficulties Questionnaire (SDQ) as a screening tool. The SDQ, which was administered to their moms, evaluated the children's strengths and challenges. Multiple logistic regression analysis and the chi-square test were employed for analysis. 15.8 (6.5) was the mean (SD) overall SDQ score. In SLD, 47.8% of the scores had abnormally high total difficulty. Cases with younger age at SLD diagnosis, dyscalculia, excessive preschool screen time (>4 h), and hospitalisation history also had higher odds of these conditions.
- xv. **Ashraf and Najam** (2020) conducted a cross-sectional study to determine the prevalence and co-occurrence of specific learning disability (SLD) symptoms in four schools in Lahore, including dyslexia, dysgraphia, and dyscalculia.

With a mean age of 13 years (SD=1.44), we looked at 666 participants—384 boys and 282 girls—from two public (n=409) and two private (n=257) schools in Lahore. Results showed that 39% of participants displayed symptoms of SLD, 33% of dyslexia, 48% of dysgraphia, and 45% of dyscalculia. Students were found to have a high prevalence of SLD symptoms and comorbidity, which is concerning. Boys scored higher on SLD and dyslexia, while girls did well on dysgraphia and dyscalculia. Therefore, it is imperative to introduce screening tools for SLD assessment as well as management techniques to address these problems.

- xvi. **Kariyawasam et al.** (2018) conducted a screening approach for dysgraphia, dyscalculia and dyslexia using deep learning and machine learning techniques. On the smartphone application, spoken letters and words, written letters and words, and written numbers are all detected using trained convolutional neural networks. Convolutional neural network outputs are input into models that screen for learning impairments. K-nearest Neighbours, Random Forest, and Support Vector Machine are some of the machine learning techniques utilised in the model building process. The screening findings from the models developed in this study have accuracy levels for dyslexia, letter dysgraphia, dyscalculia, and numeric dysgraphia of 89%, 90%, 92%, and 92%, respectively. This game-based tool for diagnosing and treating dyslexia, letter dysgraphia, dyscalculia, and numeric dysgraphia is the first of its kind.
- xvii. **Uwakwe and Akanbi** (2017) investigated a study that used a 2x3x2 factorial matrix with a pretest-posttest control group quasi-experimental approach. 42 secondary school students with learning disabilities were chosen using a purposeful random selecting procedure. The experimental and control groups were distributed to the participants at random. The therapy had a significant impact on the participants' test anxiety ($F(1,29) = 101.875$; $P = 0.0000.05$). When compared to the control group ($X=36.392$), DBT participants ($X=25.725$) showed less test anxiety. However, the participants' test anxiety was not significantly affected by the different learning difficulties (dyslexia, dyscalculia, and dysgraphia). Gender had no discernible main impact on participants' test anxiety.
- xviii. **Rababah and Alghazo** (2016) conducted a study with a group of students who had been diagnosed with dyscalculia; a diagnostic evaluation programme was developed and put into practise in this study. Pre- and post-tests were administered to students in both the control group and the treatment groups, and the findings were used to gauge the program's success. On the post-test, the results showed statistically significant differences between the control group and the treatment groups, showing that the diagnostic evaluation technique was successful in enhancing the mathematical skills of dyscalculia students. This article discusses the program's development and implementation as well as the ramifications of the results.
- xix. **Alipor and Najmabadi** (2014) conducted a study where 280 children with dyslexia, dysgraphia, and dyscalculia were compared to children without these conditions to evaluate central coherence. The population was separated into four equal groups, each with 70 patients. King and Frys (1993)'s Block Design Task was utilised to evaluate the tasks. One-way analysis of variance was used in the statistical analysis of the data. The findings indicated that children with dyslexia, dysgraphia, and dyscalculia differ significantly from children without these conditions in terms of mean central coherence scores and mean times, but these differences were not seen in children with dyslexia, dysgraphia, and dyscalculia. Based on the study's findings, we can say that a deficit in a child's central coherence is one of the things that separates normal kids from kids with learning problems.
- xx. **Kariyawasam et al.** (2013) conducted a study, where "Pubudu," one of the first deep learning and machine learning-based smartphone applications for dyslexia, dysgraphia, and dyscalculia screening and intervention, was developed. 50 children with disabilities and 50 typically developing children were used in the system testing. With the initial dataset, neural networks were able to detect letter dysgraphia, dyslexia, and numeric dysgraphia with 88%, 58%, and 99% accuracy, respectively. By contrast, dyscalculia was detected with 90% accuracy. "Pubudu" has a great deal of potential for diagnosing and treating dyslexia, dysgraphia, and dyscalculia in local languages, motivating kids and giving them interactive skills. It would be a helpful software for the majority of Sri Lanka's disadvantaged kids.

