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in this issue

The International Technology Education Association defines educational technology as "the use of technological developments, such as computers, audio-visual equipment, and mass media, as tools to enhance and optimize the teaching and learning environment in all school subjects, including technology education."This issue of *RBS Currents* focuses on the use of technology in the classroom in order to "enhance and optimize" teaching and learning. There are many ways that technology can be a resource in education, other than just as a learning tool, but we chose to set our focus on where technology directly impacts students in the continuous effort to improve student academic achievement. In this issue, you'll read about technology standards, the *No Child Left Behind* Act and technology, the use of calculators, and what research says about the use of educational technology. There are also examples of how educational technology is being used within the mid-Atlantic region, information on organizations that support technology in the classroom, and much more.

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Technology in the Classroom

by Mike Speziale

Why should we use technology in education? Does it simply replace paper and pencil or are there ways to use technology to enhance the learning experience? Though there are no clear-cut answers to these questions, there are some indicators for the effective integration of technology in education.

In 1996, the report *Getting America's Students Ready for the 21st Century*, stated the following:

The United States and the world are now in the midst of an economic and social revolution every bit as sweeping as any that has gone before: computers and information technologies are transforming nearly every aspect of American life. They are changing the way Americans work and play, increasing productivity, and creating entirely new ways of doing things. Every major U.S. industry has begun to rely heavily on computers and telecommunications to do its work.

But so far, America's schools have been an exception to this information revolution. Computers and information technologies are not part of the way most American students learn. Today's students spend an average of only a few minutes a day using computers for learning (U.S. Department of Education).

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Does Technology Increase Student Learning?

by Debra Gingerich

Most people probably believe that technology should be used in the classroom. It just makes sense; technology is used everywhere else. Conventional wisdom suggests that it benefits students to learn the technology that they will need to use in the workforce. The International ICT (Information and Communication Technologies) Literacy Panel's report *Digital Transformation* (Education Testing Service, 2002) states, "The notion of a literate populace must be expanded to include the technology-based skills and abilities that will enable citizens to function in an increasingly technological world" (p. 1). But when determining whether or not technology should be used in the classroom, it is important to ask if educational technology increases students' learning. Does it have a positive impact on student achievement?

Some Recent Research

As is true in many areas of education, more research needs to be conducted on the use of technology in the classroom, and the research that has been done does not lead to one clear conclusion. Still, recent meta-analyses of research studies indicate that technology has produced a small but positive effect on student achievement.

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SRI International's Center for Technology in Learning has conducted a meta-analysis on the effectiveness of technology that looked specifically at discrete educational software (Murphy, et al., 2002). The kinds of software included were integrated learning systems, computer-assisted instruction, computer-based instruction, and software designed to teach reading and mathematics. Out of the 195 studies it found, only 31 met its requirements for analysis: the use of a comparison group, large enough samples, reliable measures of achievement, and sufficient information for estimating an effect size. The authors of this study bemoaned both the limited research base in this area and many studies' failure to report the basic information needed to evaluate their outcomes. From the studies they did evaluate, they "found evidence of a positive association between student achievement and the use of discrete educational software products to support instruction in reading and math" (p. 38).

In 1999, the Milken Exchange on Education Technology analyzed the five largest studies of educational technology to date (Schacter, 1999). The studies it examined were:

- A meta-analysis of over 500 studies
- A review of hundreds of individual studies
- A partnership between Apple Computer, Inc. and five schools
- West Virginia's 10-year statewide education technology initiative
- A national sample of fourth- and eighth-grade students using newer simulation and higher-order thinking technologies.

This study concluded that in the use of computer-assisted instruction, integrated learning systems technology, simulations and software that teach higher-order thinking, collaborative networked technologies, and design and programming technologies, there were positive gains in achievement on researcher-constructed tests, standardized tests, and national tests.

In December 2002, the North Central Regional Educational Laboratory published its findings on the effects of teaching and learning with technology on student outcomes (Waxman, et al., 2002). This analysis looked at 20 studies containing a combined sample of about 4,400 students. Its results indicated that "teaching and learning with technology has a small, positive, significant effect on student outcomes when compared to traditional instruction" (p. 2). Its findings also concluded that there was little difference in results among kinds of technology used, instructional style, subject, and characteristics of the study.

Practical Implementation

Even though research suggests that the use of technology in the classroom can improve student achievement, educators should not hastily run out to their local computer store and start buying software. Technology must be thoughtfully integrated into an educational setting. The authors of "Changing How and What Children Learn in School with Computer-Based Technology" conclude, "Using technology to improve education is not a simple matter. There are many kinds of technology, and many ways that an attempted use can fail" (Roschelle, et al., 2001, p. 25). They suggest that technology be chosen that enhances the four characteristics cognitive research has shown to be fundamental for effective learning: (1) active engagement, (2) participation in groups, (3) frequent interaction and feedback, and (4) connections to real-world context. Carol Kimble (1999), in her policy brief *The Impact of Technology on Learning: Making Sense of the Research,* offers two guidelines for successfully integrating technology: decide what is the best way to use it within a particular context and content, and pursue teacher training specifically related to the intended use.

The WestEd Regional Technology in Education Consortium also helps outline some best practices for using technology in the classroom (Ringstaff & Kelley, 2002). It recently published a review of findings from research on the learning return of educational technology investment. The authors of this review drew from a selection of methodologically sound research that studied computer-based tools: hardware, software, the Internet, and computer-based multi-media. They determined six factors that appeared to be crucial elements for successfully using technology:

- Technology is best used as one component in a broad-based reform effort.
- Teachers must be adequately trained to use technology.
- Teachers may need to change their beliefs about teaching and learning.
- Technology resources must be sufficient and accessible.
- Effective technology use requires long-term planning and support.
- Technology should be integrated into the curricular and instructional framework (pp.2-3).

Conclusion

With the constant advancement and use of technology in work and personal life, it cannot be ignored in the classroom. And though more studies are needed, the present research does seem to indicate that it is an asset for student learning. As with all the choices that educators make regarding how best to teach a subject or lesson, technology integration must be considered thoughtfully. Educators must make their decisions based on the needs of the students, teaching methods used, learning styles, and professional development needed, as well as the hardware, software, and networking requirements. Educators need to gain knowledge about the different technologies available, what research says about their use, and how best to use the technology to enhance their educational program.

