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Technology for Dyscalculic Elementary School Students

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I. INTRODUCTION

Mathematics is a complex subject, involving language, space and quantity. Much research into the development of mathematical skills has focused upon relatively basic numerical abilities, such as arithmetic or counting (Bisanz, 1999), but even at such early levels many complex abilities are involved. These include transcoding between spoken number words and Arabic numerals, relating these to semantic representations of set size("numerosity"), reasoning about relative set sizes (if 1 is added to 2, the result should be 3); and understanding the relations between set size and counting order. A person with mathematical disability has a difficult time solving arithmetic problems and grasping math concepts. The complexity of numerical processing has made defining what it means to have a specific mathematical learning disability (dyscalculia).

The term Dyscalculia is derived from the Greek root 'dys'(difficulty) and Latin 'calculia' from the root word calculus- a small stone or pebble used for calculation. Dyscalculia is a specific learning difficulty that has also been referred to as 'number blindness', in much the same way as dyslexia was once described as 'word blindness'. In view of Butterworth,(2003), a range of descriptive terms have been used, such as 'developmental dyscalculia', 'mathematical disability', 'arithmetic learning disability', 'number fact disorder'and ' psychological difficulties in mathematics'. Mazzocco, (2005) defined dyscalculia as a genetic, neurological disorder that affects an individual's ability to do mathematic (as cited by Wadlington, 2008).

Dyscalculia is described as a specific disturbance in learning mathematical concepts and computation associated with a neurological, central nervous system dysfunction by Janet and Frank (2006). Essentially, it describes a difficulty with numbers which can be a developmental cognitive condition, or an acquired difficulty as a result of brain injury (Doyle, 2010).

SYMPTOMS OF DYSCALCULIA

- Difficulty working with numbers
- Confused by math symbols
- Difficulty with basic facts (adding, subtracting, multiplying and dividing)
- Often will reverse or transpose numbers (36: 63)
- Difficulty with mental math
- Difficulty telling time
- Difficulty with directions (as for playing a game)
- Difficulty grasping and remembering math concepts
- Poor memory for layout of things (for example, numbers on a clock)
- Limited strategic planning skills (like used in chess)
- Relies on tangible supports such as fingers, tally marks
- Slowness in given answers to math questions
- Difficulty with estimation and approximation
- Difficulty finding different approaches to one problem
- Trouble with visualizing patterns, different parts of a math problem, or identifying critical information needed in problem solving
- History of academic failure contributing to the development of learned helplessness in mathematics

A child with dyscalculia will have average or above average intelligence but cannot achieve to that degree in the area of mathematics.

TYPES OF DYSCALCULIA

In a landmark article, Kosc (1974) identified six types of dyscalculia which are as under:

(i) Verbal dyscalculia, a difficulty in using mathematical concepts in oral language.

(ii) Practognostic dyscalculia, difficulty in manipulating concrete material.

(iii) Lexical dyscalculia, a difficulty in reading mathematics symbols.

(iv) Graphical dyscalculia, a difficulty in writing mathematical symbols.

(v) Operational dyscalculia, a difficulty in performing specified mathematical operations.

(vi) Ideognostical dyscalculia, a difficulty in understanding mathematical relationship.

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CAUSES OFDYSCALCULIA

There are many possible causes, namely neurobiological, genetic and environmental, and an interaction of the two.

a. Neurobiological: Dyscalculic children have problems in working out calculations. For dyscalculic children, small area of the brain is activated for calculation when compared with normal children. The parietal lobe of the cerebral cortex is highly responsible for numerical operations and children with math difficulties have some form of damage in their parietal lobe (Lemer 2003; Kucian, et.al.2006).

b. Genetic: Genetics plays an important role in acquiring dyscalculia. Alarcon, et al. (1997), Shalev and Gross Tsur (2001) revealed that nearly half of the siblings of dyscalculic parents are dyscalculic. Genetic causes include known genetic disorders such as Turner's syndrome, Fragile x syndrome, Velocardiofacial syndrome, Williams
syndrome. These genes present in the population increase the risk of dyscalculia in their sibilings.

c. Environmental Factors: The environment at home also plays a major role for dyscalculia.
i. When mothers are not confident of doing mathematics, their children are also lacking confidence (Young-Loveridges; 1989).
ii. Home environment promotes attitude towards learning mathematics (Hannel; 2005).
iii. Negative mathematics identity at home influences the math
learning difficulty of the wards (Anning and Edwards; 1999).
iv. Children from low socio-economic background also encounter math learning difficulty. (Sammons, et al.2002)
Known environmental causes include alcohol consumption during pregnancy and pre-term birth. Both of these can result in underdevelopment of the brain.

