

# Math = Success

## New Inclusionary Math Software Programs

### Add Up to a Brighter Future

**Abstract:** Many teachers and students in this country are changing their notions about teaching and learning math. General education teachers are learning that students with disabilities can be successful in their classes when both teachers and students are provided with adequate support. Students are learning that math concepts are threads that run through other subjects and that learning math can be meaningful, relevant, and fun. Students with disabilities are learning that they can do the same math as their peers without disabilities. Most importantly, as expectations of students change, so do perceptions about them. Through an innovative project with IntelliTools, Inc., funded by the National Science Foundation, teachers are learning that all children can learn math successfully when they are offered appropriate tools and strategies.

#### Using New Technology to Reach Students

In 1995, *IntelliTools*<sup>®</sup> was awarded a three year Instructional Materials Development Grant from the National Science Foundation to create adapted math programs for children with disabilities in elementary school (Khalsa, 1994). As part of this project, five schools in Tennessee used several math software programs that were being developed. See (“Sidebar 1”) for a more complete description of the software and accessible hardware.

During one school year, three new products were evaluated: *Measure It!*<sup>™</sup>, *Number Concepts 1 with Oshi the Otter*<sup>®</sup> and *MathPad*<sup>™</sup>. *Measure It!* is a set of measurement tools and a series of templates used with *IntelliTalk II*<sup>™</sup> (a new talking word processor). *Measure It!* teaches the concepts of length, weight and volume with hands-on, accessible manipulatives. At the same time, students learn to write about their math discoveries by taking advantage of the auditory and graphics features built into *IntelliTalk II*. *Number Concepts 1* is a program that teaches early number sense. It teaches counting, greater than/less than, and addition/subtraction to 20.

With *Number Concepts 1*, children use on-screen manipulatives to solidify their understanding of arithmetic facts. *MathPad* is a program that allows students to solve addition, subtraction, multiplication and long division problems using the computer. It provides a resource for children to demonstrate their knowledge of math facts, which they may be unable to do otherwise. *MathPad* was first developed by InfoUse of Berkeley, CA, with a grant from the National Institutes of Health (Kraus, 1994).

East Tennessee Technology Access Center (ETTAC) based in Knoxville, TN, coordinated the use of the software in the classrooms. ETTAC worked with several schools in eastern Tennessee on this project, including Mountain City, Sunbright, Ellen Myers in Harrogate, Debusk Primary in Greenville, and York Elementary in Jamestown, TN. During this evaluation, the staff at ETTAC was looking at broad questions: How could the use of these accessible technology products impact the teachers? Would teachers change how they taught? Would there be a change in teachers’ perceptions of teaching children with disabilities? How would dynamics in the classroom be changed? To what extent would use of these materials help children with disabilities become included and help learn math concepts?

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We found that teachers did change how they taught, and their perceptions of what was possible for their students changed as well. The accessible platforms allowed students with various disabilities to become active participants in their classrooms. This led to one of the most important results: the children's self-perception improved and they began to feel more connected with their classmates.

### **Using Math Software In Low-Income Rural Tennessee**

New forms of classroom technology have been introduced to schools by ETTAC in order to reach students who were not learning with traditional tools and strategies. Ellen Myers Primary School is one of those schools. It is the only elementary school in the small town of Harrogate, Tennessee, in the shadow of Cumberland Gap, a region made famous by the author and poet Jesse Stuart. Most of the families who live and work in this rural part of East Tennessee depend on farming, coal-mining, or small local businesses to make a living. Many are receiving public assistance. The pervasive poverty has many related effects on diet, health, and capacity to learn. Expectations are low for many children, but particularly for children with disabilities.

In an effort to battle these issues, concerned administrators and teachers at Ellen Myers School have employed novel teaching strategies to address the needs of children with and without disabilities. One of these strategies is for general and special education teachers in grades K-2 to team-teach in classrooms that include students with and without disabilities. A second strategy is to use different forms of technology to reach students who are not learning with traditional tools and strategies.

### **Opening a Door for the Teacher**

To the surprise of staff from the East Tennessee Technology Access Center and the staff at IntelliTools, one of the greatest changes resulting from the Math Project has been in the teaching approach of a general education teacher at Ellen Myers School, Teresa Adams. At the beginning of the project, Teresa had voiced her reluctance about participating in a Math Project:

“I was very hesitant about teaching math. It is not my best subject. I love writing, and I wanted to incorporate writing and math but wasn't sure how to start. First graders can't spell many of the math words. I wasn't sure they would understand many of the math concepts because they are so abstract. I thought math should be relevant, fun and hands-on, but I didn't know how to start making it that way.”