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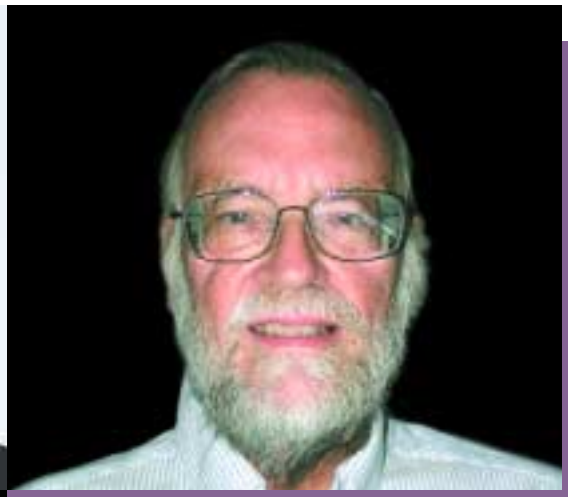

Calculating Success in Mathematics: An Interview with:

Dr. Frank Demana *Dr. Bert Waits*

by Alison Rooney

Educational technology experts Dr. Frank Demana and Dr. Bert Waits have been working as a team for 20 years, which becomes immediately apparent when you talk with them about their work. This self-described "duo" can finish each other's sentences and anticipate one another's responses, even during a phone interview while they are in different parts of the country. This rapport developed over years of teaching at Ohio State University, where they are now professors emeritus of mathematics, and has continued with their various other collaborative projects. They founded their own mathematics in-service teacher professional development program in the mid-1980s called T3 (Teachers Teaching with Technology). The T3 program is now part of the professional development program of Texas Instruments (TI). Demana and Waits have been consultants for TI since the late 1980s, designing materials to use computers and graphing calculator technology for more effective teaching of mathematics. They helped design TI's first graphing calculator, the TI-81, and worked on making computer-generated visualization part of high school and college textbooks. Today they consult for several organizations to train teachers in how to use technology in their teaching. Our conversation focused on one of their many shared passions—how the proper use of technology leads to better understanding and stronger mathematics skills for K–12 students.

RBS: Why should our students use calculators in learning mathematics? Won't that lessen students' skills and command of basic facts and make them reliant on the calculator to do all of the work?

Demana: The question is not whether students should be exposed to this technology, but when and under what circumstances. When used appropriately, these devices are very effective in demonstrating the power of visualization. We do not believe that calculators should take the place of old-fashioned, pencil-and-paper mathematical computations. Students should by all means also be creating tables and plotting coordinates using only graph paper and their brains.

RBS: How can calculator technology change and/or strengthen the mathematics that we teach?

Demana: Using pencil and paper is necessary to start the process. There is tremendous skill required in converting those processes that are done on paper into technology, if students are to understand why the processes work, and what is the mathematics behind the conversion.

With the help of calculators, middle school students can do optimization problems (finding the maximum or minimum) in algebra, because the technology removes the tedious paper and pencil computations. Without them teachers would have to wait until calculus for students to have enough tools to do this kind of problem. The technology makes the problem possible, and therefore makes more mathematics possible.

Technology has also caused a drastic change in what people are teaching. Now it is possible to introduce students to problems that use real data sets. These data sets give students a context in which to learn mathematics. And it has been shown that when students learn in context, they are more likely to retain the information or skill. Algebraic computations without that context are not as meaningful to students.

RBS: Why should we use calculators, or handheld technology, instead of computers?

Waits: A graphing calculator is both portable and affordable. These handheld devices are very inexpensive compared to desktop computers. They perform several of the same important functions that desktop computers can, at generally under $100.

Demana: Schools do not have enough computers or computer lab time. Many schools are lucky to have one computer lab, which must be shared with other subjects and cannot be available for mathematics instruction all the time. With handheld technology, students have the technology at their disposal at all times—students can put calculators in their backpacks and use them on buses. They are also a good investment, in that they do not become obsolete as quickly as computers.

RBS: What problems do you see when teachers and students use calculators in mathematics classes?

Waits: Sometimes a teacher will let students use calculators for a problem that they should be able to do in their heads. For example, students should be very familiar with the graph of y=x2; they should know it's a parabola, where its origin is, what it looks like, and how it opens up—*without using any technology!* However, once they understand this, it is helpful to use this example when they are starting to use a graphing calculator, to show that the results agree with what they already know. It is a place to begin to tie together their previous pencil-and-paper experience with their work on the calculator.

Demana: We try to teach the teachers when it is appropriate to use each approach—when the technology will be more beneficial and when the traditional approach is better. Teachers who skip the first step of doing things on paper miss the chance to explore how the two are connected. If students don't know how they got from pencil and paper to technology, then the technology isn't helpful.

RBS: How can teachers communicate with parents to help them understand why students can benefit from the use of calculators in mathematics?

Waits: One thing that has been effective is to have parents come in and sit in the classroom with their son or daughter and see what they are doing and how powerful it is for the student—using specific applications, like computing interest on loans or visualizing a mathematical concept like optimization. Then have the students show the parent the value of the technology and that it is not just being used as a shortcut. This can be effective even with the younger grades.

RBS: How can using calculators in the classroom help students prepare for and take high-stakes tests that do not permit the use of calculators?

Demana: We believe it's possible to take kids to a higher level in mathematics with the practice of tasks using technology, then doing the same items by hand, and seeing how the two compare. In the classroom, students do traditional problems without technology. Then, using technology, students can work to solve more difficult problems that delve more deeply into the mathematical concepts. The technology makes probability scenarios, for example, far more understandable. Students gain a deeper understanding of the concepts to help them better approach the more routine problems that are on the tests.

RBS: How are calculators best suited to the different grade levels in K–12?

Waits: Because school districts generally do not provide the support that the teachers need in order to appropriately and effectively teach with calculators in elementary school, I personally have difficulty encouraging teachers in pre-K through fifth grade to use calculators, though they can be of value for students with the right presentation and teacher training. In higher grades this is less of a problem. At the middle school level, graphing calculators can be helpful if they are used in context by trained teachers. In grades 9–12, graphing calculators are suitable and necessary as both a learning and computational tool.