IMPORTANCE OF ASSISTIVE TECHNOLGY FOR DYSCALCULICS

Children with learning disabilities experience unique learning challenges in classroom environment, which often differ from their peers. It is important when using technology in a classroom that all students will benefit from its learning outcomes.
Assistive technology can be used to help students with dyscalculia perform in the classroom. It enables students with learning disabilities to independently learn. Assistive technology can also provide the learning disabled students with remedial and compensatory support. Categories of dyscalculic learning disabilities that affect mathematics learning include spokenlanguage, written language, arithmetic, and reasoning. There is a variety of assistive technology that can help students with different types of dyscalculia overcome these difficulties.

A. MULTIMEDIA HELP FOR DYSCALCULIA

Children with dyscalculia lack a "number sense"---they have problems relating number symbols to real-world objects and situations. Software titles such as "Mighty Math," available for the classroom and at home, incorporates math learning into interactive video, using stories, music and visual cues to help students relate math concepts to everyday life.

a. Electronic Math Worksheets
Electronic math worksheets are delivered on a child's computer. They take the place of the traditional paper worksheets. For students with visual difficulties, the font size and style can be adjusted to suit their needs. Additionally, the sheets provide immediate feedback and some even offer homework help topics.

b. Math Software-Number Race
Dyscalculic students may have difficulties with making visual-spatial connections to numbers. Utilizing 3D and other technology, software packages like "The Number Race" rely on a multidimensional computer algorithm which allows students to see relationships between symbols and physical space. These programs are able to track problem areas and adjust levels of difficulty as a student progresses.

Math software is available to students of all ages and learning styles. Math software enables students who might not otherwise be able to participate in math activities the opportunity to construct and manipulate objects, count, sort, and combine using specially designed software programs.

c. Adapted Measuring Devices
Adapted measuring devices take a regular measuring device (like a beaker) and add large text or a voice synthesizer. Talking measuring jugs, color coded measuring cups, and big number funnel sets are all examples of types of adapted measuring devices.

d. Reading books
Most people with the learning disability are also known to be strong readers, so it should not be a surprise that books are among the tools available to Dyscalculics. These include the use of illustrated handbooks, like the helpful "Teach Yourself Visually: Algebra."
e. Babakus

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The Babakus is a calculator that combines the best qualities of the western slide ruler with those of the eastern Abacus. It's part of a method for students with dyscalculia to easily work with addition, subtraction, multiplication and division. Although the focus of the method lies on those who find it difficult to deal with numbers and figures, the Babakus is an excellent proficiency training tool for those adept at counting as well. The method is highly scalable to fit each student's level of skill and understanding.

f. Computer Assisted Instruction (CAI)

CAI is particularly effective for
• Motivating students
• Providing individual instruction
• Precise monitoring for teachers.
• Drill and practice type activities in Maths

g. iPad

Applications (apps) are run on the Ipads' operating system called iOS which allows the user to control the Ipad by a multi-touch feature. MathBoard is an example of a popular app which teaches children addition, subtraction, multiplication, division, squares, cubes and square root problems. The Long Division app can be used to teach and study the long division method on iPod. It allows the user to solve a long division problem step by step and animates all the steps. In the steps the user will divide, multiply or subtract. The correct answer will fly to the 5 right place. If the user presses the wrong button the answer will appear above the keyboard but it will not move.

h. Quick link Pen Elite & SuperPen Professional

- To scan a word or line of text and hear it.
- To see the definition of the word.
- To transfer text and images to PC
- Comes with dictionaries covering medicine, finance, computing, geography, science & a thesaurus.

i. Digital Pen

- IO Pen saves an image of pages written in a special notebook to a PC.
- Can use handwriting recognition but problems with:
- Spelling errors
- Terminology & equations

j. Graphics Tablet

A graphics tablet can be used to enter diagrams or equations graphically alongside a PC.

- But requires good co-ordination skills.
- Still slower than writing by hand

k. Talking calculators

Talking calculators use a voice synthesizer to tell the student which keys are being pressed. If a student often transposes numbers like 21 with 12, the calculator's assistance will help the student to identify the correct number. Additionally, the calculator will speak the answers outloud so that the student does not have to read the screen. This eliminates the risk of transposing numbers where transferring them from the screen onto paper.

