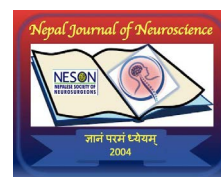


Fostering Student Success: A Prevailing Provision for Dyscalculia & Dyslexia in the School Curriculum and Strategies for Support

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Abstract

This article examines the impact of dyscalculia and dyslexia on students' mathematics learning and proposes strategies for supporting learners with these learning disabilities. It provides a concise overview of dyscalculia and dyslexia, emphasizing their distinct characteristics and prevalence rates within the Nepalese context. The study explores the challenges faced by students with dyscalculia and dyslexia in mathematics education and discusses the importance of inclusive education. It also provides an overview of the school-level curriculum in Nepal, highlighting the effects of dyscalculia and dyslexia on mathematics learning and the specific challenges experienced by students with these disabilities. The article uncovers areas within the school-level curriculum in Nepal that require attention and offers practical ways to support learners with dyscalculia and dyslexia. Overall, this article provides valuable insights into the challenges faced by students with dyscalculia and dyslexia in learning mathematics and offers practical recommendations for developing an inclusive curriculum that caters to the specific needs of the dyscalculic and dyslexic learners.

Keywords: Dyscalculia, Dyslexia, Inclusion, Learning disabilities, Support

Introduction

Mathematics learning disability (MLD), also known as dyscalculia, is a specific learning disorder in mathematics that shares similarities with other specific learning disorders like dyslexia¹. MLD is characterized by significant and enduring difficulties in mathematics that cannot be solely attributed to inadequate instruction, environmental factors, or behavioral and emotional disorders¹. It can affect overall performance in mathematics and can increase mental health problems². It is believed that MLD is rooted in underlying brain abnormalities, likely stemming from genetic factors³. Dyscalculia has a significant impact on learners' ability to comprehend the logical steps involved in solving mathematical problems, remember number-related facts, and perform everyday numerical tasks⁴. Specific learning deficits in mathematics include challenges with memorizing arithmetic facts, developing number sense, accurate and fluent calculations, and mathematical reasoning due to cognitive deficits¹.

Research strongly supports the idea that dyscalculia is associated with brain-based abnormalities. Studies by Kucian⁶ and Espina et al.⁷ highlight the correlation between neurobiology and dyscalculia. The prevalence of dyscalculia among school-age children typically ranges from 3% to 6%, with some studies suggesting a higher occurrence of 6 to 8%^{5, 8}. Dyscalculic individuals face challenges in mathematical computation and reasoning, which impact their overall mathematical performance⁹. These difficulties often emerge during elementary school and can persist throughout an individual's life¹⁰. However, in Nepal, there is a lack of large-scale studies addressing dyscalculia and limited emphasis on addressing the challenges faced by school children in this area.

Initially, dyslexia was thought to be primarily a visual processing disorder¹¹. However, subsequent research has revealed that it is primarily a phonological processing disorder, affecting the ability to recognize and manipulate speech sounds¹². Dyslexia is characterized by difficulties in accurate and/or fluent word recognition, spelling, and decoding skills¹⁰. It is a complex condition influenced by genetic and environmental factors¹³. While there is no singular cause of dyslexia, a combination of genetic predisposition and environmental factors, such as language and literacy experiences, contribute to its development¹⁴. Dyscalculia and dyslexia both have significant impacts on learning, with dyscalculia specifically affecting mathematics education¹⁵ and dyslexia primarily impacting reading and language skills¹⁶. Thus, this article aims to explore the difficulties faced by students with dyscalculia and dyslexia, highlighting the importance of inclusive education and providing strategies and support mechanisms to assist these learners.

Context of Mathematics Teaching and Learning

The learning context encompasses the atmosphere and phenomena that shape the learning environment¹⁷. It bounds where and how learning takes place, influencing how concepts are formed¹⁸. Proper contexts can facilitate effective learning

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through conceptual, methodological, and pedagogical approaches^{17,19}. However, teacher variables, curricula, social/cultural dynamics, and lack of resources can hinder learning, especially for weaker students¹⁹. Constructivist perspectives suggest using varied teaching tools and materials to engage students in knowledge construction¹⁷. The classroom environment should accommodate addressing issues like gender, language, equity, technology integration, and achievement¹⁹. However, for many school-level mathematics learners, especially in developing nations, well-equipped environments are inaccessible¹⁹. In these contexts, institutions strive to provide suitable alternatives due to management and resource challenges. For dyslexic children, learning mathematics is made increasingly difficult in such constrained contexts that hamper proper support.