RBS: Could you give us an example of a problem involving calculators that (1) stretches students beyond what they can do in mathematics without the use of calculators, and (2) helps students to better understand mathematics concepts?

Demana: Take a piece of lined rectangular graph paper (lined in inches). Cut a one-inch square from each corner, then fold the tabs up to make a box with no top. With pencil and paper, have the students write down the height, length, and width of the box. Now ask a concrete question like, "How much popcorn would fit into the box?" This illustrates volume. Now have students experiment with creating different-sized boxes by cutting different-sized squares from the corners. As students plot the various values, they can see volume as a function of the size of the box. Now the problem becomes, "What shape produces the most volume?" Use a calculator to determine the volume of various boxes that the students create. Because these calculations are tedious and time consuming, this wouldn't be reasonable to do unless you introduced calculators.

Waits: Then students can follow up with determining an algebraic model (a function) that represents the box-volume problem and graphing the function to find a square cutout that yields the maximum volume. This is an example that can be developed by teachers in middle grades through calculus.

Drs. Waits and Demana have written papers on the above problem and others like it. For more problems and further information, visit:

http://emptweb.mps.ohio-state.edu/dwme/papers.asp and
http://education.ti.com/story/success.jsp

Laptops Raise Student Motivation and Achievement in DC Classroom

by Wendy Coffman

"I've been teaching for 34 years, and this year was by far the height of my career," says sixth grade teacher Muriel Jackson of Thomson Elementary in DC Public Schools, who for the first time had a laptop computer for each student in her classroom.

"At the beginning of the year, I was told that the outlook for my class might not be so good because of discipline problems. But the computers helped to motivate the students and everyone could see the change. And what's more, the test scores proved it. They went from below basic to above the national norm in reading and math all in one semester!"

Jackson's students were a culturally diverse group of 19 students coming from African American, Asian/Pacific Islander, and Latino backgrounds. Five were English language learners. All but two of the students had scored below basic in the previous year. Few had computers at home.

The school year began on unfamiliar ground because Thomson Elementary was undergoing renovation and had to relocate its classrooms to a district professional development center. Rather than being a disruption, the change in venue turned into an opportunity. The district's technology office was housed in the same building and had laptops that weren't being used. By January of 2003, Jackson found her classroom outfitted with Internet-connected laptop computers.

Armed with the content standards and her own knowledge of educational software and Internet resources, Jackson set out to make the best use of the computers to help her students learn. Not long after, she saw the motivation level of her students increasing. She credits the computers for improved attendance, an increase in student respect for one another, and the establishment of a cooperative learning atmosphere. "With the computers, they were excited to teach each other and to learn from each other," said Jackson.

With the increased motivation came increased learning. For example, maintaining electronic portfolios of their work helped to improve the students' organizational and study skills. Online educational sites and software programs allowed each student to work on his or her own level and feel comfortable with the material. Using electronic spreadsheets helped students better understand, analyze, and chart data. Students improved their research skills through Internet searches and learned how to tap into the online card catalog of the public library. They improved their speaking and presentation skills by presenting multimedia summaries at the end of the year.

Jackson found that Internet resources were particularly helpful in science. "In the past, I had to help students choose a topic for the science fair. This year, my students searched the Internet and had no trouble coming up with their own topics and researching them. For many students, the Internet resources were much more student-friendly than their science textbook."

Parent involvement also increased. Jackson built relationships with all of the students' parents, and had both a classroom mother and father who were visible and helpful throughout the year.

The year culminated with the students' release of the documentary they filmed using iMOVIE. The documentary chronicled the past few months at the school and tested the students' editing and writing skills. The students' work was so compelling that Apple Computer and the American Federation of Teachers invited the students to demonstrate what they learned and how they produced the movie at their annual summer conference.

When asked what motivated a 34-year veteran teacher to stay current with new technologies, Jackson explained that 10 years ago, she began seeing new teachers with educational technology skills that she, as an experienced teacher, did not have. She realized that for her years of experience to mean something to student learning, she had to take the initiative to keep herself current with educational technologies. "As I developed new skills, I took them to the classroom. It's that easy."

PA State Team Sponsors Technology in Mathematics and Science Conference

by Debra Gingerich

Nearly 200 people weathered the snow and ice to attend the Technology in Mathematics and Science Conference, held in State College, PA on February 24-25, 2003. This conference, sponsored by the Pennsylvania State Team for Mathematics and Science Education supported by RBS, was coordinated by Janie Zimmer, RBS' mathematics associate and liaison to the PA State Team. Conference participants received valuable hands-on information on the educational uses of technology in mathematics and science, including computers and computer software, basic and graphing calculators, scientific probes, Internet use, distance learning, and much more. The conference included keynote addresses, sessions, and exhibits intended to meet its three objectives. The conference endeavored to help participants:

A participant shares an insight for an application.

1. increase their awareness of technologies that can be used to strengthen the teaching and learning of mathematics and science in their own classrooms and schools

2. increase their knowledge of how to obtain educational technologies for their own classrooms and schools

3. increase their abilities to incorporate technology effectively into their own classrooms and schools.

Four keynote addresses framed the conference. Dennis Christopher of the NASA Goddard Space Flight Center opened the event on Monday morning. He outlined the ways that everyone can learn from the experiences of those who are a part of the Educator Astronaut Program. Christopher also contributed to two popular sessions at the conference: a report on the Space Shuttle Blake Project and ways to work NASA distance learning into the curriculum.

Participants explore the electronic version of Game of 24.

The mid-day keynote address focused on the three digital school districts in Pennsylvania: Quaker Valley School District, Carlisle School District, and Spring Cove School District. These digital districts are intended to be living laboratories that demonstrate how an infusion of sophisticated technology use by well-trained educators can systematically redefine all aspects of teaching and learning. This address highlighted the successes and challenges of these districts. For those seeking additional information on the digital districts, sessions were offered that focused on one-to-one computing and how the classroom looks different in a digital school.

Milton Norman of Texas Instruments concluded the activities on Monday with his keynote address, "How much electronic technology is too much?" One of the 12 original instructors in the Teachers Teaching with Technology program, Norman, as well as others experienced in calculator use, provided several demonstrations and educational sessions on the graphing calculators that Texas Instruments has available. Participants learned how to use these calculators as well as how to integrate their use into the classroom.

Participants ponder the possibilities of the TI-92 graphic calculator.

