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qatar
assistive
technology
center

Assistive Technologies for
Those who have difficulties
In Mathematics

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Assistive technology for people who have difficulties with Mathematics.

There are many reasons why a person may have difficulty with Maths. Dyscalculia defined as a learning disability in maths is a term used to describe someone with severe difficulties in maths. It includes all types of difficulties with maths from the inability to understand the meaning of numbers to inability to identify and organize the steps to a problem. People with a Learning Disability who have math problems usually have visual perception difficulties that affect their ability to see likenesses and differences in shape and form. Because math symbols represent a way to express numerical language concepts, language skills become very important to math achievement. Students with learning disabilities can also have reading difficulties that interfere with their ability to solve word problems.

However many people without learning disabilities have difficulties with Maths. Blind and visual impaired people can have great difficulties with maths. They can have access issues in that their screenreader is not able to correctly read the mathematical concepts as written on a page. Vision impaired people will struggle with graphs that are colour coded and with understanding what shapes and structures look like. People with physical difficulties also can have difficulties with maths. A child with dexterity or poor fine motor skills will have difficulties in writing numbers or equations legibly and in the spaces provided on a worksheet. They could lack finger strength or control to generate graphics needed to depict a math problem.

Difficulties with Visual Processing, visual Spatial or Visual motor Integration Challenges:

A student with difficulties in this area could have

- Problems counting a group of items,
- May mix up numbers like 7 and 5 , 6 or 9,
- Problems understanding the space between numbers reading 712 as 7 12
- Miss the placement of decimal points
- Stumble with operational symbols for example meaning or + or – (ask a child to fill out $9 \text{ ---} 3 = 6$ which symbol)
- Correctly align numbers in a vertical math problem, writing within margins or on lines
- Differentiating colours or similarly shaped letters and numbers (b, d and p,q)

- Correctly find coordinates on a graph or map
- A problem with Judging distances (placing things too close to the edge) Bumping into objects and things.
- Understanding the concept of amount.

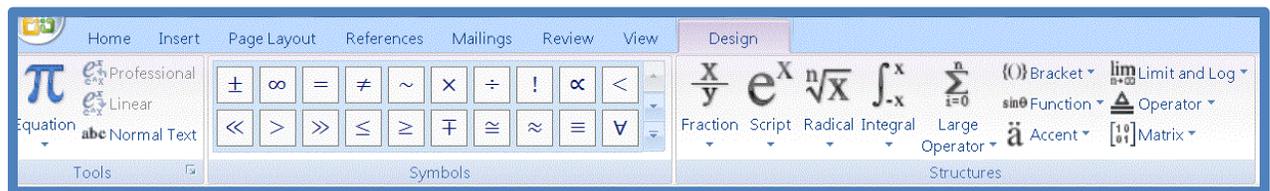
Multiple Steps / Organization

Student could have difficulty with:

- Following the steps in the correct order, sequencing the appropriate steps to complete a math problem.
- Have trouble with sequence including left to right orientation, they will read numbers out of sequence
- Calculations e.g. missing the carried number in an addition problem ,
- Applying multiple operations
- Applying the concrete to the abstract. If you house is 100 km from the school how many km do you walk everyday to and from school? The child may be unable to transfer this concept to numbers $100 + 100$

Reading and Writing Math Language

Mathematical and scientific notation offer an entirely different vocabulary set to learn. It is number, symbol and image –based. Finding and typing the math symbols and sentences on a computer is not easy however Ms Office Word has a toolbar called Equation Editor. It can be accessed using the insert Tab.



Assistive Technology Solutions

It is important to understand what is the underlying cause of students' difficulties with maths before deciding on which assistive technology tools may be beneficial. It is also important that teachers facilitate learners to know why they are doing what they are doing. Learners need to understand the **process** of Math. Assistive technology can then assist students in gaining or demonstrating this understanding.

Talking calculators

Talking calculators use a built-in speech synthesizer to speak number, symbol or operation keys as they are pressed. They also read answers from completed calculations. Hearing the numbers or symbols may help some people find input errors, such as pressing the wrong key. Also, hearing the answer aloud helps users double-check for errors that may have been made when copying numbers, such as transposing 91 for 19, or confusing a 6 with a 9.

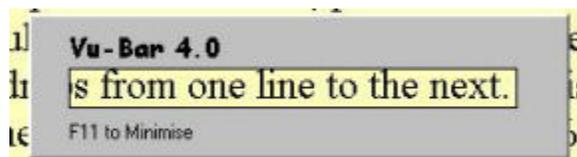
Electronic math worksheets

These worksheets can help a student organize, align and navigate through basic math problems on a computer screen. Addition, subtraction, multiplication and division problems are entered via keyboard or mouse and automatically aligned to the correct vertical format. Numbers on the screen can be read aloud by a speech synthesizer. These software programs may be helpful for individuals who have difficulty organizing and aligning math problems with pencil and paper.

