This is Why We Teach
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About the Front Cover:
The students on the cover are from a 7th grade math class at Summerville Middle School and a 9th grade Honors Geometry Class at Landmark Christian School. Photos are by Carla Moldavan and Cheryl Hughes.

About Your Mailing Label:
Please notice 2 important parts of the mailing label on the back of the journal. Above your name you will find your membership number and expiration date. In an effort to conserve costs, we will not be issuing membership cards, but will include this information on your mailing label on each issue of the journal.
If you should ever need verification of your membership in GCTM for professional reasons, please contact Susan Criag, Membership Director, whose contact information is on page 28.
Hello to All! The ‘05-’06 school year is coming to a close. Our spring and summer months will soon be filled with activities of renewal and preparation for the new school year of ‘06-’07. Of course, this year’s news was filled with conversation and training around the Georgia Performance Standards for Mathematics. As I have visited schools and teachers around the state, I am hearing that a majority of teachers are becoming very excited as they learn more about the organization, power and depth of the mathematics GPS. Of course, there are areas of the GPS that will require all of us to learn something new or brush up on something old, at every grade level. Some events that will occur this summer will help all of us and give us the information and support that we need to help move the math GPS from being the award-winning document that it currently is to becoming becoming a reality in our classrooms.

First, you should be aware that the Georgia Department of Education, in an effort to offer you expert support, has coalesced expert groups of mathematics professionals from around the state to create units of study and Frameworks for each and every grade level of the math GPS. The creators of these units and Frameworks have worked in teams that consist of college and university mathematics faculty, classroom teachers/practitioners and mathematics supervisors/leaders. These frameworks are units of study; they are not lesson plans. The lesson plans need to be created by each of us, as we decide how to take our students on the journey to reach the expected levels of mastery of each grade level GPS. These units and frameworks are certainly not required to be implemented but they are just fabulous and should be referenced as the “standard” level of mastery if you are writing your own units. The goal of the DOE is that frameworks for kindergarten, first, second and seventh grades will be complete by early spring. Grades 3-5 and 8 should be finished by the end of the summer. Course development for the high school courses Mathematics 1 and Mathematics 2 should also be complete by August 31. Check it out on the DOE Web site and look for “Frameworks” in the mathematics GPS section.

Next, I’ve heard from many of you this spring with questions about what is needed to participate in textbook adoption processes and that these activities will begin in some of your districts this summer. There are a couple of extraordinarily important things to keep in mind about choosing a new textbook or series. Immerse yourself and your team in thoroughly understanding the new GPS. Know what is being mastered at each grade and how concepts are building and growing from year to year.

DO THE MATH! You and your team must do some of the tasks and culminating products that are found in each of the Frameworks that I previously mentioned. Until you do some of those tasks yourself, it is difficult to understand the cognitive demand that is placed on students and how mastery is expected to be demonstrated. After you try some of the culminating tasks yourself, you will have a very different view of what kind of support you will need from a textbook to help you take your students to these levels of mastery.

Be critical consumers of the textbook products available.
CONTINUED FROM PG. 1

ucts. Take nothing for granted. The only way to ensure that you and the students are going to make it to the expected levels of skill and mastery, on time, is to have strong and clear alignment between your standards and your instruction. You can’t get there with a loose “correlation” between the standards and the text. Every single textbook and product you look at will claim to aligned to the GPS; otherwise, they can’t make it to the state adoption list. It is up to you to determine how strong the alignment is, among the GPS, the textbook and the culminating task.

Remember the “do the math” part? Well after you do the math, you have to look at what the text is offering you as support and ask the question, “Will this type of experience, in this textbook, help my students accomplish tasks like these?”

Keep in mind that even a great textbook or series may not meet every single need across several grade levels. That is, you may find that a series does an excellent job for four (4) of your K-6 grade levels and not such a great job for 2 of them. This has to be weighed and it will be a touch decision. But you may find that you adopt knowing that in a grade or two you are going to have to do add something or not use some portions of that book.