STATE TEAMS

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The final keynote speaker on Tuesday, William Hadley of Carnegie Learning, offered a history of the role of technology in education and pondered the challenges and possibilities for the continued use of technology. He emphasized the importance of ensuring that educational technology be effective.

The hours between the keynote addresses, break times, and meals were filled with sessions on many kinds of technology and their classroom uses. Handheld computers, classroom Web pages, effective use of the Internet, four-function calculators, classroom activities using K'NEX, and data-driven decision making were just a few of the sessions offered.

Participants left the conference with ideas that could be directly integrated into their classrooms as well as understandings of what the future could hold in educational technology. As one teacher explained, "Overall, the conference was excellent. I am returning with several ideas and materials to implement those ideas." The PA State Team plans to sponsor another technology conference in March 2004 to continue to provide educators with much-needed information on technology and its effective use in education.

ETTCs Support Educational Technology in New Jersey

by Alison Rooney

Each of the 21 counties in New Jersey houses an Educational Technology Training Center (ETTC) that offers educators professional development in technology. One of these ETTCs, the Southern Regional ETTC based at Richard Stockton College of New Jersey in Pomona, received a prestigious National Telecommunications Partnership Award in 2002.

The Southern Regional ETTC Consortium represents some 66 school districts and other regional organizations in Atlantic, Cumberland, Cape May, Monmouth, and Ocean counties and over 72,000 K-12 students. It is open for membership to schools, organizations, and nonprofits outside the region as well, for a very modest annual fee. The ETTC provides guidance and technical assistance sessions supporting database design and maintenance, proposal writing, and technology planning. The ETTC Demonstration Center provides teachers and school staff a chance for hands-on exploration of computers and educational software. It also offers books, self-study guides, manuals, curriculum-related materials, and sample lesson plans. Staff members are always on hand to answer questions.

The ETTC offers a comprehensive list of courses on educational technology as well as other topics. One course offered this fall is "Starting to Teach," a four-session course for new elementary and middle school teachers covering everything from classroom management to technology ideas. This spring it will be introducing two new series, both funded through the New Jersey Statewide Systemic Initiative (NJ SSI): "Technology Integration for Everyday Math" and a professional development opportunity based on the ecology of the Pinelands. There are also a number of selections related to classroom integration of technology. All listings are available online.

One of the ETTC's most popular offerings each year is the annual conference, "From My Classroom to Yours." Dina Abbamondi, the ETTC interim director, says, "This year's conference brought together 400 teachers for 60 workshops on a wide range of issues including character education, distance learning, mathematics and science education, multidisciplinary strategies and special needs, and technology integration." Next year's conference will be held on May 10, 2004.

The ETTC online resource center provides a number of links that educators will find helpful including: the "ETTC top ten" Web sites, lesson plan databases from local teachers, mathematics/science resources created for NJ SSI projects, workshop materials, and an online WebQuest course. Educators can also explore winning ideas from past years of the ETTC annual Technology in the Classroom Contest. This annual contest fosters the growth of new ideas on how technology can fit in K-12 education.

For more information visit http://www.ettc.net.

Technology and NCLB

by Debra Gingerich

Though the focus of the *No Child Left Behind* (NCLB) Act has been on improving students' achievement in reading, mathematics, and science, NCLB also supports the learning of technology and its use in the classroom to help improve academic achievement. U.S. Secretary of Education Rod Paige said in a press release in 2002, "By harnessing technology, we can expand access to learning and close the achievement gap in America. And that's the critical mission of the *No Child Left Behind* Act of 2001."

The U.S. Department of Education (ED) states that the way to improve student achievement with technology is to teach children how to use technological tools available to them and to integrate that technology into the curriculum. NCLB includes several grants and programs intended to help educators effectively provide technology in the classroom.

Community Technology Centers

The Community Technology Centers grant offers funds to create, expand, and evaluate community technology centers that provide access to information technology and training to residents of economically disadvantaged urban and rural communities. Eligible applicants could be state educational agencies, local educational agencies, institutions of higher learning, for-profit businesses, non-profit organizations, or a group of these. At these locations, people should get free or low-cost access to computers and computer-related technology, such as the Internet, along with learning opportunities. More information on these centers can be found at the Community Technology Centers' Network Web site (http://www.ctcnet.org).

Enhancing Education through Technology

The Enhancing Education through Technology (Ed-Tech) grant program's primary goal is to improve student academic achievement through the use of technology in schools. To reach this main goal, the program is designed to assist students to become technologically literate by the end of eighth grade and ensure that teachers are able to integrate technology into the curriculum by supporting appropriate professional development. ED provides grants to state educational agencies through Ed-Tech. States can keep up to five percent of their allocations. One-half of the remainder is available to eligible districts through a formula based on Title I. The other half is awarded through a competitive process to high-needs districts or partnerships with high-needs districts. Each state and district is required to develop accountability measures to ensure its activities are effective in supporting the integration of technology into curriculum and instruction. To find out more about receiving money through this program, contact your state's department of education technology office. A list of these offices is available at http://www.ed.gov/offices/OESE/SST/EdTechContacts.html.

Most of the state educational agencies in the mid-Atlantic region also have Web pages devoted to technology:

Delaware at http://www.dcet.k12.de.us/index.html,
Maryland at http://www.msde.state.md.us/technology/rfa.html,
New Jersey at http://www.state.nj.us/njded/techno,
and Pennsylvania at http://www.pde.state.pa.us/ed_tech/site/default.asp.

Regional Technology in Education Consortia

NCLB authorizes funding for the remaining years of the current grant to the Regional Technology in Education Consortia. This program funds 10 regional consortia composed of institutions of higher learning, non-profit organizations, and state educational agencies. The consortia provide professional development, technical assistance, and dissemination of information on technology to educators. The Mid-Atlantic Regional Technology in Education Consortium (MAR*TEC) is housed at Temple University (http://www.temple.edu/martec). MAR*TEC provides the Tech Fellows Institute, Technology Mentoring Project, State-of-the-Art Seminars, and other professional development opportunities.

