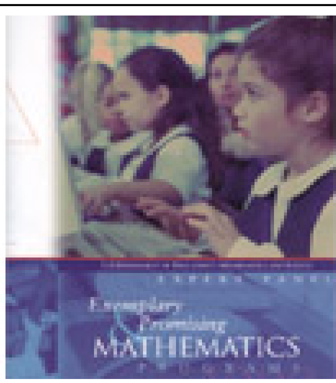
Solving the AYP Mathematics Dilemma with Technology

Lack of educational progress in reading and mathematics is not an option with ***No Child Left Behind*** *(NCLB) accountability mandates. Every academic year since January 2002 has produced a steady increase in the number of K-12 public schools identified as needing improvement. Simultaneously, due to an increasing influx of immigrants, the cultural diversity in public schools has mushroomed a decade earlier than expected. The re-authorization of the* ***Individuals with Disabilities Education Improvement Act*** *(IDEA) has ensured "appropriate services for all students" and reduced disproportionality in educational settings for minorities and English-limited students. Further, IDEA's "Highly Qualified Teachers" component inextricably links Special Education and General Education classrooms. Taken as a whole, these measures and events have synergistically created "a perfect storm" for K-12 education. How can any school or district guarantee adequate yearly progress (AYP) in mathematics for ALL students?*

The Mississippi Bend E2T2 Consortium

In 2002, the Mississippi Bend AEA analyzed LEA Iowa Test data, identified problem areas, set goals, aligned them with federal (**NCLB**) and state (**Iowa Goals**) legislation, developed action plans in reading and math, and set about the task of finding and funding an appropriate mathematics intervention. The funding problem was solved through NCLB Title II D monies. School district superintendents met and discussed a collaborative E2T2 math project proposal and district in-kind commitments. Sixteen out of 22 AEA 9 school districts chose to participate in the implementation of *Cognitive Tutor Algebra I*. Three districts opted to continue with their own math programs but agreed to participate in the E2T2 Consortium project as "controls". The remaining three were either not suitable for the content (two K-6 districts) or qualified for their own E2T2 project (an Urban Eight Network district).



Math Project with Integrated Technology

The search for the best mathematics intervention specifically addressing math problem-solving among students in grades 7-12 benefited from the work of a panel of experts assembled by the **National Science Foundation** in 1999. Their report identified 5 Exemplary and 5 Promising national mathematics curricula. The Consortium also sought a program that would develop students' technological abilities (**Iowa Goals**). Based on its rich developmental history, strong research base, and integrated use of technology, the E2T2 Consortium decided to implement Carnegie Learning's *Cognitive Tutor Algebra I* curriculum. This program subscribes to the **NCTM** process and algebra content standards. E2T2 funds were used to purchase software site licenses, student textbooks, professional development training, teacher training materials, teacher stipends, external evaluation and calculators.

Technology Infrastructure

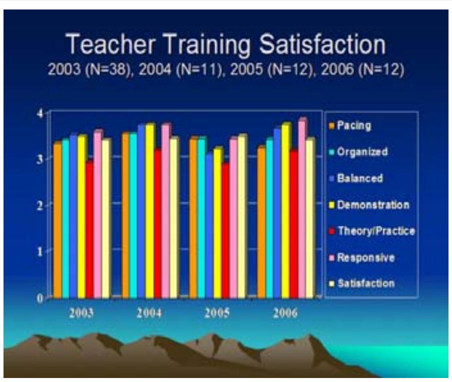
E2T2 Consortium school districts agreed to commit teachers, computers and the hardware necessary to support the mathematics project. Optimum implementation of *Cognitive Tutor Algebra I* requires a 1:1 student computer ratio. Overcoming this hurdle caused delays in implementation as districts bought new or added to their existing computer network systems. In most schools the program has been implemented by students traveling to a dedicated computer lab. In a few schools, students work on laptops in their math classrooms. In-kind support from Media funds were used to pay for AEA 9/LEA Internet services, ICN fees and acquisition of videoconferencing units. In addition, a **Scott County Regional Authority** grant provided funds for purchasing local units. Cognitive Tutor teachers are connected by this technology. **ESETP** funds provide scorer stipends for the Constructed Response test.