Teresa found that the IntelliTools product under development, *Measure It!* (a series of math templates and manipulatives) did a wonderful job in correlating the way children think about math with the way they write, while simultaneously helping them to learn math concepts. She also noticed that the program made math fun and relevant. *Measure It!* is structured to help shape and develop the natural math intuitions of children, which are developed more through experience than through formal math teaching (Gardner, 1991).

As a result of the success Teresa had with *Measure It!*, she decided to attend the National Math Conference in Washington, D.C., something she had never done before. Upon returning, she and her special education team teacher, Alice Brooks, did a countywide math workshop for other teachers. “I am not as hesitant now,” Teresa says. “I don't back off teaching math. I learned that the children are capable of learning math language, and if we don't hold back, they can learn. We [teachers] have put them in a box and limited them.”

Teresa's newfound enthusiasm for math has inspired and motivated many of her students. Andy, a first grade student who knew nothing of basic numbers at the beginning of the year, has increased his math

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knowledge by leaps and bounds. Using another IntelliTools math product, *Number Concepts 1*, Andy went from learning his numbers in December to adding and subtracting to 18 by May. He loved doing math on the computer. “Oshi, the animated otter in the *Number Concepts 1* program, gave Andy self-confidence — the ability to say, ‘I know how to do that!’ It helped him develop his self-confidence because of the degree of feedback the software provided to him,” says Teresa.

The software is designed to give three levels of corrective feedback for students who need assistance. If the user does not know what to do, he or she is provided with the correct answer on the third try. Teresa also noted that “the record keeping was also very important. I could put any child on this program, and start him or her where necessary.” The software is designed to track the progress of each student, allowing the teacher to come back to the computer later to see how the student performed with his/her math problems.

Teresa and Alice used the new math technology products to help students in other ways. They demonstrated Andy's use of the manipulatives (which are part of the *Measure It!* program) at an Individualized Education Plan [IEP] meeting with his doubtful mother, to confirm Andy's difficulty in holding on to objects. This demonstration resulted in the mother agreeing to occupational therapy services for her son, something she had not “seen the need for” before this.

### **Improving Literacy with a Math Program**

Teresa and Alice noticed that children's expressive language skills at Ellen Myers School increased through the use of *Measure It!* because of the program's emphasis on speaking and writing. They also found that children expanded their speaking and writing vocabulary as a result of using IntelliTalk II, a new word processing program developed by IntelliTools.

At Ellen Myers School and at other sites in east Tennessee, children using the new *Measure It!* program were heard making new comparisons, first aloud and then in writing: “*The eraser is bigger than the paper clip, and the paper clip is smaller than the eraser.*” “*The book weighs more than the pencil.*” Teachers and ETTAC staff observed that incidental learning occurred frequently. ETTAC staff observing one lesson heard this dialogue between a teacher and her first grade students, while she held up a two-quart milk carton:

Teacher:        *What can you tell me about this carton?*

Students:       *It's a milk carton... It's heavy... It's light... It's full... It's empty... It's made of plastic... It's made of cardboard covered with wax... It's half full... We can't see through it... We don't know what's in it... We don't know its weight... We don't know its capacity until we know if there's something already in it... We can't compare it to other things, except size, until we see in it...*

The teachers attributed the richness of their descriptions to their use of *MeasureIt!*

Several children participating in the Math Project at other schools had significant expressive language disabilities and delays. Two children used augmentative communication devices, and two other children had limited vocabulary. Their gains were not measured in math as much as in expressive language skills. One little girl at Sunbright said her first word, “*Oshi*,” because of the great affection she developed for Oshi the Otter, the animated character in the *Number Concepts 1* software program.

In a full inclusion kindergarten in Greenville, a girl named Susan has a genetic disability that limits her speech and communication. Teachers added words to her communication device like 'big,' 'small,'

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'more,' 'heavy,' and 'light,' to prepare for the lessons with *Measure It!* They recognized that a lesson on comparing the weight of objects might not immediately be meaningful to her, so they looked at the lesson to find concepts that would be meaningful and useful and would help her in other ways, at school and at home. Susan loved to fill the measuring cups and bowls with the beans used in the *Measure It!* experiments, and other children would coach her to add more, to take some away, and then to place the container on the scales to weigh it.