Preparing Tomorrow's Teachers to Use Technology

The Preparing Tomorrow's Teachers to Use Technology (PT3) grant program's goal is to transform teacher education so that technology is integrated throughout teaching and learning. Since 1999, PT3 has awarded over 400 grants to educational consortia to help address this challenge. They work to ensure that new teachers enter the classroom prepared to effectively use the computers that await them. More information on PT3, including a list of grantees and their projects, is available at http://www.ed.gov/teachtech/index.html.

National Educational Technology Standards Support Teachers and Administrators

by Wendy Coffman

The ways in which educational technologies can support student learning seem to be growing and changing every day. Effectively integrating technology in this ever-changing environment is an ongoing challenge for educators. How do we know if our classrooms are integrating technology appropriately? What support is there for educators who want to improve their use of technology to aid student learning?

One guide for technology integration is the National Educational Technology Standards (NETS). Published by the International Society for Technology in Education (ISTE), the NETS provide standards and performance indicators for students, teachers, and administrators. Summaries of these standards are shown in Tables 1, 2, and 3.

Because educational technology can be integrated across all subject areas, the NETS are written to complement subject area standards. ISTE provides supportive resources to help educators use the standards in their daily practice. Two online publications, *Preparing Teachers to Use Technology* (http://cnets.iste.org/teachers/t_book.html) and *Connecting Curriculum with Technology* (http://cnets.iste.org/students/s_book.html), provide lesson plans, learning activities, and assessment resources that are matched with the technology standards and subject area standards. In addition, the monthly publication *Learning and Leading with Technology* (http://www.iste.org/LL/30/9/index.cfm) includes lessons and ideas that are referenced to the NETS and aims to develop leadership.

"Leadership is a key factor," says Don Knezek, CEO of ISTE. "We find that when educational technology integration is done well, there is usually a savvy leader involved. It is critical for leaders to be able to recognize and reward good integration of technology and quality technology-based instruction."

In the article "Standards for Technology-Supported Learning Environments," Thomas and Knezek (2002) describe the essential conditions for supporting standards implementation. These include long-range planning that ensures a shared vision, equitable access that is consistent across all educational environments, skilled personnel, professional development, technical assistance, content standards, and curriculum resources. These essential conditions for implementing technology standards for students, teachers, and administrators are available at http://cnets.iste.org/teachers/t_esscond.html.

"Our mission is to support people who are using the standards," explains Lajeane Thomas, project director of the NETS. Thomas describes the importance of making the standards useable for educators. "We used a collaborative process with input from teachers of all

Table 1: NETS for Students

Basic operations and concepts

- Students demonstrate a sound understanding of the nature and operation of technology systems.
- Students are proficient in the use of technology.

Social, ethical, and human issues

- Students understand the ethical, cultural, and societal issues related to technology.
- Students practice responsible use of technology systems, information, and software.
- Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.

Technology productivity tools

- Students use technology tools to enhance learning, increase productivity, and promote creativity.
- Students use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.

Technology communications tools

- Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.
- Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.

Technology research tools

- Students use technology to locate, evaluate, and collect information from a variety of sources.
- Students use technology tools to process data and report results.
- Students evaluate and select new information resources and technological innovations based on the appropriateness for specific tasks.

Technology problem-solving and decision-making tools

- Students use technology resources for solving problems and making informed decisions.
- Students employ technology in the development of strategies for solving problems in the real world.

grades and subjects, librarians, technology specialists, administrators, and students to help develop standards that are sensible, useable, and measurable."

At present, 48 states, including all in the mid-Atlantic region, have adapted, adopted, aligned with or referenced the NETS in their state technology plans and other state documents. Currently the NETS program is focusing on developing more assessment resources.

The NETS and supportive materials are on the ISTE Web site at http://cnets.iste.org. Additional materials supporting integration of technology in the classroom are available at the main ISTE site: http://www.iste.org.

Table 2: NETS for Teachers

Technology operations and concepts

- Teachers demonstrate a sound understanding of technology operations and concepts.

Planning and designing learning environments and experiences

- Teachers plan and design effective learning environments and experiences supported by technology.

Teaching, learning, and the curriculum

- Teachers implement curriculum plans that include methods and strategies for applying technology to maximize student learning.

Assessment and evaluation

- Teachers apply technology to facilitate a variety of effective assessment and evaluation strategies.

Productivity and professional practice

- Teachers use technology to enhance their productivity and professional practice.

Social, ethical, legal, and human issues.

- Teachers understand the social, ethical, legal, and human issues surrounding the use of technology in PK-12 schools and apply those principles in practice.

Table 3: NETS for Administrators

Leadership and vision

- Educational leaders inspire a shared vision for comprehensive integration of technology and foster an environment and culture conducive to the realization of that vision.

Learning and teaching

- Educational leaders ensure that curricular design, instructional strategies, and learning environments integrate appropriate technologies to maximize learning and teaching.

Productivity and professional practice

- Educational leaders apply technology to enhance their professional practice and to increase their own productivity and that of others.

Support, management, and operations

- Educational leaders ensure the integration of technology to support productive systems for learning and administration.

Assessment and evaluation

- Educational leaders use technology to plan and implement comprehensive systems of effective assessment and evaluation.

Social, legal, and ethical issues

- Educational leaders understand the social, legal, and ethical issues related to technology and model responsible decision-making related to these issues.

Reference

Thomas, L.G., & Knezek, D.G. (2002). Standards for Technology-Supported Learning Environments. *The State Education Standard,* 3, 14-20.

Technology in the Classroom

Continued from Page 1

As a result of this and other similar reports, educational leaders and government officials alike have emphasized the need for technology to be an integral part of the move toward high standards in all subjects (Barron, et al., 2003). In 2001-2002 alone, schools spent an estimated 5.6 billion dollars on technology (McCabe & Skinner, 2003). Why are districts pouring countless dollars into technology? The answer comes from many sources, but there is a common realization that our country's position as a leader in the global economy is dependent on how well our schools prepare students to use advanced technologies.

Even in view of this realization, positive effects of technology on student performance have been slow to materialize. As another article in this issue shows, there is research that indicates an increase in student achievement due to the use of technology. But others like McCabe and Skinner (2003) have reported that "in many research studies, the link between educational technology use and improved student achievement is uncertain, at best" (p. 50). Some researchers assert that this is due to the limited and ineffective applications of computers and other technological devices in the teaching/learning environment. McCain and Jukes (2001) state, "For the most part, computers are still being used to reinforce old ways of doing things—we simply have powerful new devices that allow us to do this work faster and more efficiently" (p. 8). In order for technology to become effective, it must become a seamless part of the instructional process, much the way that blackboards and overhead projectors have become ubiquitous tools for teaching.