Strategies

In implementing *Cognitive Tutor*, technology supports mathematics instruction, it doesn't supplant it. Sixty percent of class time is spent in **direct** teacher **instruction**. The remaining 40% of class time, is spent on student-**computer tutoring**. The *Cognitive Tutor Algebra I* software is designed to deliver personalized math instruction using **multiple representations**. The graphical user interface displays **real-world scenarios** (relevant math problems) using text, drawings, tables and graphs. As students work to solve a problems, they are provided with just-in-time feedback (if needed) and guided to an efficient solution pathway. The student continues to receive similar problems until topic **mastery** is achieved. Computer instruction is scaffolded and spiraled. Since learning is socially-mediated (Vygotsky), **cooperative learning** techniques are an integral part of classroom instruction.

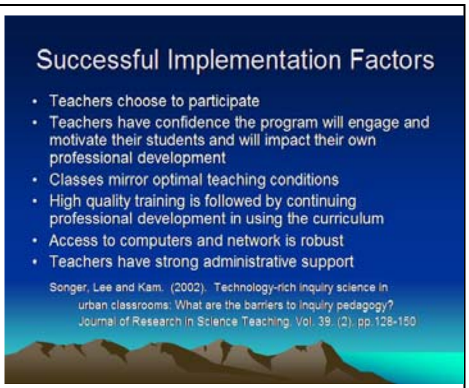
Learning Math

According to Thornburg, in the course of history, learning communities have met in "four primordial learning spaces: the campfire, the watering hole, the cave, and life". The power of cyberspace technology (the new campfire) is its ability to engage students — in classrooms (the watering hole) and on computers (the cave). *Cognitive Tutor* software, using research-based strategies (Cawelti, 2003), capitalizes on this ability and involves students in mathematics classrooms in applying mathematics principles to solve real-world problems (life) displayed in a visually accessible format on their computer screens. *Cognitive Tutor* supports Iowa's **Every Student Counts** (ESC) K-12 math initiative. The three pillars of the ESC program — teaching for understanding, problem-based instructional tasks and meaningful distributed practice — are embedded in the *Cognitive Tutor* curriculum.



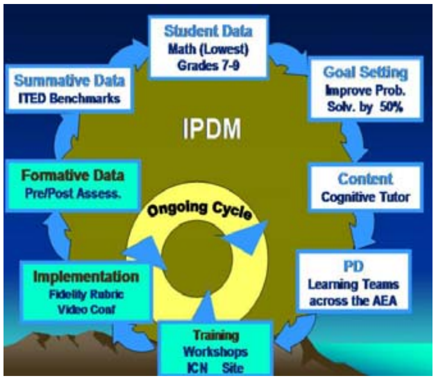
Training

Cognitive Tutor Algebra I teacher training began in the summer of 2003. The training format includes: an introduction to learning theory, the research behind the curriculum, cooperative learning research and strategies, demonstration of teaching scenarios, practice with the software, discussion of pacing, assessment and grading and planning time with veteran teachers that includes how to conduct a Family Math Night kit to encourage parent involvement. To date, 68 mathematics teachers have been trained to implement Algebra I; 10 teachers have been trained in Geometry (2005) and 4 teachers were trained in Bridge to Algebra (2006). Since 2004, Update training has been offered to all prior trainees. E2T2 funds purchase teacher training materials from Carnegie Learning. Monitoring data collected by Carnegie Learning support teacher satisfaction with this professional development event.



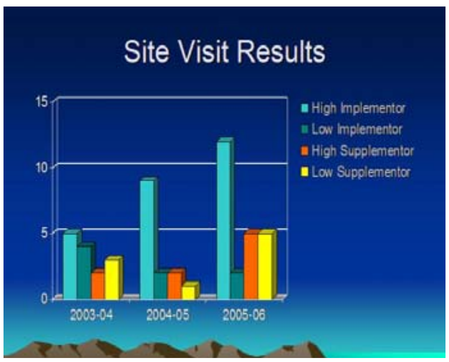
Implementation Support

Because of local control, AEA 9 school districts have used *Cognitive Tutor Algebra I* in two ways: as a complete program — textbook and software (implementation) or as a partial program — software only (as a supplement). And, the program is used in middle and high schools with students of differing abilities. Carnegie Learning's ideal *Cognitive Tutor* model requires teacher-directed learning 60% of class time and computer tutoring 40% of class time. Implementation support for the Cognitive Tutor teacher comes in several forms: Carnegie Learning has a 24/7 phone-in Help Desk, online tech support, an online K-12 Community Master Series website, and provides speakers on request; AEA 9 provides resources and pedagogical support; and classroom videoconferencing units allow all *Cognitive Tutor* teachers to connect with each other to discuss problems, observe a lesson, or to participate in coaching.