Last, in choosing a new textbook, remember that it does no good to spend the kind of money required for a new adoption (in some of your districts the cost of the adoption will exceed a million dollars!) if you are going to use a new textbook in the same old way. If you are going to do that you might as well keep the book you have and save the money! The truth is, many of the old series that we are using already have many of the features and components that are needed for conceptual learning of mathematics. They are in the boxes, kits and supplemental materials that come with the series.

The problem is that we don’t use them, when in fact, they are the real treasure of a series. My guess is that we need help and support from our new books, not a new version of the old problems, in new books, with new pictures. Good luck!

I will close with some reminders of other events and ways to get support for the coming year. You will find more in-depth articles, ads and reminders of these events in this issue of Reflections of these events.

GCTM will offer Summer Academies for grades 3-5, 8, and high school to help prepare for the rollout of GPS.

The state mathematics conference at Rock Eagle (October 2006) will once again be focused on helping us all become experts at teaching the GPS.

The NCTM National Conference and Exposition will be held in Atlanta in March 2007. This is actually next school year (’06-’07) and you want to help your school/system budget for that now. We are also looking for volunteers to help with this conference.

Visit the GCTM Web site and nominate your colleagues for mathematics teaching awards.

Have a wonderful summer! Be a learner! I leave you with one of my favorite quotes from Margaret Mead, “Never doubt that the actions of a few committed citizens can change the world. Indeed, it is the only thing that ever has.”

—Dottie
GCTM Membership at an All–Time High!

There is no better time than now to be a member of GCTM. Our membership rolls are at the highest level in a number of years, thanks to all of you who have encouraged new and continued memberships among your friends and colleagues. Our student enrollment is at an all time high also—which offers our future teachers the promise of excellent professional growth for their entire careers.

Even more exciting is the promise of a wonderful opportunity in the upcoming 2007 NCTM Annual Meeting, to be held in Atlanta in March. This is the first annual meeting to be held in Atlanta in 30 years. I remember well that previous meeting as being my first annual NCTM conference. As a young teacher, I was in awe at the sheer number of mathematics teachers from all over the country, the huge exhibit area, the vast array of speakers and topics. If you have never attended an annual nationwide conference, you are in for the professional experience of your life. So mark your calendars now!

What’s even better than attending this meeting? Being an active part of the team that will make this conference the best ever. GCTM needs you now, more than ever before. And we need your colleagues as well. So plan on being a part of this conference workforce and seek out others to join GCTM now so they, too, can help with the tremendous task of welcoming the mathematics education world to Atlanta next year. Invite a teacher to membership in GCTM today!

You will notice that this issue of Reflections has a membership card printed on the cover. This is a new method of distributing cards to insure that you have a current card if you so desire. Your GCTM membership number and expiration date appear with your mailing label.

Please inform GCTM of any changes to your mailing and email addresses. Just send changes to SCraig@gctm.org. We appreciate your help in keeping your information up-to-date.

Membership Report April 2006

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Save the Date!

NCTM 2007
Annual Meeting and Exposition

March 21–24, 2007
Atlanta, Georgia

Mathematics:
Representing the Future

There are as many ways to represent mathematics as there are shapes and sizes of Georgia peaches. Here are just a few examples representing the myriad reasons you should join us for the 2007 Annual Meeting and Exposition in Atlanta, Georgia:

- Learn from the more than 1,000 presentations in all areas of mathematics.
- Share your experience and ideas with colleagues from around the world.
- Experience the latest products and services, instead of just reading about them, at the NCTM Exhibit Hall.
- Develop your mathematics resource library with books, CDs and videos from the NCTM bookstore.
- Explore all the rich history and cultural diversity that Atlanta has to offer.

This is a professional development opportunity you can’t afford to miss. Visit www.nctm.org/meetings for the most up-to-date information.
GCTM Academy 2006

Sharpen your teaching expertise . . .
Gather exciting ideas for your classroom . . .
Become even more familiar with the
Georgia Performance Standards . . .

Attend the GCTM Academy
June 14-16
at
Macon State College

If you are an elementary teacher, middle school teacher or high school teacher in Georgia, there is a session for you.

