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BOCES

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Learning and Thinking Skills: Critical Thinking and Problem Solving in Mathematics

By: Elaine Zseller

All students are thinkers. Elder and Paul identify six developmental stages for thinking: unreflective, challenged, beginning, practicing, advanced, and master.

"Effective mathematical problem solvers are flexible and fluent thinkers... problem-solving habits of mind prepare individuals for real problems—situations requiring effort and thought, lacking an immediately obvious strategy or solution." (Rigelman, p.308)

When teachers analyze the items on a New York State mathematics assessment, the single concept and single strategy items have the highest percentage of being answered correctly. As the thinking required by the problems becomes more complex, the percent of students getting a multiple choice item correct, or the percent receiving full-credit on a constructed response begins to drop.

"Teachers need to develop problem-solvers rather than problem-performers." (Rigelman, p.309) Problem-performers are focused on completion of the problem. The emphasis in class may be on a specific strategy for solving a problem or a specific format for the write-up. This approach may "leave students dependent on prescribed processes and unable to face problems without an immediately obvious strategy." (p.309) Problem-solvers develop flexible and fluent mathematical thinking skills.

The teacher who develops problem-



performers, asks questions that lead the student toward the information that the teacher wants the student to include in the solution. The teacher who develops problem-solvers may ask the students to show how they saw the problem, and is willing to accept multiple procedures that demonstrate correct mathematical thinking. Students are asked to share their reasoning for the solution. Problem-solvers develop methods for thinking about the problem. Students know that they need to "prove their thinking to be reasonable and valid." (p.312)

Mathematical thinking is crucial to success on the New York State assessments. About two-thirds of the points on the mathematics Grades 3–8 assessments are from the constructed response items. To achieve at least one point on every constructed response item, the student needs to demonstrate an "understanding of the mathematical concepts and/or procedures."

Elder, L. & Paul, R. Critical thinking development: a stage theory with implications for instruction. The Critical Thinking Community, www.criticalthinking.org/page.cfm?PageID=483&CategoryID=68.
Rigelman, N. (February, 2007). Fostering mathematical thinking and problem solving: the teachers' role. Teaching Children Mathematics. National Council of Teachers of Mathematics.
New York State Education Department. Two point holistic rubric.

Free Tech Tools

Federal Resources for Education Excellence

With budgets so tight, it's nice to see the feds providing a whole wealth of free (yes, free) and useful material for the classroom. More than 1,500 federally supported teaching and learning resources are packed into this site, ranging in scope from Arctic explorers and data analysis to algebra, geology, exercise, and visual arts. www.free.ed.gov/

Educator Social Networking Site

Following the trend of hugely popular social networking sites, TeacherEvents.com is a social networking Web site, specifically for educators, that was launched in June. After signing up for a free account, teachers can access multiple resources on the site, including a discussion forum, use "gadgets" like games and activities, or join groups, while meeting new fellow educators and networking with colleagues from the United States and Canada. www.TeacherEvents.com

Animoto has announced the release of Animoto for Education, a new video-production tool just for teachers. It's designed to allow K–12 teachers unlimited access to Animoto's standard and premium services, including online tools, to quickly and easily create exciting, dynamic videos for the classroom. The program "thinks" like an actual director and editor. It analyzes and combines images and music with the same post-production techniques used in TV and film. Teachers can upload their images or pick a song, and Animoto produces the video in minutes.

www.animoto.com

Digital Media

Discovering Math: Problem Solving

Aspects of problem-solving are addressed in this program, including representation of quantities and patterns, mathematical modeling algorithms, language and symbolism, and logic and proof. Grades 9–12 www.DiscoveryEducation.com

27th Critical Thinking Conference Keynote Address

An excerpt from the keynote address by Dr. Richard Paul at the 2007



International Conference on Critical Thinking is available on this site. Theme: Critical Thinking in Every Field of Knowledge and Belief.

www.teachertube.com/view_video.php?viewkey=55449d68d0b67ffda8c8

Discovering Math: The General Nature and Uses of Math

All of mathematics is based on standard concepts and principals discovered centuries ago, but its applications in the world today are infinite. In this technological age, new strands of traditional mathematical branches are continually being developed which aid scientists, musicians, fashion designers, doctors, meteorologists, cryptologists, and a host of others in solving real-world problems and creating new standards in many fields of study. Grades 9–12

www.DiscoveryEducation.com

Einstein's Innovative Thinking

Students are introduced to two of Einstein's most famous theories—special relativity and general relativity—and what he was thinking when he developed them.

www.thirteen.org/edonline/edvideo/index.html

Cyber Sources

Problem solving, critical thinking, mathematical thinking and reasoning, daily math prompts, teacher resources, teaching and classroom supplies, books and educational materials. www.oblockbooks.com/shoppingcart/html/pages/math4.htm

Interactive Web site portal for science and mathematics. www.learner.org/interactives/

"This Web site is a beginning! A repository of math instructional ideas offered by the Math Department staff. A place where we can share ideas, approaches, methods and resources. A place where students can go for practice." Offered by the Math Department of Queensborough Community College, City University of New York. <http://65.36.157.237/qcc/qccmath/summitactivities.htm>

An article on problem-based learning in mathematics. ERIC Digest.

www.ericdigests.org/2004-3/math.html

ISTE—An article on critical thinking, problem solving, and decision making. <http://nets-implementation.iste.wikispaces.net/Critical+Thinking,+Problem+Solving,+and+Decision+Making>

Critical Thinking Page is part of the school library section. This page has general information, lesson plans and bibliographies to help educators interested in higher order thinking skills.

