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## **Assistive Technology and Mathematics Education**

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**Abstract** Educators and caregivers now have the opportunity to individualize and differentiate instructions with many technological devices never before available. Assistive Technology is being introduced in the classroom at all levels as a tool for teachers to help deliver instruction to all students. Assistive Technology is widely used to ensure appropriate educational opportunities to all students, including ELL students, students at risk, and students being considered as gifted and talented. The purpose of this article is to describe various assistive technology devices as mathematics tools to help all struggling students, not just students with disabilities, overcome math difficulties.

**Keywords** Assistive Technology, Mathematics Education, Mathematics Tools, Technology

#### 1. Introduction

Today the challenges of teaching a diverse student population are the forefront of all education initiatives nationwide. Assistive Technology (AT) is a tool that can help teachers meet these challenges and improve mathematics instruction to help raise student math achievement. All math educators should become competent in using assistive technology in math education.

Assistive Technology can be any item, piece of equipment, or teacher made product that is designed to improve a student's functional capability or help a student succeed in accessing the general education curriculum. Students with disabilities have used items such as pencil grips and text'-to-speech devices to succeed in inclusive classrooms. Akpan and Beard (2013), and Beard, Carpenter and Johnston(2011)identified the AT continuum for instructional purposes as follows:

- no tech—no aids required;
- light-tech—easily attainable adaptations teachers provide on a day-to-day basis, which are readily available in the classroom;
- high-tech—computer access and electronic devices.
  (Akpan and Beard, 2013: Beard, Carpenter and Johnston, 2011).

The Individuals with Disabilities Education Act

(IDEA)(2004) and the Americans with Disabilities Act (ADA) (2008) extend equal opportunity to students with disabilities so they can experience the same services that have always been accessible to the general population. Under these laws, students with disabilities are not receiving something extra; they are merely gaining access to what the general population has taken for granted (Stefanich, 2007). Similarly, math education reform documents support math education's goal of math literacy for all regardless of any categorization of learners' abilities (McGinnis &Stefanich, 2007). These laws and reform documents lie behind the inclusion model, in which students with disabilities are placed in regular classrooms to the greatest extent appropriate.

Mathematics curriculum and instruction continues to be a controversial area to all educators. Math instruction is an area in which many students require special education intervention. Based on sound assessment practices and methodology, mathematics instruction can be planned effectively using AT devices to prepare and enable students to become astute consumers and problem-solvers using mathematical concepts and skills. Teachers must keep an open mind with the importance of incorporating AT devices into mathematics curriculum and providing instruction in a variety ways. Math teachers can use AT in assisting students to improve functioning in their learning environment. Implications for potential beneficial applications of AT go beyond the advantages that these technologies provide math students who have physical and academic disabilities in doing mathematics. Math learning difficulties of students, as verbalizing the problem, problem-solving, and organization can be reduced through the use of AT devices.

Assistive Technology can promote greater independence for students by enabling them to perform tasks that they were formerly either unable to accomplish, or had great difficulty accomplishing, by providing enhancements to or changed methods of interacting with the curriculum (Burns, 2007; Checkly, 2006; Gibilisco, 2006). In other words, AT can either augment or replace student weaknesses.

Mathematics is one of the areas that students find most challenging. Building mathematical skills have life long implications for students but prerequisite skills can be easily overlooked. Math requires reading and abstract thinking. Daily basic life tasks such as paying bills, balancing a checkbook, creating budgets, measuring can be difficult for people without some basic math skills. AT can assist student with disabilities in accessing the general education curriculum. AT can also help promote mastery of basic mathematics facts in the acquisition stage of learning.

# 2. Mathematics and Assistive Technology

Students may have problems with mathematics for a variety of reasons. AT can be an asset and time-saver for teachers when use efficiently for classroom instruction and management, especially for students who typically score below their chronological peers on measures of mathematics achievement (National Council for Teachers of Mathematics 2010; Beard, Carpenter & Johnston, 2011). Assistive technology and network resources can bridge accessibility gaps for people with disabilities in mathematics (Burgstahler, 2006; Burns, 2007; Gibilisco, 2006). AT tools help students to gain access to resources, communicate with others, and perform academic tasks independently (Burgstahler, 2006). The National Council for Teachers of Mathematics (NCTM) strongly recommends that the primary emphasis should be on problem solving and activity-based learning in mathematics. NCTM standards state that mathematics should include methods of reasoning and methods of communication mathematically (National Council of Teachers of Mathematics, 2010).