The 2006 Georgia Council of Teachers of Mathematics invites you to join us for a two and one-half day session designed to inform and assist Georgia teachers of mathematics with implementing the more rigorous Georgia Performance Standards. Emphasis of the GCTM 2006 Academy will be on 3-5th grades, 8th grade, and high school standards-based education along with the challenges that must be faced and addressed to support our teachers and this strong, cohesive and coherent curriculum.

Should we have an intense interest and many requests for the K-2 and 6-7 grades, there is the possibility of including additional sessions for these teachers.

We look forward to seeing you at the 2006 Academy!
To register, complete the application at www.gctm.org.

For more information contact us at academy@gctm.org.
Earn a PLU When You Attend the Georgia Mathematics Conference at Rock Eagle in October

Many teachers around the state have earned 1 or 2 PLU’s while attending the annual Fall Mathematics Conferences in 2004 and 2005. Let 2006 be the year when you take advantage of this opportunity.

The Prior Approval Form will be on the GCTM website in August and September. Visit www.gctm.org to download the form. Fill it out and get the required signatures before you attend the conference.

Bring the form to the PLU desk in the registration area and receive information regarding the two steps required for completion of the unit. Step 2 is accomplished at the conference and step 3 is an On-the-job assessment in your school system.

The deadline for submission of the On-the-job performance for the 2005 conference was March 1, 2006. Anyone having questions regarding this requirement should contact Becky King, Executive Director, GCTM at bwking@comcast.net.
At beautiful Rock Eagle 4-H Campground, Eatonton, Georgia
“Globally Positioning ALL Students for Success”
Featuring the Georgia Performance Standards!

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<th>SUPER SATURDAY:</th>
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Don’t miss the cookout, karaoke, and more fun!
Go to www.gctm.org for more information.
Children’s Literature and Mathematics

Book: Curious George Makes Pancakes
Author: Margret and H.A. Rey
Publisher: Houghton Mifflin Company (1998)

Lesson plan by Tina Johnson

This book is just one of many with a pancake theme. Use it and the activities below to celebrate “Pancake Day.” In many areas of the world, pancakes were believed to bring good luck because they contained many ingredients associated with prosperity and longevity.

MEASUREMENT

Using a favorite recipe and an electric griddle, the teacher can make pancakes in the classroom. Have students work together using teaspoons, tablespoons and cups to mix the ingredients. They will use Reasoning and Proof to determine which utensils they should measure the ingredients with. Should a cup be used to measure salt? Should a teaspoon be used to measure the flour? This activity will also help students understand and represent commonly used fractions.

GEOMETRY

The cook poured little batter circles. Have the students cut out and label other pancake shapes.

COMMUNICATION & PROBLEM-SOLVING

Students will work together to write word problems. They will have opportunities to see the perspectives of others in solving one-step problems using addition and subtraction. For example: If Mom, Dad, and three children each want one pancake, how many pancakes would George have to cook? If Dad wants 3 pancakes, Mom wants 2 pancakes, and four children each want one pancake, how much would they pay for their pancakes? If George has twenty blueberries for five pancakes, how many will he use for one?

NUMBER and OPERATIONS

Pancakes at the fundraiser cost $1.00. What combinations of quarters, dimes, nickels, and pennies could be used to buy a pancake? Have coins available so the students can experiment with different combinations. Show them how to make a chart to record their answers.

CONNECTIONS

How is math used in making the hospital fundraiser a success? Students can discuss the concept of business. How could we use our math skills to make a lemonade stand successful?

REPRESENTATION

Students will create a pictograph to compare their favorite pancake toppings. They can also create a representation to show their understanding of fractions. Students can do surveys to gather information for data analysis to determine what type of pancakes should be made for the next fundraiser.

TECHNOLOGY

A computer game can be found at www.ihop.com/pancakekids/gamehouse.htm
ART PROJECTS
Students can cut pancakes out of brown paper and use a whole punch to cut blueberries from blue paper. They can glue berries onto the pancake in the shape of their first initial. Have students count the dots (number and operations). They can also discuss their discoveries about any relationships between letters. Coloring sheets can be found at www.ihop.com/pancakekids/princolor.htm

GAMES
Have students participate in a pancake flipping contest using skillets made by using a ruler taped to the bottom of an aluminum pie plate. Each student will make a “pancake” out of modeling clay. The pancakes should be at least five inches in diameter. They will use rulers to measure their creations. The teacher will say “Ready, set, FLIP!” While holding the “skiller” in front of them at arm’s length, the students must flip the pancake at least one foot in the air (estimation) and turn it over completely when they hear the word “FLIP.”