Vu-Bar 4.5

A unique piece of software, provides an on-screen, slotted ruler. Useful with dyslexia and Dyscalculia when the user skips lines or drops from one line to the next. This version allows the user to select the bar width, 25%, 50%, 75% or 100% of screen width and set the slot height to the required font size.

This version adds the option to lock the bar onto the mouse pointer for movement, as well as improved keyboard movement options.



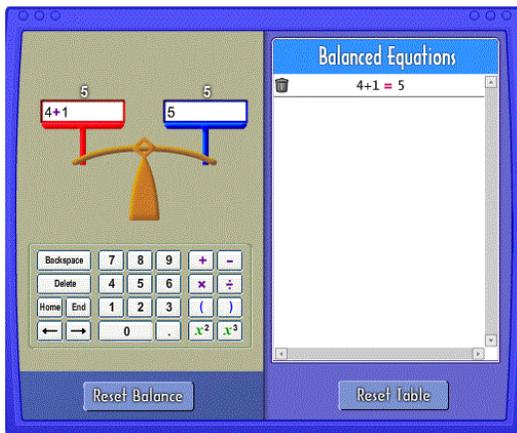
Virtual Manipulatives

Virtual manipulatives are basically digital “objects” that resemble physical objects and can be manipulated, usually with a mouse, in the same ways as their authentic counterparts. They increase the potential for adaptation and access. Students who struggle in mathematics often have trouble connecting visual and symbolic representations; virtual manipulatives can make such connections explicit to students. You can use a Google search to find interactive for the desired maths concepts. Key words like simulation, model, interactive or tutorial

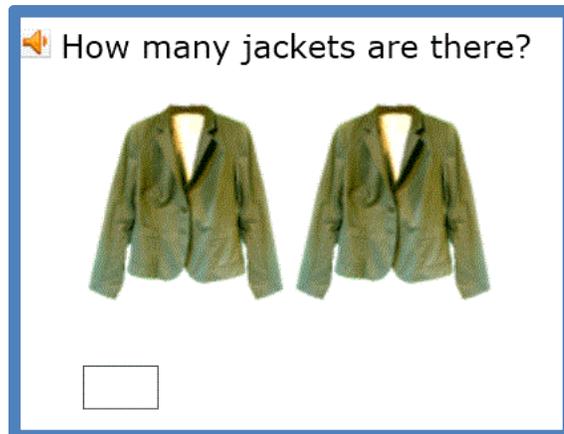
should generate the visuals or manipulatives you need. Pan Balance numbers available online at no cost from: [http](http://illuminations.nctm.org/ActivityDetail.aspx?ID=26)

The [National Library of Virtual Manipulatives](http://illuminations.nctm.org/ActivityDetail.aspx?ID=26) is a library of web-based interactive virtual manipulative and concept tutorials. Manipulatives are sorted by grade level and math content area, and each manipulative includes instructions, suggested activities, lesson plans, and connection to relevant NCTM standards. The manipulatives include some that are commonly used in teaching (base 10 blocks, pattern blocks, and algebra blocks).

<http://illuminations.nctm.org/ActivityDetail.aspx?ID=26>



It is also available for shapes and algebraic expressions. Use this tool to strengthen understanding and computation of numerical expressions and equality. In understanding equality, one of the first things students must realize is that equality is a relationship, not an operation. Many students view "=" as "find the answer." For these students, it is difficult to understand equations such as $11 = 4 + 7$ or $3 \times 5 = 7 - 2$.



<http://www.icoachmath.com/home.aspx>

This site has many lessons available on line for all different levels .Math problems can be represented visually to introduce mathematical concepts.

<http://www.intellitools.com/default.html>

Switch It Early Math with Spider and Friends



Early Math provides a variety of multimedia early learning activities that focus on mathematic concepts. Students get to practice sorting, matching, copying, drawing, counting, and more. This program was designed for single switch use but can be controlled with a mouse. (Mac/Win)

MathPad™



MathPad is an alternative and accessible tool used to support basic skill instruction in the areas of addition, subtraction, multiplication, and division. Math problems can be quickly entered, displayed in the appropriate format, and solved with minimum keystrokes, movements or prompting. MathPad is accessible through IntelliKeys, switches, a standard keyboard and

the mouse.

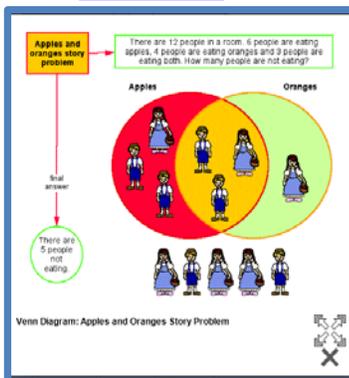
http://web.riverdeep.net/portal/page?_pageid=818,1381089&_dad=portal&_schema=PORTAL

Many resources available at the above site to use for students with learning difficulties in maths examples below:



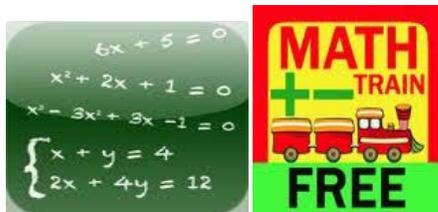
A comprehensive introduction to teaching pre-primary mathematics. Designed specifically for non readers, this course teaches important mathematical concepts and skills students will need to understand the world around them. The lessons and activities in this pre-primary course include the following topics: Counting from 1 to 100, Addition and subtraction, Identifying shapes, Patterns, Graphing data. There are many other games available on this site where Students can build a foundation of fundamental math concepts and thinking skills. Through activities that feel like play, students explore numbers, shapes, sizes, quantities, patterns, sequencing, and new activities addressing measurement concepts and number sentences.