- Read & Write Gold and ClaroRead provide speech enabled software-based calculators
- Handheld talking calculators are available but expensive : £200+
- Designed for visually impaired

l. Text-to-speech Speech Engine

- Speech engines will attempt to pronounce terminology using phonetic rules
- Can not read-back equations represented as images or in PDF files

m. Virtual Classrooms

Virtual environments are computer generated, 3D environments, which respond in real time to the activity of their users. They are 3Dvirtual worlds depicted on a screen where the user can navigate their way around the graphical environment using input devices, such as mice, keyboards and joysticks. This is a particularly positive aspect for users with severe learning difficulties for whom certain skills and particular training can be difficult to learn. In virtual worlds users are able to practice skills repetitively until they are ready themselves to move on comfortably with new exercises.

n. Microsoft Powerpoint 2010

Presentation software such as PowerPoint 2010 is a type of classroom technology, which is usable for both teachers and students. PowerPoint 2010 which was developed by Microsoft allows presentations to be displayed live on a computer or navigated through at the command of the presenter

o. Kurzweil 3000

It is a program designed to help dyscalculics. Students can scan in a teacher's article and the kurzweil will read the article out loud. There are options to read slower or faster, to take notes, and to highlight text.

B. MULTISENSORY HELP FOR DYSCALCULIA

Because children with dyscalculia have problems relating abstract number symbols to physical quantities and amounts, using the senses to establish a physical connection to the symbol is helpful. Programs like "Touch Math" encourage

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children to establish a tactile connection to number symbols by tracing, touching, or outlining them, creating a physical understanding of quantity and size relationships.

MULTISENSORY RESOURCES FOR MATHS

a. Numicon

The Numicon shapes make numbers real for children because they can see them and touch them. The shapes make odd and even numbers very apparent and they help children to understand addition, subtraction, multiplication and division. There are kits available for 7 groups of children and 'One to One' kits that are ideal for tutors and parents. Included in the kits are guide books with structured teaching ideas.

b. Cuisenaire Rods

The Rods come in 10 different colours and lengths representing different numbers. Young children soon get used to the colour system and older students find Cuisenaire Rods acceptable to work with too. They can be used to demonstrate things like number bonds, area, perimeter, factors, multiples, double numbers, near doubles, fractions, ratios. Cuisenaire rods can be used in conjunction with the number tracks from Numicon.

c. Nuggets

Glass nuggets are very tactile, so good for any counting exercise.

d. Plastic Peg Board & Peg Set.

Peg Boards with 100 holes are good for demonstrating percentages and fractions.

e. Base Ten or Dienes Blocks

The blocks are good for illustrating the number system and place value. They can be used for adding and subtracting numbers and concepts such as 'carrying' and 'borrowing'.

f. Stile System

This is a self checking system. The tiles are placed in a special tray, and if all the answers are right, a given pattern, which matches with the exercise from the book, will be revealed when the tray is turned over. There are three packs; 'Numbers and the Number System' (which is especially helpful for children with dyscalculia), 'Calculations' and 'Shape and Measure'. Suitable for children in Key Stage 2 and older children who need reinforcement at this level. The packs offer a systematic approach.

g. Numbershark

Numbershark is a motivating computer programme that uses 45 games to teach and reinforce numeracy and improve understanding and the use of numbers. The wide variety of carefullydesigned games provides many ways in which to practise at a chosen level and then to build 8 skills in very gradual steps. The games focus on: the number system and sequencing (very useful for dyscalculics); addition, subtraction, multiplication, division,fractions, decimals and percentages.

h. Stern's Structural Arithmetic

Stern's multi-sensory maths system was designed to develop a child's emergent number sense by building-up number knowledge and number facts in a logical and structured manner thus enabling children to think logically and reason mathematically. Stern facilitates the understanding and application of the four number operations. Since the system is based on two tangible sets of number representations, the blocks and patterns promote a clear image of number in the concrete enabling pupils to discover for themselves all of the attributes on a physical level. When numerals are introduced they correspond to the blocks and patterns by embodying the intrinsic qualities and values of those numbers.

i. Concrete models

Using concrete models is the first step in building the meaning behind mathematical concepts. These models include a variety of math manipulative, measuring tools, building blocks, fractional boards, peg boards, chips, marbles, 2d and 3d charts and shapes, dice, straws and strips that students can handle during a lesson. Research-based studies show that students who use concrete materials develop more precise and more comprehensive mental representations, often show more motivation and on-task behavior, understand mathematical ideas and better apply these ideas to life situations.

DISADVANTAGES THAT SURROUNDS THE AREA OF TECHNOLOGY IN INDIAN CONTEXT

- Lack of knowledge among recent innovations in assistive technology among teachers and Indian educational institutions especially government sector.
- Needs time, labour and huge money to prepare or buy the aids for teaching dyscalculics.
- Lack of awareness in screening, identifying, assessing dyscalculics and providing individual remedial measures for them.
- Inadequate number of special education teachers to teach dyscalculics both in special and inclusive schools.

CONCLUSION

This paper discussed about symptoms of dyscalculia, causes of dyscalculia, different types dyscalculia prevailing among children and the importance of technology in the lives of dyscalculic children both at home and in classrooms. It widely discussed about the various assistive tech multisensory and multimedia. It also looked at the disadvantages that surrounds the area of technology in Indian context for the children with dyscalculia.

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