Book: *Nature by Numbers*
Author: Lynette Ruschak
Illustrated by G.B. McIntosh
Publisher: Little Simon Books, 1994

Lesson plan by Joanna Johnson

This is a wonderfully illustrated book that integrates science and math. It is a pop-up book showing the progression of different plants and animals as they grow. The book begins with the number one and goes through ten. The last thing it counts is one hundred fireflies. This book is colorful and bold inviting children to explore nature.

PROBLEM SOLVING
Teachers and parents can foster this inclination by helping students make mathematical problems from their worlds.

Children can create their own chart using one through ten. Instruct the students to go out into their own yards and find one item of their choice. Have the students draw a picture of what they think it will become as it grows. (Example: kitten becomes a cat.)

REASONING AND PROOF
Using a graph, predict as a group what the most common thing was that they found in their yards. Then have the students tell what they found. Create a graph to compare their predictions with the actual collections.

TECHNOLOGY
Using a digital camera, take the students into the school yard and assist the students in finding items to demonstrate their own book about nature and numbers. Discuss the importance of protecting nature.

COMMUNICATION
Students can use the number 100 and communicate in a group the different items they could find everyday to equal 100. Then have groups report to the class about their findings. The teacher should have several collections of 100 things in the classroom for the students to use to SEE one hundred.

CONTINUED ON PG.13
Mathematics + GPS = Access for All

With the roll-out of the new Georgia Performance Standards (GPS) in Mathematics and the revision of the Georgia Criterion Referenced Competency Test (CRCT), the focus on ensuring that Georgia’s students are given opportunities to learn and demonstrate knowledge in mathematics skills is growing sharper. While instruction and assessment on Georgia’s Quality Core Curriculum (QCC) and GPS have been established for students in general education, a new set of students is now joining the group. These are students with significant cognitive disabilities.

In All

The concept of providing access to the general curriculum for students with disabilities has been in place since the 1990s; a mandate in the Individuals with Disabilities Education Act of 1997 (IDEA) strengthened the focus towards providing access for all students (Orkwis, 1999). To provide even more emphasis on the concept, the reauthorized IDEA 2004 was teamed with the No Child Left Behind Act to provide school-based accountability for students with and without disabilities. These two laws provide the expectation that 1) all students are given “challenging content” which to learn and “high expectations” for learning are set and 2) all students are expected to participate in state-wide assessments which measure their progress in the general curriculum in the areas of English/language arts and mathematics (Yell, Katsiyannas, & Shiner, 2006). While IDEA and No Child Left Behind gives teachers a legal basis for providing access to the general curriculum for the special education students they teach, there are other reasons that access is so important.

First, providing students with opportunities to learn important skills in the context of grade-level activities is good educational practice. Students learn new skills best when they are given practice within relevant activities, and students with significant cognitive disabilities are no exception.

Second, the more opportunities to practice skills, the more proficient students become at using those skills. Providing access to the GPS gives teachers new avenues for incorporating, or embedding, skills into activities that are grade-level, increasing the number of opportunities for students to practice the skills.

Finally, providing access to the general curriculum will give students with significant cognitive disabilities more opportunities to show others what they know and can do within a number of environments and activities, which, in turn, gives teachers and others more information about student progress and next steps for appropriate education.

Add

There are two ways access to the GPS can be provided to students with significant cognitive disabilities. Both methods focus on “alignment”, or matching the educational program for the student with special needs to the curriculum that is provided to all students, with and without disabilities (Courtaid-Little & Browder, 2005).

The first method aligns objectives on the Individual Educational Program (IEP) to the general education curriculum. IEP objectives which align to the GPS provide part of the basis of the daily instruction for the student
and are evaluated using criteria set as part of the IEP process.