Benchmarks for seamless integration have been developed by the International Society for Technology in Education (ISTE) through the National Educational Technology Standards (NETS) project (see other article in this issue). The NETS project has identified standards for students, teachers, and administrators. NETS for teachers include standards in the following six areas:

- Technology operations and concepts
- Planning and designing learning environments and experiences
- Teaching, learning, and the curriculum
- Assessment and evaluation
- Productivity and professional practice
- Social, ethical, legal, and human issues (ISTE, 2003).

Only when teachers have mastered these standards, in particular the one that relates to planning and designing learning environments and experiences, will seamless integration occur. Effective professional development for teachers and principals and improved pre-service teacher education are necessary for achieving this goal. Too often, computers have been provided for teachers with little or no associated training. Consequently, applications in classrooms have been focused on simplistic uses such as drill and practice programs—a traditional use ofcomputers, but not effective integration.

Dockterman (1998) addresses the learning environment standard and identifies integration strategies for teaching methodologies including whole and small (cooperative) group instruction, learning centers, individualized programming, productivity tools, and communication tools. In each of the methodologies, technology becomes a tool that enriches the learning environment. Below are some examples of how a teacher might integrate technology into different teaching methodologies.

Whole Group Instruction

In whole group instruction, computers can be coupled with projection devices to display computer images so that all students can view the contents. For example, when lecturing about volcanic activity and tectonic plates, a science teacher can use a computer to call up a video from United Learning (http://www.unitedlearning.com), an on-line source for thousands of content-rich video clips and related educational materials.

A mathematics teacher can use Geometer's Sketchpad® (http://www.keypress.com/sketchpad/) to dynamically demonstrate the properties of an isosceles triangle. The teacher can display one triangle and have students generate possible characteristics. As additional isosceles triangles are displayed, the students apply their self-generated characteristics. Over a period of time, the students arrive at characteristics that apply to all isosceles triangles. This represents a constructivist alternative to material that is traditionally taught as a series of figures and a simple definition of terms.

Small (Cooperative) Groups

A science teacher can use The Great Ocean Rescue (http://www.tomsnyder.com) as a culminating, performance-based activity. The class can be divided into cooperative groups of four with each student in a group given a different responsibility (i.e. oceanographer, geologist, etc.). The teacher shows the class a digital video that poses a problem. In order for the group to be successful at solving the problem, each member must contribute from his/her role-play perspective.

In a mathematics class, a teacher can divide the class into groups of four and assign each group a separate WebQuest (http://webquest.sdsu.edu/) dealing with statistics. One group can complete the WebQuest on population growth while another works on statistics related to the final voyage of the Titanic. Groups can use graphics and presentation software to present their findings to the class.

Individualized Programming

A student who is having difficulty in mathematics can be assigned specific units in an integrated learning system (e.g., CompassLearning Odyssey™–http://www.compasslearning.com). The program provides a tutorial on the specific standards and objectives identified through a variety of classroom assessments. This can occur during independent student time or after school—extending the learning day.

Productivity

Students can use multimedia presentation tools like Hyperstudio® (http://www.hyperstudio.com/) and PowerPoint® (http://www.microsoft.com/office/powerpoint/default.asp) to demonstrate their understanding of concepts. For example, students in science can create a Hyperstudio® stack to show the interactions of pressure and volume. Students in mathematics can use PowerPoint® to show the relationships between decimals and fractions.

Learning Centers

One product that can be used as a learning station in a science lab is Exploring the Nardoo (http://www.its-about-time.com/htmls/software/sonardoo.html), a watershed simulation tool to conduct tests on the Nardoo River. With this product, students use a simulated digital tool that allows them to conduct a variety of tests (e.g., oxygen and nitrogen levels) at different points in time. The river goes through an evolution as it is subjected to deforestation, mining, and other contaminating factors.

Communication Tools

The Internet and e-mail have provided the impetus for a revolution in education. Teachers can use the Internet in any of the teaching methodologies listed above and at the same time foster "real world" applications of knowledge.

In Journey North (http://www.learner.org/jnorth/), students can collect and report data pertaining to wildlife migration and the coming of spring in the northern hemisphere. In one specific activity, students plant tulips in the fall and then observe and report growth patterns in the spring. As students from across the country do the same, data are displayed on the site. Many inquiries arise that require students to research and collaborate in order to answer the questions.

Hybrid courses that utilize online components built with authoring programs such as WebCT (http://www.webct.com) or Blackboard (http://www.blackboard.com) extend the learning day and provide supports for students who need additional assistance. For example, an algebra teacher can place class notes and step-by-step solutions to problems along with explanations on a class Web site. Students who did not understand the concept in class can use the material to work through their difficulties.

Another communication tool available is interactive video-conferencing. Traditionally, this technology has used ISDN phone lines, but a great deal of progress has been made in converting the technology to an Internet-based application. No matter which form a teacher employs, the technology offers a wealth of opportunities to participate in virtual field trips to sites otherwise inaccessible to students.

Conclusion

The examples cited here represent just a small fraction of the potentially effective integration strategies that can and should be employed by teachers across the curriculum. Once teachers have mastered the art of *planning and designing the learning environment* (ISTE, 2003), schools will begin to see a return on their investment in technology in the way of improved student performance.

Of course to accomplish this goal, schools will have to offer effective professional development, aid teachers with on-demand technical support, and provide opportunities for educational technology specialists to work with teachers in their classrooms. Colleges and universities will also have to provide pre-service teachers with similar opportunities to integrate technology throughout the educational curriculum.

As advances in technology race ahead, we must ensure that the nation's students become technologically literate. Not to meet this challenge will mean that American students will only fall further and further behind. With reading, writing, and arithmetic, technology has become the nation's "new basic." Our children's future, the future economic health of the nation, and the competence of America's future workforce depend on our meeting this challenge (U.S. Department of Education, 1996).

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Please note: The specific kinds of software and Web sites listed in this article are offered as possibilities for integrating technology in the classroom. Their inclusion does not represent an endorsement of the products by Research for Better Schools.

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Internet Jones vs. the River Killers!