Inclusive Education for Students with Dyscalculia and Dyslexia

Inclusive education plays a vital role in providing equal opportunities for students with dyscalculia and dyslexia. It ensures that they have access to educational opportunities, resources, and support services on par with their peers²⁰. It promotes their active participation and engagement in the learning process and helps create a level playing field for these students.

One of the key benefits of inclusive education is the provision of tailored support. It recognizes that students with dyscalculia and dyslexia have specific learning needs and offers individualized accommodations to address them. This may involve specialized instruction, assistive technologies, and strategies designed to help them overcome challenges and achieve academic success²¹. Inclusive education empowers these students to reach their full potential by providing support. Inclusive education also fosters social and emotional development for students with dyscalculia and dyslexia by creating a supportive and accepting environment that enables them to interact and collaborate with their peers. This social interaction not only promotes the development of essential social skills but also enhances self-esteem and a sense of belonging²¹. The opportunity to engage with others in an inclusive setting contributes to their overall well-being.

Furthermore, inclusive education recognizes the importance of holistic development for students with dyscalculia and dyslexia. It takes into account their strengths, interests, and diverse learning styles by considering the support to their overall growth and well-being²². Importantly, inclusive education has been linked to positive educational outcomes for students with dyscalculia and dyslexia. Research indicates that inclusive practices can improve academic achievement, boost self-confidence, and enhance long-term educational and employment prospects²². Providing an inclusive learning environment, education systems maximize the potential of these students and facilitate their success. In conclusion, inclusive education is crucial for students with dyscalculia and dyslexia as it offers equal opportunities, tailored support, social and emotional development, holistic growth, and positive educational outcomes. Thus, educational institutions can create an environment by embracing inclusivity where every learner can thrive and reach their full potential.

Overview of the School-level Curriculum in Nepal

The formal education system in Nepal is comprised

of one-year early childhood education for children completing four years of age, primary education (grades 1-8), where grades 1-3 follow an integrated curriculum, and secondary education begins from grades 9-12²³. The National Curriculum Framework (NCF) for School Education in Nepal outlines the goals and approach for education at each level, with the latest version aiming to make education more participatory, practical, and focused on developing life skills²³. The vision of school education is to build a prosperous nation based on social justice and competent, competitive citizens.

At the primary level, the curriculum focuses on developing literacy, numeracy, social skills, and basic knowledge, though overcrowded classrooms make addressing individual learning needs challenging²³. Children with disabilities and special needs are allowed to access education, however, priority is given to physical disabilities rather than neurodevelopmental disabilities. Also, the lack of accommodation, teaching support, and awareness hinder their participation and progress²⁴. Mainstreaming of children with disabilities began in 1997 but implementation faces challenges due to a lack of teacher training and awareness, though some schools have adopted inclusive practices²⁵. The Government of Nepal is committed to inclusive education under the UN CRPD, but resource and capacity constraints have limited progress²⁴. Studies find the curriculum and teaching need diversifying to accommodate different learning styles and disabilities, though progress remains gradual due to a lack of funding and expertise^{25, 26}. In summary, while Nepal aims to mainstream children with disabilities, implementation challenges remain in adequately addressing diverse learning needs through curriculum and teaching practices at the school level, with capacity building of teachers key to fulfilling inclusive education goals.

Dyscalculia and Its Effects in Learning Mathematics

Dyscalculia, a specific learning disorder in mathematics, can be attributed to various cognitive, behavioral, and biological factors. Cognitive causes may involve challenges in acquiring number concepts aligned with Piaget's stages of development or processing numerical information as described in information processing theories^{2, 1}. Behavioral factors, such as inadequate teaching methods, unsupportive learning environments, lack of motivation, and sociocultural influences, can hinder the development of numerical abilities²⁷. Biological factors may include atypical brain development related to prematurity or genetics⁵. Research conducted by Kunwar and Sharma indicates that the prevalence rate of dyscalculic learners is 6.8% in basic schools in Nepal, and the Nepalese government has not taken any steps to address this issue for school children¹⁵. Dyscalculic individuals commonly encounter difficulties in fundamental aspects of numbers. They struggle with recognizing and remembering numerical symbols and quantities⁵. Counting, associating numbers with values, and difficulties with patterns and sequencing are also common challenges^{28, 5, 29}.