The second method is by incorporating aligned activities, those which “hit” the standard but at a level appropriate for the student, into the instructional day. Aligned activities provide an opportunity for students to use skills in a grade-appropriate context, work with materials that have been modified to meet their needs, and access the instruction that will allow for progress in both targeted IEP skills and the general curriculum. Access to the GPS through aligned activities for students with significant impairments will be evaluated by the functional programs include non-academic (functional) objectives; access to the GPS is only part of the instruction these students will receive. IEP teams and teachers can determine which standards and elements are relevant for students and need to be addressed. In addition, students may learn a standard as written, but be on a different level of progression toward it. Due to disability levels, students may also use prerequisite skills to work on GPS activities. Access is provided when students actively participate in lessons which are focused on academic standards (Courtade-Little & Browder, 2005).

Georgia Alternative Assessment (GAA), which will document the student’s progress on skills that are presented within the activities.

It is important to remember that students with significant cognitive impairments are not required to be exposed to every standard and element of the GPS (Courtade-Little & Browder). Students with special needs’ edu-

Combined

What does this mean for general education teachers? As the concept of access to the general curriculum becomes part of the special education classroom, and as the GAA becomes a test of student progress with this access, there is a greater need to ensure that general and special education teachers are working together to give ALL students a challenging, meaningful, and successful school career (Cushing, Clark, Carter & Kennedy, 2005).

Special education teachers are experienced at determining student level, identifying relevant and meaningful skills and activities, and making accommodations to activities and materials to meet student needs. However, many special education teachers, especially those who may work with students with significant cognitive
impairments, may not be as familiar with academic curricula, concepts, or resources as the general education teachers who use these things every day.

In contrast, general education teachers may need new ideas for differentiated instruction, including students with different learning styles and learning levels in the activities in the classroom. By working together, both groups can have positive outcomes (Cushing et al., 2005).

Special education teachers may need to know the “big idea” behind a standard or may need some guidance on the meaning of a particular concept. General education teachers can provide that support and guidance. General education teachers may have the knowledge of the curriculum, but need additional ideas on ways to target instruction for the students who may be struggling or need more support in the general education classroom.

Finally, instruction teams of both general and special education teachers can support all learners, who then progress in skills shown on the CRCT or GAA, leading to higher school scores and better AYP information. By combining the knowledge and skills of teachers, both general and special education, and adding access to the general curriculum that meets student’s needs, success for ALL students will increase.

### Credits

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**Materials for Flat Stanley unit:** Deborah Foushee, M.S., CCC-SLP, Gwinnett County Public Schools, Georgia

**Ideas for Flat Stanley unit:** Deborah Foushee, M.S., CCC-SLP; Susan D. Benjamin & Mary Kay Potlock, Special Education Teachers, Gwinnett County Public Schools, Georgia

**Student photo credit:** David L. Thomas, Georgia Department of Education

**Boardmaker Picture Communication Symbols from Mayer-Johnson, LLC.**

### References


Ruder ("Roger") Boskovic (1711 – 1787) was born in the independent republic of Dubrovnik, now a part of modern day Croatia. At the age of 14 he made the decision to become a Jesuit (Society of Jesus) priest. In 1740, after years of study, he graduated from the College of Rome and was immediately promoted to Professor of Mathematics.

Much of Boskovic's work involved the application of geometry to astronomy. He developed procedures for determining the orbit of a planet given three different observations of its position, and for locating the equator of a planet given three different observations of a feature on its surface.

In 1758 he argued that matter is not continuous, but consists of discrete, indivisible atoms, thus reviving the ideas of the early Greek philosopher Democritus. He also championed Copernicus’s heliocentric theory, and was influential in convincing the Pope to have it removed from the infamous Index of forbidden works. Although Boskovic had mastered the scientific classics, he was also quick to grasp and promote more recent work that he deemed significant, such as that of Isaac Newton.

Although famous for his brilliant theoretical research in mathematics and science, Boskovic was not above down-to-earth matters. When a crack was discovered in the dome of St. Peter’s basilica, Boskovic suggested a series of iron bands to stabilize the structure. He also served as an ambassador to London at a time of strained relations between Dubrovnik and England, and while there was made a member of the Royal Society.