Publisher: Research for Better Schools (2001, 20 pages)

In this comic-book science adventure, our super heroine enlists her students and colleagues to confront an environmental crisis. As the crisis deepens and the classroom investigation takes on a sense of urgency, Internet Jones and her team use the Internet to facilitate collaboration, research, and the sharing of results.

Created by a team of educators and a professional cartoonist, this publication was designed specifically as a learning tool to support K-12 mathematics and science teachers' effective use of the Internet. It appeals to "children of all ages" and requires zero to moderate exposure to the Internet. In addition to the storyline illustrated in full color, this 20-page book offers advice and resources for getting started with the online experience.

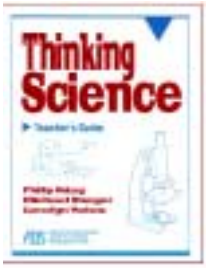
si41: $.99 with the purchase of any other RBS publication.

Adding It Up: Helping Children Learn Mathematics

Publisher: National Research Council (2001, 454 pages)

"Public concern about how well U.S. children are learning mathematics is abundant and growing," opens the preface to *Adding It Up*. The result of 16 experts working through the National Research Council, the book addresses this concern with diverse and rich research that portrays the mathematics children need to learn, how they learn it, and how it might be taught to them effectively. By focusing on issues associated with teaching and learning numbers, the book examines how children can become mathematically proficient and how teachers can teach such skills and knowledge. Changes are suggested for teaching methods, curricula, and teacher education. The book concludes with five key recommendations, including detailed policies and practices needed if all children are to become mathematically proficient.

pd44: $29.95



Thinking Science Set

Publisher: Research for Better Schools (1992)

This is a program of 30 classroom activities that develop the complex thinking skills needed in science. Each activity involves an experiment that provides a rich developmental experience. Based on the theory of development from concrete to formal operational thinking, the program has been extensively tested in Great Britain and received much interest in the United States. The American edition is geared for the 7th grade and up science curriculum. It is an enrichment program to be used along with the regular course materials. The set includes a Teacher's Guide (with apparatus details) and 10 Student Manuals.

CM09: Sale price $59.95

Thinking Science Manuals, set of 10
CM09a: Sale price $57.95

Thinking Science Teacher's Guide
CM09b: Sale price $5.95

Lesson Study: A Handbook of Teacher-Led Instructional Change

Publisher: Research for Better Schools (2002, 135 pages)

Lesson study--the form of professional development long favored by Japanese teachers--has recently been initiated by teachers at many sites across North America. This handbook illuminates both the key ideas underlying lesson study and the practical support needed to make it succeed in any subject area. Drawing upon experiences with schools in Japan and the U.S., award-winning author and lesson study expert Catherine Lewis brings to life the struggles and victories that characterize the intensity of lesson study. If you believe that teachers should be the central force in their own professional growth, then read this book to discover both why and how lesson study is so effective in improving student learning.

pd55: $24.99

PIRLS-Related Resources

The Progress in International Reading Literacy Study (PIRLS) is a large international comparative study of the reading literacy of students at the fourth grade level. Thirty-five countries participated in PIRLS 2001. With 150,000 students tested, PIRLS 2001 is the first in a planned five-year cycle of international trend studies in reading literacy. RBS has several of the publications from this study available for free: PIRLS 2001 International Report, PIRLS 2001 Encyclopedia, Framework and Specifications for PIRLS Assessment 2001, and PIRLS 2001 Highlights. To request these and other free mathematics, science, and education resources, visit the "Free Publications" page of the RBS Web site at http://www.rbs.org/mathsci/free_pubs/ or call (215) 568-6150, x280.

IMAGES: Improving Measurement and Geometry in Elementary Schools

Publisher: Research for Better Schools (2002, 232 pages)

The PA State Team for Mathematics and Science Education at RBS has developed *IMAGES* to assist teachers and students in improving their concepts and skills in measurement and geometry. *IMAGES* presents necessary K-5 content for both teachers and students and provides strategies for teaching and assessing concepts in these areas. Nearly half of this 232-page book is devoted to instructional activities and lesson plans that address NCTM and PA standards and offer teachers tangible ways to teach geometry to their students. *IMAGES* also discusses cognitive and developmental issues, print and non-print resources, manipulatives, and technology.

cm56: $25.99

Organizations Supporting Technology in the Classroom

There are many organizations that support the use of technology in the classroom. Here is a listing of several national and regional organizations with information on how they might help you as you work toward integrating technology into your classroom, school, or district.

National

Alliance for Technology Access
http://www.ataccess.org/resources/atk12/default.html
The Alliance for Technology Access is a national network of organizations that focus solely on technology for people with disabilities. The mission is to increase the use of technology by children and adults with disabilities and functional limitations. Their K-12 Web page provides a range of information about integrating assistive technology into schools, such as "what to know about AT," selecting software, assessment resources, best practices, and training resources.

Center for Applied Research in Educational Technology
http://caret.iste.org/index.cfm
The Center for Applied Research in Educational Technology (CARET) is a project of the International Society for Technology in Education. CARET bridges educational technology research to practice by offering research-based answers to critical questions. The Web site allows users to browse questions and answers to learn what studies show about topics such as technology integration with student learning, curriculum and instruction, and professional development. The site helps educators to understand and use research in making educational decisions.

The Concord Consortium
http://www.concord.org/
The Concord Consortium is a non-profit educational research and development organization that creates interactive materials to utilize the power of information technologies. The primary goal is digital equity–improving learning opportunities for all students. Some of Concord's projects include the Jason Academy (a distance learning project in science, geography, and environmental education), Seeing Math (a telecommunications project to improve mathematics teaching through online digital professional development), and Probesight and Usight, which advocate the use of probeware, sensors, and handheld devises to enhance science and mathematics education. Educators who are interested in these projects should contact the consortium.

Education Development Center
http://main.edc.org/theme/schools.asp
The Education Development Center (EDC) is an international, non-profit organization committed to bringing hands-on, inquiry-based learning to people of all ages and backgrounds. EDC works in partnership with educators and administrators to ensure that they have the knowledge and tools they need to support student learning. Several EDC centers and projects provide guidance on technology integration to schools and districts, based on the research and evaluation that EDC conducts on educational technology programs. One example of its projects is YouthLearn (http://www.youthlearn.org/), which provides resources for using technology to create exciting learning environments, including online lesson resources, "kids creations," and professional development opportunities.