RESEARCH METHODOLOGY

The research paper discussed various aspects of learning difficulties, including dyslexia, dysgraphia, dyscalculia, and specific learning disorders (SLDs). The studies employed diverse methodologies and explored interventions, diagnostic tools, awareness levels, and the impact of different approaches on the well-being and academic performance of individuals with learning difficulties. Several studies focused on intervention strategies to address learning difficulties. Alam et al. (2023) found that art therapy significantly reduced aggressive behavior and improved self-esteem in children with learning difficulties. Mitsea et al. (2023) highlighted the efficacy of virtual reality gaming in enhancing motivation, metacognitive skills, emotional intelligence, and overall well-being. Coacci et al. (2023) underscored the positive effects of exercise games on executive function functioning and academic performance in children with SLDs. These findings emphasize the importance of incorporating creative and technology-based interventions to support individuals with learning difficulties. The studies by Agarwal et al. (2023) and Kariyawasam et al. (2018) explored the potential of machine learning models and deep learning techniques in identifying and screening for dysgraphia, dyslexia, and dyscalculia. These approaches showed promising results, demonstrating the potential for technology to assist in the early detection and intervention of learning difficulties. Diagnostic evaluation and screening tools were also examined in the studies. Yoong (2023) discussed the development of an instrument for dyscalculia using the ADDIE model, providing a systematic approach for creating tools tailored to specific learning challenges. Uket et al. (2023) created and standardized a dyscalculia test that targeted working memory, number perception, and arithmetic operations. These studies highlight the importance of accurate assessment and diagnosis for effective support and intervention. Awareness levels among teachers and parents were addressed in several studies. Islam (2022) explored the perspectives of English language instructors in Bangladesh, revealing a need for greater understanding and awareness of learning difficulties. Kshirsagar and Nathani (2022) found a lack of awareness among mothers regarding dyslexia, dyscalculia, and dysgraphia, which can hinder early intervention efforts. These findings underscore the importance of comprehensive awareness and training programs for educators, parents, and caregivers to identify and support individuals with learning difficulties. Furthermore, studies such as Fritzlzar et al. (2022) and Salisa and Meiliasari (2023) examined the utilization of extracurricular support and disparities in understanding dyscalculia in educational settings. These studies highlight the need for accessible and inclusive support systems, as well as improved knowledge and awareness among educators and policymakers.

SUGGESTIONS FOR FUTURE RESEARCH

- i. Long-term follow-up: Many of the studies reviewed had relatively short-term interventions or assessments. Future research should consider conducting long-term follow-up studies to examine the sustainability and lasting effects of interventions for individuals with learning difficulties. This would provide a more comprehensive understanding of the long-term benefits and challenges associated with different interventions.
- ii. Comparative studies: While each study focused on specific interventions or approaches, conducting comparative studies could provide valuable insights into the relative effectiveness of different interventions for specific learning difficulties. Comparative studies would help identify the most effective approaches and inform evidence-based practices for individuals with learning difficulties.
- iii. Generalizability: The studies reviewed were conducted in various geographical locations and cultural contexts. However, it would be beneficial to expand the research to include a more diverse sample of participants from different cultural backgrounds to determine the generalizability of the findings. This would contribute to a more comprehensive understanding of learning difficulties across different populations.