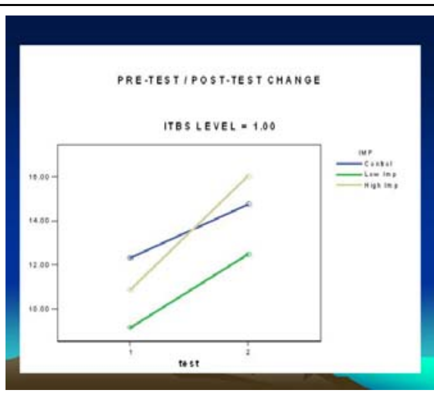
On-going Professional Development

The AEA 9 E2T2 Consortium project has followed the **Iowa Professional Development Model** (IPDM). To improve the quality of mathematics instruction and the technological abilities of the teacher trainees, E2T2 professional development has been technology-dependent. E2T2 resources are posted on the AEA 9 website: (http://www.aea9.k12.ia.us/04/ql_cog_tutor.php). Monthly professional development meetings are conducted over the **Iowa Communications Network** (ICN). Cognitive Tutor teachers communicate through email, a listserv and a distribution list. Two districts serve as Cognitive Tutor demonstration sites. Videoconferencing cohorts are formed with grade level peers. A new course, "Analyzing School/District Data to Improve Student Achievement", was piloted during the 2005-06 school year to assist Cognitive Tutor teachers in examining their district assessment data.



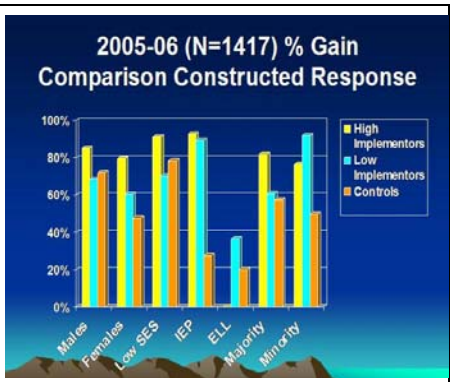
Site Visits

Formal on-site visits to evaluate program implementation began in December 2003. In collaboration with Carnegie Learning, an implementation rubric was developed from Songer's research. Representatives of Carnegie Learning have participated in all site visits. The purpose of the visit is to determine if the teacher is using the Cognitive Tutor program with fidelity to the Carnegie model, i.e. content and strategies. Since the 2003-04 school year, 65 teachers and classrooms have been visited. In 2006, the availability of videoconferencing units in Cognitive Tutor classrooms permitted some of these visits to be virtual. In the spring of 2006, select AEA 9 8th grade *Cognitive Tutor Algebra I* teachers were visited virtually by Gary Phye, the E2T2 external evaluator. Site visits give meaning to the analysis of data. Implementation fidelity and student gains are strongly correlated.



Assessing Impact

The goal of the E2T2 math project has always been to increase the percentage of low SES, minority and IEP students who are proficient in math in grades 7-12. An Algebra Assessment was developed to measure student attitude (25-item survey), content knowledge (30-item Multiple Choice test), and problem-solving ability (30-point Constructed Response test). A baseline test was administered in the spring of 2002 and again in 2003. Since the students were not the same it was decided that the assessment should be administered in the fall and spring using standard testing procedures. This has been the case since fall 2004. Cognitive Tutor teachers score the Constructed Response test twice a year. The scoring rubric has been refined and anchor papers compiled to provide consistency in scoring. A Geometry Assessment mirroring the Algebra format was developed and piloted in 2004-05.



Student Gain

For the last two years, E2T2 student achievement data from the Algebra and Geometry Assessments have been disaggregated by districts and subgroups and compared. In looking at the *Cognitive Tutor Algebra I* data by district, the pattern that seems to emerge is this: if the classroom teacher supplements with Cognitive Tutor, gain scores range between 7% and 18%; if the classroom teacher implements Cognitive Tutor with fidelity, gain scores range between 11% and 36%. Differences can be attributed to class and teacher characteristics. *Cognitive Tutor Geometry* data by district is more compelling. The geometry teachers are all implementing with fidelity and their gain scores range between 24% and 30%. A comparison of low SES, minority and IEP students in high and low implementation and control groups seems to show that using the *Cognitive Tutor Algebra I* curriculum benefits these students.