The impact of dyscalculia on mathematics learning is significant. It affects the acquisition of basic arithmetic concepts from early schooling, leading to poor number sense and reasoning^{5, 30}. Dyscalculia can impede abilities needed for everyday tasks involving amounts, time, distance, speed, and calculation^{29, 5}. It also diminishes self-efficacy and motivation

for mathematics due to persistent struggles²⁹. Dyscalculia is associated with low self-esteem and avoidance of activities requiring numerical reasoning⁵. Targeted interventions are crucial for addressing the challenges posed by dyscalculia. Dyscalculia significantly affects individuals' mathematical abilities, including their understanding of mathematical concepts, calculation skills, and problem-solving capabilities. It encompasses difficulties with number sense, arithmetic operations, mathematical reasoning, and spatial visualization^{8, 30}. Dyscalculic individuals struggle with comprehending numerical magnitudes and relationships, which are integral to number sense⁸. They also encounter impairments in various aspects of number processing, such as estimating numbers, retrieving arithmetic facts, and engaging in mathematical reasoning⁴. Dyscalculia poses challenges in arithmetic skills, accurate calculation, understanding mathematical operations, and solving math word problems³¹. Furthermore, individuals with dyscalculia may have difficulties comprehending mathematical concepts, applying strategies, and organizing information systematically⁵. The disorder also impacts spatial and visuospatial abilities necessary for geometry, measurement, and spatial relationships in mathematics, resulting in difficulties visualizing and mentally manipulating geometric shapes, maps, and graphs^{8, 5}.

Dyslexia and Its Effects in Learning Mathematics

While dyslexia presents obstacles to reading, writing, and comprehension, intelligence and development are typically unaffected³². However, individuals with dyslexia are sometimes incorrectly viewed as lazy or unintelligent due merely to their reading struggles³³. Dyslexia's effects extend beyond academics - those with dyslexia may internalize stigma, leading to disengagement and even depression without proper support³. Support needs vary depending on personal and sociocultural factors as well as resource availability³⁴. Developed countries have established teacher training, classroom accommodations, and technologies to aid dyslexic learners, whereas underdeveloped nations often lack these supports³⁵. A study conducted by Kunwar³ revealed that the prevalence rate of dyslexic learners of secondary school level in Nepal. However, no efforts has been made by the Nepal Government to address this issue. This lack of initiative raises concerns about the educational system's ability to cater to the needs of these learners.

In countries like Nepal, "dyslexia" remains relatively unknown, so teachers lack specialized training and knowledge³. This can cause misdiagnosis, inappropriate assistance, and lack of support for dyslexic students⁸. Stigma from educators and peers may lower self-esteem and confidence³³. Access to professionals and specialized schools is limited, hindering appropriate accommodations in educational settings³⁶. Multilingual contexts pose additional challenges, as dyslexic learners of non-Nepali languages face difficulties learning to read and write³⁶. Targeted interventions are needed to address these multifaceted challenges.

While dyslexia primarily involves difficulties with reading and language skills, it can also affect one's ability to learn mathematics^{3, 9}. Individuals with dyslexia may struggle in various aspects of math, from comprehending word problems to interpreting mathematical symbols and notations⁹.

One reason for this is that dyslexia often involves weaknesses in phonological processing - the ability to manipulate sounds³⁴. Phonological awareness, which is important for acquiring and understanding math vocabulary and concepts, can be impaired in those with dyslexia⁹. Those with dyslexia can have trouble decoding and comprehending the language used in word problems, hindering their ability to extract relevant information and apply the correct operations³⁴.

Dyslexia may also make it challenging to accurately interpret and manipulate mathematical symbols and notations due to potential issues with visual processing and symbol recognition⁹. Furthermore, the phonological processing deficits linked to dyslexia impact the development of math skills that depend on decoding and comprehending math-related vocabulary³⁴. Struggles with working memory may also play a role²⁸. It's important to note that the degree of math difficulties can vary among individuals with dyslexia, and some may experience overlapping dyscalculia^{28, 9}. Thorough evaluations and targeted support are needed to address each student's unique learning profile²⁸.

Specific Challenges Faced by Students with Dyscalculia in Mathematics

Several studies have identified key indicators that often characterize difficulties experienced by dyscalculic children. Espina⁷ notes struggles with recognizing and remembering numbers, counting, associating number symbols with values, and identifying patterns and sequences. Concerning Hornigold⁵ and Espina⁷, some common areas of challenge are discussed below. Counting backward, sequencing, and recognizing patterns. Dyscalculic children may have trouble counting backward or recognizing number patterns like odds and evens^{5, 7}. Number calculations and orientation. Struggles can include choosing the appropriate operation, using number lines, and distinguishing directions like left/right^{5, 4}. Time, estimation, and assessing quantities. Telling time on an analog clock, estimating amounts, understanding place value, and identifying larger/smaller numbers can be challenging^{5, 7}. Mental mathematics, fractions, and money memorizing facts, linking symbols to amounts, visual-spatial skills for fractions, and estimating monetary values can be impacted⁵. Targeted support is needed to address dyscalculic students' diverse difficulties.