Inspiration / kidspiration: Software that offers several examples of math graphic organizers on their website. <http://www.inspiration.com/kidspiration-math-examples>



Kidspiration visual maths tools help build problem solving and reasoning skills by developing a conceptual understanding of mathematical procedures. Helps students to build number sense, spatial reasoning and understanding of the four basic operations while communicating their thinking with words numbers and maths symbols

IPAD Applications



There are many applications on the IPAD that can be used to facilitate learning from very Early Maths concepts e.g. mathemagics, basic addition, subtraction and division apps, to apps that help with the sometimes complicated concepts of geometry and trigonometry. There are applications that help with complex equations and many different types of talking calculators available for the IPAD. Please refer to Mada's presentation on IPAD apps for Maths for more detailed description of these apps)

Vision Impaired and Maths Difficulties

The use of magnification software such as zoomtext or Ms Office Magnifier can sometimes distort how equations are presented on the screen and if the magnification breaks up an equation the meaning can be unclear. This can be avoided if when preparing Maths for low vision students line breaks and line wrapping are used correctly. However there is a major challenge for Blind users to access Maths when using a screen reader. In written English it is the linear order of letters that conveys meaning. In maths it is the two dimensional relative positioning of symbols, their relative sizes etc that codes meaning. This means

that a screen reader will be unable to read the equation in a meaningful way. The equation represented in this diagram could be written:

' $A = \sqrt{(x^2 - y) / z}$ ' this linear representation would be adequate for a blind user however if there was any increase in complexity it becomes apparent how these linear representations would no longer be useful either.

To make maths accessible to screenreader users the following is suggested:

1. As Equations contain the normal set of characters but also a new set of special characters. Provide a label for each formula or equation whether the equation is an image or text.
2. Whenever input math equations as text, especially if they are one line. The visuals will be generally being of higher quality, especially for low vision users. Symbols should be inputted in Unicode encoding whenever possible.
3. If a screen reader cannot interpret a symbol, then you may be able to append a pronunciation file (particularly in Jaws 6.1 +).
4. If a pronunciation file cannot be appended, then use hidden text (e.g. ALT text of an invisible graphic) to spell out the formula replacing symbols like \neq with words like "not equals".
5. Provide ALT tag for any images used spelling out the formula. If the description is over 255 characters, then link to an extended text description
6. PDF files or Word Files can be beneficial, but make sure the content is accessible to screen readers.

(Ref: <http://accessibility.psu.edu/math#links>)

Math ML

Math ML is an XML platform designed to deliver equations as text. Equation Editors such as Math Type can convert equations to MathML. Many of the traditional readers such as Kurzweil, text help will also read MathML.

The Abacus Traditional Counting Frame



The abacus traditional counting frame is often used to introduce maths concepts to vision impaired as it facilitates understanding of mathematical concepts as

opposed to talking calculators which focus on the result rather than the process involved.

Math talk

This software program requires Dragon Naturally speaking to run. With this software program a user can voice own work and print work, user can also choose to translate maths work to Braille. Video demonstrations of this software can be viewed at <http://www.mathtalk.com/demos.htm> .

Summary

When considering assistive technology in any situation, the focus should be on what the device does for a person, not on the device or technology itself. Assistive technology is merely the support to “get the job done” more independently. People who have severe difficulties with Maths can be helped with assistive technologies , for some it makes it possible for them to access the Maths curriculum in schools for others it makes mathematical concepts easier to grasp.

For further information contact the MADA Qatar Assistive Technology Center, 7th Floor, Al Nasr Tower B, Al Corniche Road, West Bay, Doha, Qatar. P.O. Box 24230. Ph: +974 44594050

References and Resources

<http://nixty.com/course/LD-Primer>

Online course on Learning Disabilities

<http://www.sc.edu/scatp/ld.htm>

Article on Assistive technology and Learning Disabilities

<http://accessibility.psu.edu/math#links>

Outlines how to make Maths accessible to vision impaired and screen reader users

<http://www.wati.org/content/supports/free/pdf/Ch8-Mathematics.pdf>

Chapter outlining many assistive technologies available to facilitate Maths learning.

<http://atto.buffalo.edu/registered/ATBasics/Curriculum/Math/curricular.php>

Provides many games and software for younger children to acquire Maths skills

<http://www.dessci.com/en/products/mathplayer/tech/accessibility.htm>

Information about Mathplayer and accessibility for Maths

<http://www.snv.jussieu.fr/inova/villette2002/act5b.htm>

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