International Society for Technology in Education
http://www.iste.org/
The International Society for Technology in Education is a non-profit professional organization dedicated to providing leadership and service to improve teaching and learning by advancing the effective use of technology in K–12 and teacher education. ISTE developed the National Educational Technology Standards and many educator resources to accompany them so that they can be practiced in the classroom. The ISTE Web site includes resources on curriculum, equity, funding, policy, professional development, and technology integration.

International Technology Education Association
http://www.iteawww.org/
Technological literacy is the mission of the International Technology Education Association (ITEA). ITEA launched its Technology for All Americans Project as a means to advance student attainment of technological literacy. As part of this project, ITEA published the Standards for Technological Literacy: Content for the Study of Technology. ITEA's professional development division is the Center to Advance the Teaching of Technology and Science (CATTS). Among its services, CATTS holds an annual conference to help educators stay abreast of the constant changes that take place in technology education.

National Science & Technology Education Partnership
http://www.nationalstep.org
The National Science & Technology Education Partnership (NSTEP) works on behalf of the greater electronics community to develop tomorrow's technology leaders. One of its educational technology programs is TechXplore. TechXplore pairs technology experts from electronics, telecommunications, and high-tech companies with teams of students to help young people explore technology by proposing solutions to real world problems and addressing quality of life issues using technology. The teams compete in an online competition with other teams from around the world. People who are interested in becoming teacher-project leaders, technical mentors, company partners, or student participants can sign up online for more information.

TECH CORPS
http://www.techcorps.org/
TECH CORPS is a national non-profit organization dedicated to improving K-12 education at the grassroots level by helping educators effectively use technology in their schools. Implemented largely by volunteers, TECH CORPS supports the advancement of equal access to technology, technological resources, and skills development for students across America. The Web site offers links for people who are interested in becoming a volunteer or being matched with a volunteer. In the mid-Atlantic region, state chapters are active in NJ, DC, and MD.

Regional

Center for Improved Engineering and Science Education at Stevens Institute of Technology
http://k12science.ati.stevens-tech.edu/
The Center for Improved Engineering and Science Education at Stevens Institute of Technology (CIESE) in Hoboken, NJ helps bring the Institute's technology experience to the K-12 sector. Working collaboratively with K-12 schools and school districts, in concert with a variety of other partners, CIESE has helped more than 700 schools in New Jersey realize the benefits of technology. Current programs involve collaborations in New Jersey and four other states to train more than 10,000 teachers. Resources for teachers include classroom projects, educational links, Internet safety, net tools, and a variety of workshops from basic Internet training to mathematical explorations using the Internet. Classroom projects are available online and include technology-infused projects on topics such as global water sampling, air pollution, and ocean currents.

Educational Technology Training Centers (NJ)
http://www.state.nj.us/njded/techno/ettc/
The New Jersey Department of Education awarded grants to local school districts in each of the state's 21 counties to provide an Educational Technology Training Center (ETTC) as a county-based resource center that offers educators professional development opportunities. The ETTCs contain demonstration technology equipment and offer training programs to assist teachers in implementing the Core Curriculum Content Standards. Visit the Web site to identify the ETTC in your county.

Johns Hopkins University Ctr. for Technology in Education (MD)
http://cte.jhu.edu/
The Center for Technology in Education (CTE) applies the best educational practices in the use of technology—supported by teaching, research, and leadership—to transform education. CTE strives to improve the quality of life of all children and youth, particularly those with special needs. One way in which CTE reaches out to educators is the Maryland Technology Academy, an intensive professional development opportunity for K-16 teachers across Maryland focusing on using technology to significantly impact student learning and promote school improvement (http://cte.jhu.edu/techacademy/index.cfm).

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currents

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MATHEMATICS AND SCIENCE EDUCATION NEWS FROM THE MID-ATLANTIC EISENHOWER CONSORTIUM

Mark Your Calendars!

Lesson Study Conference: November 19-21, 2003
The second annual Lesson Study Conference, co-sponsored by Global Education Resources, RBS, TERC, and the Greenwich Japanese School, will be held November 19-21, 2003 in Greenwich/Stamford, CT. Conference attendees will discuss issues surrounding the implementation of lesson study and participate in an open house at the Greenwich Japanese School. More information is available at http://www.rbs.org/lesson_study/conference/2003/index.shtml.
Papers and presentations for the first Lesson Study Conference are posted on the RBS Web site at http://www.rbs.org/lesson_study/conference/2002/papers/index.shtml.

Regional Conference: January 12-13, 2004
You are invited to join the Mid-Atlantic Eisenhower Consortium for "Leaving No Child Behind in Mathematics and Science: Resources to Help All Students Reach High Standards of Achievement." The conference will take place at the Marriott Hotel at the Philadelphia Airport on January 12 and 13, 2004. Registration is $125 for individuals or $100 per person for teams. An early bird discount of $25 is available until November 3. Two hundred registrants will be accepted on a first come/first served basis. More information and the registration form are available at http://www.rbs.org/conference/2004/invitation.shtml.

Technology Conference: March 2004
The second annual Technology in Mathematics and Science Education Conference is slated for March 2004 in Pennsylvania. It is sponsored by the PA State Team for Mathematics and Science at RBS. If you are a teacher, curriculum coordinator, professional developer, or a school or district administrator who wants to increase your knowledge of technology integration in K-12 mathematics and science instruction, then this conference is for you. For more information and the registration form, visit http://www.rbs.org/mathsci/states/pa/conf2004/index.shtml.

About RBS: www.rbs.org
Research for Better Schools, Inc. is a private, nonprofit R&D corporation dedicated to the improvement of education through the use of research findings and best practices.

Co-directors: Dr. Keith M. Kershner, Dr. Louis M. Maguire

About the Consortium: www.rbs.org/eisenhower
The Mid-Atlantic Eisenhower Consortium for Mathematics and Science Education supports professional development and other improvement efforts in the District of Columbia, Delaware, Maryland, New Jersey, and Pennsylvania. Services and membership are free. It is a part of the National Network of Eisenhower Regional Consortia and Clearinghouse, www.mathsciencenetwork.org

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