Uncovering Areas for Inclusion within the School-level Curriculum in Nepal

The school curriculum in Nepal has progressed in recognizing the need for inclusive education but there are still opportunities to strengthen support for diverse learners. A study by Chalise³⁷ identified gaps between Nepal's formal policies of inclusion and implementation in classrooms. They found students with disabilities faced barriers due to inadequate teacher training and a lack of accommodation in curriculum, learning materials, and assessment practices. Similarly, Kunwar and Sapkota³⁴ highlighted how the curriculum does not adequately address the needs of students with dyslexia. They argue for explicit inclusion of strategies to support literacy development as well as modifications to assessments that accommodate variations in reading abilities. Kunwar and Adhikari²² also uncovered a lack of accommodations for ethnic and linguistic diversity within the curriculum. Their research underscores

the need for mother-tongue and multilingual teaching methods to foster equitable access to learning. These studies point to various areas, such as differentiated instruction, accessibility of materials, and culturally responsive pedagogy that could strengthen inclusion within Nepal's school curriculum to better support the needs of all students.

Research emphasizes the need to examine instructional and administrative practices within Nepali schools to adequately address learning disabilities such as dyscalculia³⁸. Mathematics difficulties posed by dyscalculia present a significant challenge for both students and teachers⁶. The impact of dyscalculia on mathematics learning has been recognized as a key issue warranting investigation³⁸. This study aimed to contribute insights into how the mathematics learning of dyscalculic students could be better supported by focusing on the problems they face. Addressing classroom priorities and management approaches may help improve outcomes for dyscalculic learners³⁸. Further exploration of dyscalculia interventions tailored to the Nepali educational context could enhance mathematics learning for students with this disability.

Ways to Support Learners with Dyscalculia and Dyslexia

The problem of learning mathematics due to dyscalculia and dyslexia in school-level education can be effectively addressed through teacher professional development. Equipping teachers with appropriate training and resources enables them to gain a better understanding of the needs of students who struggle with math and implement effective instructional strategies. This approach enables teachers to enhance their pedagogical skills and employ tailored approaches that cater to the unique challenges faced by these students. Investing in comprehensive professional development programs empowers educational institutions to enable their educators to create inclusive and supportive learning environments that promote math success for all students³⁹. Teacher professional development is the fundamental aspect of supporting students with disability. Some of the major ways to support students with disabilities are discussed briefly.

Teacher Professional Development

To address the specific needs of students with math learning disabilities, teachers require specialized training or teacher professional development⁴. Math learning disabilities, also known as dyscalculia, involve persistent difficulties in learning and comprehending mathematical concepts⁴⁰. Students with math learning disabilities often struggle with number sense, mathematical reasoning, and procedural knowledge^{31, 41}. To effectively support these students, teachers need to possess a deep understanding of mathematical concepts and employ evidence-based instructional strategies⁴. It is crucial to address the lack of adequate teacher training in schools that serve learners with diverse disabilities, as highlighted by research^{42, 43}. Insufficient training hinders the educational progress of students with disabilities and perpetuates barriers to their learning and inclusion⁴⁴. Therefore, in-service teacher training programs should be implemented to address the immediate problem. Additionally, for long-term solutions, it is essential to incorporate crucial areas of disability, such as dyscalculia and dyslexia, into higher-level teacher preparation curricula and pre-service teacher training courses⁴⁴. With the integration of these topics into teacher education, future educators can be better

equipped to support students with diverse learning needs. As suggested by Borg³⁹, a crucial step in addressing math learning disabilities is to continuously update teacher training courses and revise teacher preparation curricula to align with the latest research and best practices.

In the context of Nepal, the introduction of in-service teacher training programs and the inclusion of dyscalculia and dyslexia in higher-level teacher preparation curricula and pre-service training courses would be vital steps toward addressing the recent problem effectively. These measures would ensure that teachers have the necessary knowledge, skills, and strategies to support students with math learning disabilities and create inclusive learning environments.