<http://falcon.jmu.edu/~ramseyil/critical.htm>

January Spotlight

Lights, Camera, Action!

by Bonnie A. Foster, *Professional Developer, Model Schools Program*

This past summer, eleven school districts from Nassau and Suffolk County began training to implement the Title IID Grant. This is a federally funded grant designed to assist teachers in integrating technology into their classrooms. The focus for “Finding Their Voices Through Multimedia Learning” is to provide English Language Learner (ELL) students with options that would not be available in traditional learning environments.

Working with the Glen Cove School District has given me the opportunity to experience the process firsthand. Under the direction of Lawrence Carroll (Assistant Principal, Finley Middle School) and Monica Chavez (Coordinator of Foreign Language & ESL K–12, for the district), the teachers and students have been diving into their project. Using videocameras and iMovie for editing, the students are creating a video based on their school community. The teachers have worked diligently preparing the students with writing scripts, interviewing/oral language skills, and video filming and editing techniques. The video that they are producing will be a “welcome” for



Students take direction from their technology teacher (Mr. Chris Claro) regarding their script and the use of video equipment.

students arriving from other countries to help them gain a better understanding of their school environment and the people to turn to when they need assistance. From the librarian, to the school nurses, to the cafeteria workers, many school employees have pitched in to make the project a success. Not only has the project brought confidence to the students, but the camaraderie from the staff has been evident as well—an outcome that no one even expected.

All the work from the grant will eventually be shared online at Moodle. We look forward to viewing all the other projects and ideas that have come from this opportunity!

Model Schools: Making an Impact

This year, the Nassau BOCES Model Schools program hit the ground running, providing training in more than seven academic content areas in thirty-eight school districts across Nassau County. Our professional developers are state-certified content area specialists who help educators deliver researched-based instructional strategies and teach curricular content using the latest technology tools. Simply put, we serve as “coaches” to teachers, supporting them as they apply technology in their classrooms to enhance lessons and improve student achievement.

This year we are training educators to use more than twenty different technologies, including SMART boards, Student Response Systems (CPS), RM Math, Geometer’s Sketchpad, podcasting, wikis, blogs, and a host of popular Mac applications such as iPods, iMovie, iWeb, iPhoto and Garage Band.

Teachers are working closely with our experts to strategically integrate these technologies into lessons across the curriculum in math, science, English, social studies, ESL, foreign language and art.

Educators throughout the county have taken advantage of our workshops on building 21st Century classrooms for science instruction and the use of Flash animation software. They are also joining us online for professional development on a dozen topics, including guided reading, internet safety, the effective use of assessments, teaching English language learners, visual literacy and cultural diversity.

We’re your team—let our expertise work for you. Please visit our Web site at www.nassauboces.org/cit/modelschools/ or call us at 516-608-6655. We look forward to working with you!

For information on any of CIT’s programs,

including back issues of CIT Response, up-to-date education news, NCLB, special reports, new services and more, visit the Curriculum, Instruction and Technology Web site at:

www.nassauboces.org/cit

Upcoming Events

Strategic Literacy for the Math and Science Regents

Benjamin, Amy

When: January 13, 2009

Integrated Geometry "PROVE IT"

Farrell, Lawrence

When: January 14, 2009

Where: The workshops are held at the Nassau BOCES Administrative Center, 71 Clinton Road, Garden City at 8:30 a.m. to 3:30 p.m.

www.nassauboces.org/cit/catalog/pd/Catalogindex.htm

Lunch & Learn

Odysseyware

When: January 8, 2009

The 21st Century Library

When: January 13, 2009

Skills Tutor

When: January 22, 2009

Green IT-Eco Sustainability

When: January 27, 2009



Where: All Lunch & Learn Workshops are held at the Duffy Avenue Center, Hicksville from 12:00 to 2:00 p.m.

www.nassauboces.org/cit/it/mcs/

Useful Google Sites

Reader: Reader is a web-based news aggregator that reads Atom and RSS feeds allowing users to easily subscribe, organize and share news items. It even has a mobile version allowing you to get your news on-the-go.

iGoogle: Create a custom-designed home page with iGoogle. Users can choose to have their Gmail accounts, calendars, weather, news—and more—all integrated on one main page viewable upon opening their browser. The site also offers a wide number of themes for further customization.

iGoogle

Picasa: This Google program makes it easy to manage your photos both online and off.



Users can download a photo editing and management program to their desktops making it easy to mail, upload or post photos to a blog—or they can use the online albums provided by the program.

Docs: You no longer need desktop publishing applications installed on your computer to type out documents or create spreadsheets; you can do it entirely online with Google. The services allow users to create, publish, share and collaborate on documents and presentations, and best of all, they're available on any computer with an Internet connection.



Notebook: Research can be easier with this web clipping application from Google. It makes it simple to clip text, images, and links from pages while researching and then save, retrieve or share the clips later.

Desktop: Make it easy to find everything on your desktop with this application from Google. It allows users to search through their e-mail, computer files, music, photos, chats, and web history to find what they need. It also allows them to install useful gadgets to their desktops.