The implications for students with math difficulties are clear. As teachers enter their own classrooms to become teachers of math, many ask how they may be instrumental in creating positive and accessible learning environments for all students. If students have difficulty with written composition, they will need support not only in the language arts but also mathematics. In other cases, students may not have the computation skills needed to adequately complete problems. In other instances, the factors may be related not to knowledge of math but to other factors such as motivation and ineffective teaching strategies (Burgstahler, 2006;Burns, 2007; Checkly, 2006; Ginsburg, 1997; Hasselbring, et al., n.d.; Vaughn, Boss, &Schumm, 2000).

AT devices in mathematics education have the potential to promote greater independence for all students by enabling them to perform various tasks that were formerly difficult or impossible. For example, the NCTM recommends that computer applications and the use of calculators be taught to all students. Using computer spreadsheets and databases can be helpful to students in organizing data and providing visual pictures of data. Students can then display concepts in presentation format, or they can print the data.

Students who have difficulties with paper-and-pencil tasks (i.e., keeping numbers and problems aligned) may benefit from electronic number processors and math worksheets. These programs allow students to work math problems directly on a computer.

Students may find they have few or no problems learning computations in mathematics. However, in portions of the mathematics curriculum that require the results of problem solving, reasoning, and problem formulation to be expressed in reflective, organized written form, AT devices may be considered useful by the Individualized education program (IEP) team for mathematics, too. There are many varieties of assistive technology devices for mathematics, if used appropriately can foster the success of all students.

MathPad Plus (IntelliTools).http://store.cambiumlearning .com. MathPad enables students to do arithmetic directly on the computer. The program is ideal for students who need help organizing or navigating math problems or who have difficulties doing math with traditional pencil and paper.

ViewPlus Accessible Graphing Calculator. http://www.abledata.com. An audible graphing calculator program designed for use by individuals who are blind or have low vision or visual dyslexia. This onscreen graphing calculator is capable of displaying graphs or other sets of y-versus-x data both visually and audibly as a tone graph. The audio tone plot gives users access to plots comparable to the one on standard graphing calculators.

Portable Calculator with Talking Multiplication Table. http://www.independentliving.com. This small folding calculator performs standard arithmetic functions, including displaying mathematical tables. When the key is pressed, followed by the number of the multiplication table the user wants to access, the program verbally reads the table to the student.

GTCalc Scientific Calculator. http://www.independentliv ing.com. This software offers a comprehensive range of scientific functions in logical groups for easy accessibility. Accessibility features include input via keyboard or mouse with input and output spoken, large number display, a Mouse Talk feature that speaks the button captions, and four levels of screen magnification.

Talking Texas Instruments.http://www.independentliving.com. The features of this small scientific calculator include a learning mode for key identification that does not affect calculations. The key is announced when pressed. There is a choice of silent or talking operation. Tactile, large, functionally zoned keys, volume control, and an earphone are included.

MathTalk. This AT works with dragon products to write mathematics. It enables math students to do math without the use of keyboard or mouse. Math students can choose to translate math problems into Braille in Duxbury Translator. Voice recognition math software can be view at http://www.mathtalk.com/

## 3. Math Simulation Games

Techtrekers, AT is designed to provide math teachers with free materials, information, to help and advice with related subjects beyond math. Students can perform simulation of video games as they explore statistics. In this game, students can relate concepts of statistics and data collection to solve math problems. You can view this software at http://www.techtrekers.com/sim.htm/

The Math Workshop. The features of this program contains many types of hands-on activities designed to reinforce math concepts through independent, kid-friendly, student- centered engagement. Students can work at appropriate developmental levels. The structure of the engagements allows students to make choices and use tools to gain a deeper understanding of the concept being worked on. The program includes enough independent activities to last an entire year www.themathworkshop.com

SelectMath Program with Boston Public Schools. This AT project is designed to provide math teachers and students access to virtual manipulatives that directly supports Boston's districts math and technology curricula. The Selected Math website was created by a group of teachers, coaches, and AT support specialists. http://boston.k12.ma.u s/teach/technology/select/index.html Talking Time Pieces: Talking time pieces is designed for the blind, visually impaired, deaf, and hard of hearing. There are great collections of low vision aids, hearing helpers, daily living aids, and information designed to help students regain independence. This site can help math students to adjust to life-altering changes. http://lessproducts.com/

Virtual Ruler. Small and thin, students can customize almost anything they can think of in math: size, colors, transparency, orientation, scale, measuring units, resolution, double-click actions, behavior, display of additional information.