Through this exercise Susan learned to follow directions, to work with her peers cooperatively, and to use the words 'more,' 'less,' and 'weigh.' These words were written on the devices she was using, under the pictures of the words, they were placed in different locations in her classroom and at home, and they were also signed to her. For example, "more" was on Susan's refrigerator at home. In this way, teachers addressed pre-literacy skills with Susan, including the ideas that reading is done from left to right; that objects can be represented abstractly with words; and that there are multiple ways to express words (with pictures, sign language, and with written language).

### **Increasing Independence**

Many of the teachers and teaching assistants participating in the IntelliTools project saw personality changes in students, as well as an increase in the independence of students with disabilities and their greater involvement in general classroom activities. Mark, a second grade boy with cerebral palsy, learned that he could no longer scribble his math answers, once he was introduced to *MathPad*, an on-screen math worksheet from IntelliTools that allowed him to do the same problems that the other children were doing on paper.

Although he could use a pencil, Mark had been habitually careless and hasty while finishing his math worksheets, and his answers were mostly unreadable. He often attempted to use this to his advantage, hoping that his teacher would accept his illegible efforts. She did not. Instead, she asked Mark to answer his math problems orally. "*Mark, what is  $3 + 2$ ?*" Mark's answers were always correct, but in a class with almost 30 other students, this personal attention was time-consuming and not always possible.

When Mark's teacher received *MathPad*, she recognized an answer to her dilemma. For the first time Mark was expected to do the same work as his peers, and to turn in neat and correctly finished work with all problems completed. In fact, he had to stay in from recess a few times to complete his work. The teacher was most amazed by the change in how Mark was perceived by his classmates, as they realized he could do the work as well as anyone else. He became an integral part of the class and more independent in other areas as well (Stanger, 1998).

Tim, a student with cerebral palsy at Mountain City Elementary in Johnson County, Tennessee, uses a power wheelchair for mobility and has a full-time teaching assistant with him in his general education classes. When his teaching assistant did not do things for him that he expected her to do, Tim became angry and disrupted the classroom, which often resulted in disciplinary action.

However, when Tim was provided with adequate tools for speaking, writing and math, his teachers, assistants, and peers recognized his abilities. At the start of the Math Project, Tim was introduced to a variety of adaptive technology, including the *IntelliKeys* keyboard, as well as a digitized speech device to augment his communication, since he is very difficult to understand. Tim used the word processing program *IntelliTalk*® to write about what he wanted for Christmas, and he learned to use his augmentative communication device to answer questions about spelling and math orally. He also learned that he was expected to do the same work as his peers.

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As teachers changed their expectations of Tim, his resentment about being expected to work changed to a growing sense of independence. He now wheels himself where he wants to go, moves from his wheelchair to his classroom chair with minimal assistance, and no longer uses the augmentative communication device. What his peers don't understand, he writes. He is now showing his classroom teacher and peers that he can use a pen and pencil in addition to the *IntelliKeys* keyboard.

### **Building on Mutual Success**

After closely observing and working with many teachers and students who have used the IntelliTools accessible curriculum materials for over the course of this project, we are learning that availability of proper assistive devices is just the beginning. Like any tool, assistive devices must be combined with a willing teacher, good pedagogy, and an expectant attitude. The process of using assistive technology becomes recursive: teachers see the tools, learn how to use them and see the benefits for all children.

Teachers become willing to include children with learning difficulties, want to adapt other materials, realize that the processes, tools and strategies used to teach students with disabilities are good for all students, and are willing to try new strategies with their students. The mutual successes of the teachers and the students breed new expectations. Teachers learn the power of being learners and communicate that to their students. This was seen over and over again during the IntelliTools Math Project.

As an example, Lois Symington, the ETTAC trial site leader, had the following experience during a training:

“One afternoon, after an all-day IntelliTools workshop in Mountain City, Tennessee, on how to use *Overlay Maker*<sup>®</sup>, *IntelliTalk*, *MathPad* and other new math products, I was weary and ready to go home. The teachers from local school districts seemed to have reached their capacity for absorbing what they were learning. Then at 3 p.m. one of the teachers, Daphne Greene, looked at me and said, ‘This is wonderful. Now I want to know how to adapt a social studies and science lesson for tomorrow.’ So we pulled out our chairs and kept on working and learning.”

This is what teaching and learning is all about.

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