LIMITATIONS

- i. Small sample sizes: Some of the studies reviewed had relatively small sample sizes, which could limit the generalizability of the findings. Future research should aim to include larger and more diverse samples to increase the reliability and validity of the results.
- ii. Lack of control groups: Several studies did not include control groups, making it challenging to establish a causal relationship between interventions and outcomes. Incorporating control groups in future studies would strengthen the research design and provide a better understanding of the intervention's specific impact.
- iii. Self-report measures: Many of the studies relied on self-report measures or subjective assessments, which could introduce biases and limitations in data collection. Future research could consider incorporating objective measures and multiple sources of data to provide a more comprehensive evaluation of outcomes.

Overall, the discussion of these studies underscores the significance of adopting a multidimensional and holistic approach to address learning difficulties. By combining innovative interventions, diagnostic tools, awareness campaigns, and support systems, it is possible to enhance the well-being and educational outcomes of individuals with learning difficulties. Further research and collaboration among educators, researchers, policymakers, and parents are crucial for developing effective strategies and interventions that cater to the diverse needs of individuals with learning difficulties.

CONCLUSION

In conclusion, the collection of 20 studies on learning difficulties, including dyslexia, dysgraphia, dyscalculia, and specific learning disorders (SLDs), provides a comprehensive understanding of these conditions and their implications for individuals across different age groups and educational settings. The studies encompass a range of topics, including interventions, diagnostic tools, awareness levels, and the impact of various approaches on individuals with learning difficulties.

One prominent theme that emerges from these studies is the effectiveness of innovative interventions in addressing the challenges faced by individuals with learning difficulties. Art therapy, virtual reality gaming, exercise games, and balance training activities have shown promising results in improving behavior, self-esteem, motivation, metacognitive skills, and academic performance among children and adolescents with learning difficulties. These interventions provide alternative avenues for expression, skill development, and cognitive enhancement, offering individuals with learning difficulties opportunities for growth, empowerment, and improved well-being.

Technological advancements, particularly in the field of machine learning and deep learning, have also played a significant role in identifying and screening learning difficulties. These studies demonstrate the potential of using machine learning models, trained on large datasets and various handwriting characteristics, to accurately detect dysgraphia, dyslexia, dyscalculia, and other learning challenges. By leveraging technology, researchers and educators can develop efficient and accessible tools for early detection, intervention, and personalized support for individuals with learning difficulties. The studies also shed light on the importance of accurate assessment and diagnosis in understanding the nature and specific needs of individuals with learning difficulties. The development of tailored instruments, standardized tests, and screening tools allows for more precise identification of learning challenges and facilitates appropriate interventions. Additionally, these studies emphasize the need for increased awareness among teachers, parents, and caregivers, as early recognition and timely support play a crucial role in mitigating the impact of learning difficulties and fostering positive educational outcomes.

Furthermore, the studies highlight the significance of creating inclusive support systems within educational environments. Collaborative efforts among educators, researchers, policymakers, and parents are necessary to establish comprehensive strategies that address the diverse needs of individuals with learning difficulties. The utilization of extracurricular resources, such as support programs and specialized tools, can enhance the educational experience and academic achievement of individuals with learning difficulties. Moreover, addressing disparities in understanding learning difficulties and promoting inclusive practices are essential for creating inclusive classrooms and educational environments that celebrate the strengths and potential of all learners.

In conclusion, the findings from these studies provide valuable insights into the field of learning difficulties and offer a foundation for further research, collaboration, and policy development. By adopting a multidimensional and holistic approach, it is possible to enhance the well-being, academic success, and inclusivity of individuals with learning difficulties in society. Continued efforts in research, awareness, and support are crucial to ensure the optimal development, empowerment, and fulfillment of individuals with learning difficulties, ultimately fostering a more equitable and inclusive educational landscape.

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