Individualized Approaches

Individualized approaches refer to instructional strategies and interventions tailored to meet the unique needs and capabilities of individual learners. These approaches recognize that students have diverse learning styles, strengths, and challenges, and aim to provide personalized support to optimize their learning outcomes. Assessing students' abilities, interests, and learning profiles empowers educators to develop customized learning plans that directly address their specific needs. Individualized approaches may include differentiated instruction, personalized learning plans, adaptive technologies, and targeted interventions. The goal is to provide students with opportunities for personalized growth and success, fostering their engagement, motivation, and achievement in the educational setting.

Practical Classroom Strategies

Practical classroom strategies encompass various techniques and methods that teachers can employ to create an effective and engaging learning environment. These strategies include differentiated instruction, cooperative learning, classroom management, active learning, formative assessment, technology integration, multisensory instruction, real-world connections, individualized support, and positive reinforcement. Teachers can enhance student learning, encourage active participation, and support academic success by implementing these strategies in their classrooms.

Collaborating with Specialists

Collaborating with specialists involves working together with professionals who have expertise in specific areas to support the needs of students. This collaboration can occur between teachers and specialists such as special education teachers, speech therapists, occupational therapists, school psychologists, and other related professionals. Teachers can gain valuable insights, strategies, and resources by collaborating with specialists to address the unique challenges faced by students with learning difficulties or disabilities. This collaboration may involve sharing information, setting goals, developing individualized plans, implementing interventions, and monitoring progress. Teachers and specialists can provide comprehensive support, promote inclusive practices, and maximize the academic and social success of all students by working together.

Implementing Change

Implementing change involves carefully planning, effectively communicating, and strategically executing new practices, policies, or initiatives within an organization or system.

Key steps include identifying the need for change, setting clear goals, planning the change, engaging stakeholders, providing training and resources, monitoring and evaluation, addressing resistance, and celebrating success. By following these steps, organizations can successfully introduce and integrate change, leading to positive outcomes and sustained improvements.

Evaluating Success

Evaluating success involves assessing the outcomes and impact of a project, initiative, or change effort to determine its effectiveness and identify areas for improvement. This process includes measuring progress toward the goals and objectives set during the planning phase, collecting relevant data and evidence, and analyzing the results. Evaluating success may involve various methods such as surveys, assessments, interviews, observations, and data analysis. Evaluating success allows organizations to determine whether desired outcomes have been achieved, identify potential gaps or challenges, and make informed decisions regarding future actions. This feedback loop allows for continuous improvement and helps organizations refine their strategies and approaches to maximize impact and ensure ongoing success.

Creating Inclusive Math Classrooms

Creating inclusive math classrooms involves fostering an environment where all students, regardless of their abilities, backgrounds, or learning styles, feel valued, supported, and engaged in their math learning. Inclusive practices in math classrooms encompass several key elements. First, teachers strive to establish a positive and respectful classroom culture that embraces diversity and promotes equity. They provide multiple entry points and varied instructional strategies to accommodate different learning needs and preferences. Differentiated instruction allows students to access and engage with math concepts at their individual levels. Teachers also incorporate real-world connections, hands-on activities, and visual representations to enhance understanding and make math relatable. Collaboration and cooperative learning structures encourage peer interaction and collaborative problem-solving. Inclusive math classrooms also prioritize targeted interventions and support for students with learning difficulties or disabilities. This learning strategy empowers all students to develop their mathematical abilities and achieve success.

Conclusion

Dyslexia and dyscalculia are distinct learning difficulties that can impact math learning. Dyslexia primarily affects reading and language processing, while dyscalculia specifically affects mathematical abilities. It is important to recognize the differences between these conditions and avoid equating dyscalculia to "math dyslexia". Each condition requires specific interventions and support tailored to the unique challenges it presents. To provide effective support for dyscalculic and dyslexic students in mathematics instruction, a comprehensive approach is necessary. Teacher professional development plays a vital role in equipping educators with the knowledge, skills, and strategies to effectively support these students. Strategies such as explicit instruction, multisensory approaches, differentiated instruction, individualized approaches, practical classroom strategies, collaboration with

specialists, implementing change, evaluating success, creating inclusive math classrooms, and targeted interventions can significantly enhance the mathematical learning outcomes of dyscalculic and dyslexic students. Ongoing professional development opportunities, collaboration with specialists, and continuous reflection and refinement of instructional practices are crucial for ensuring the success and progress of these students. It is recommended that educational policies be reformed and inclusive, prioritizing investment in strategies that support dyscalculic and dyslexic students in mathematics instruction. These policies should emphasize comprehensive support, professional development opportunities, and resources for educators to meet the specific needs of these students effectively.

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