http://www.desktopruler.com/products-dr-summary.htm

A Universal Design for Learning (UDL) is an AT tool for special education students that provides literacy and ELL support to students with the cognitive ability, but not the literacy skills, to learn at grade level. A text-to-speech reading software program can support both tradition and conventional students across disciplines in math, reading, writing, and for test-taking accommodations.http://www.kurzweiledu.com/default.html

Real World for Teachers. Math is http://www.realworldmath.org/. This software offers mathematics for grade 4 and up. Many math lessons lend themselves to interdisciplinary activities. This is a modem approach to mathematics that is student-centered and task oriented; it embraces active learning, constructivism, and project- learning based activities while holding to the math content standards.

http://www.mattimath.com/. This math website enables students to understand mathematics using "manipulative"-visual objects that help illustrate mathematical relationships, concepts, and applications. Manipulative also helps students to visually examine, explore and develop concepts.

## 4. Writing in Mathematics

Writing matters in mathematics. Technology-supported writing can advance all phases of writing from planning, organizing, transcribing, editing, revising, and publishing. AT also provides new sources for and means of obtaining information (e.g., the Internet, search engines) and enables sharing, editing, and collaboration among writers, teachers, caregivers, and peers. For students to do well in mathematics today much writing is required. They are expected to explain the process and how they arrived at the answer. AT devices can help students to accomplish all these tasks. The Cut, Copy, and Paste functions in most word-processing programs can help students reorganize an entire document (Gibilisco, 2006; Guranus, 2007; Hasselbring, Lott, & Janet, (n. d.). The thesaurus, grammar, and spell checker provide additional support as the student composes.

Concept mapping or minds mapping software allows students who have problems with written expression to develop ideas and organize thoughts into an outline or an idea web prior to beginning to write. Programs such as Inspiration and Kidspiration www.inspiration.com/Kidspira tioncan also help students to start and complete written processes easily.

Virtual Pencil Arithmetic (Hunter Math). Is computer software that is used to interactively solve math problems. It is designed for those who are cannot use pencils to write. It moves to the right spot on the "paper", guided by the user, and inputs the answers that the user selects. This software can do anything that a students is required to do in the math classroom (Burns, 2007; Checkly, 2006; Dell, Newton, &Petroff, 2008).

Handheld/Virtual Manipulatives. There are different types of manipulatives, such as block, rods, bean sticks, etc. Manipulatives are used to help students understand abstract mathematical concepts and fractions. This software is useful for special need students who are identified as visual learners. Manipulatives improve students with learning disabilities visual and tactile skills as they work on and enjoy math problem.

Interactive White Boards. White Boards are designed to meaningfully engage students in their own learning process. In the special education classroom, White Board means anything that helps students to more effectively learn, communicate or have their needs met. It uses interactive text, images, sound and video and the student uses all these features to construct meaning based on what they do. There are a variety of White Boards available in most schools (e.g., Smart Boards and Promethean Boards).

## 5. Funding

The number of students with disabilities in math classes is increasing, making it important for math teachers to become familiar with the available AT services and devices designed to support the education of all students.

Some AT devices and services are financially unobtainable. Funding may be found to implement high-tech

devices that can benefit math instruction. Funding for high-tech devices can come through the school system, the insurance provider, or civic organizations. If the student has special needs and the IEP team deems AT appropriate the device is paid for by the school system.

If instructional software is necessary many civic organizations provide funding for these purchases. The instructional media center within a school is also a source of potential funding.

Further, many AT devices are low cost and light-tech, and services often involve simple modifications of existing strategies that will benefit all students in math classrooms.

Some further AT funding sources can be found at: http://www.atia.org/i4a/pages/index.cfm?pageID=4219

### 6. Conclusion

AT allows students to become more independent and increase their ability to participate in classroom activities in the classroom, the home and the community. Many students find mathematics to be a difficult subject. Many students have deficits in math due to lack of instruction, skills, cognitive difficulties, or developmental issues. The importance of AT becomes more compelling in light of the academic achievement emphasis of the No Child Left Behind (NCLB) Act of 1999 (2013), as well as the increasing emphasis of the recent reauthorization of IDEA on access to the Common Core Standards (National Center for Learning Disabilities, 2013). There are growing numbers of AT products with math support. Assistive technologies include a variety of accommodations to help service students in a mathematics classroom. Many of the activities that take place in a mathematics classroom include solving mathematical problems, reading, writing, interpreting word problems, and sharing what is learned while interacting in the classroom. By incorporating these readily and user friendly available AT into math instruction for students, educators can enhance the success of all students with various types of disabilities in the math classroom.

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