The bill pictured above is a Croatian 100,000 Dinara note issued in 1993. To the right of Boskovic’s portrait are geometrical diagrams from his most famous work, A Theory of Natural Philosophy.

When Croatia achieved its independence from Yugoslavia, it devoted its entire issue of new currency (12 notes during the period from 1991 to 1993) to Boskovic. In 1994, Croatia overhauled its monetary system—replacing the dinara with the kuna, and Boskovic’s portrait with that of other national figures—thus ending the brief reign of Ruder Boskovic on Croatian banknotes.

**Children’s Literature**

**NUMBER AND OPERATIONS**

The teacher will have magazine pictures to distribute to different groups. The students will then make posters classifying pictures into groups of numbered items. (Example: shoes – six – 6 with pictures of six shoes.)
A multitude of today’s TV shows involve forensics. Almost all of the science referenced is math-based in either a subtle or very obvious manner. Now, it seems, the language of science also brings good ratings. In my trig class, we do an activity that involves trigonometry and ellipses in the investigation of a recreated crime scene and the blood spatters left behind.

The day before we begin, I splash diluted red acrylic paint onto butcher paper. This simulates the spattering of blood. I sweep my hand quickly and parallel to the ground which, in turn, creates a number of various-sized ellipses. All of those that come from the same fling (same impact wound) will have a sequential orientation to north, the same relative shape, and can be visually followed back to what seems to be a common intersection point.

The students get a brief lesson in blood and its qualities in class. They learn that in a weightless situation, blood becomes a sphere. Actually, as blood is spilled by an unfortunate victim, it does precisely that—fly through the air and form a perfect, highly-viscous ball. If this sphere hits a surface that is not very absorbent, like a wall or a linoleum floor, it very often will form an ellipse. As its leading edge hits the floor, the blood drop spreads out in the direction of travel but not sideways. The effect is a nice ellipse with measurable axes.

At this point the class is split into groups of three or four students each, and the process of collecting data begins. Two blood drops that are of same shape, size, and appear to lead back to a common spot are chosen. Usually, the teacher needs to help with choosing the pair. By watching during the creation of the spatters, the teacher will come to understand which ones were produced by the same sling. A kite string is tightly held (by fingers) along the major axis of each ellipse and these lines are physically traced back to a point of intersection.

By finding several spatters (ellipses) that seem to emanate from the same location, we can find exactly where our victim was standing. The next task is to discover how high off the ground the wound was when it was created (by a gun, knife or other unknown object). Tangents and the average distance to the victim’s location from the ellipses helps students find the height of the wound.

After these data are collected, and based solely upon knowledge gained from the calculations, each group reaches a conclusion detailing the location and height of the wound. The students are then given a police report in which the autopsy results are shown along with the suspect’s statement.

The task for the student-detective is to determine if the conclusion garnered at the scene matches the autopsy report and suspect statement. Does the math support the suspect or make him more suspicious? Is it possible that he is telling the truth? Keeping in mind that someone is assumed innocent, how could you reconcile the two sets of information if they conflict? What further questions would you ask the suspect?
Each group is asked to defend their conclusions based upon the evidence they calculated. Some groups are better at measurement than others, and sloppy work can lead to incorrect conclusions. Therefore, through this activity, the gathering of precise, accurate data collection is emphasized. Their deductive reasoning skills are also tested. The lesson, if monitored well, will take at least 45 minutes. The teacher should do the lesson on his own before attempting this with students. Once mastered, however, it is an enjoyable activity that initiates discussion and more interest in other applications of science.

Sample Crime Scene Information

Crime Scene

You have been called in as blood spatter expert to examine a dead body. In the living room, there is a large stain on the carpet next to the chair facing the door and closest to the kitchen. Stains are present on the linoleum floor of the adjacent kitchen. These spatters are consistent with impact wound evidence and are within two feet of the deceased’s location.

A lamp is turned over, possible indicator of struggle. A knife with blood smears was found in victims’ hand; no blood type analysis available at this time. One half-full can of beer on counter. Three cigarette butts are in ashtray by sofa. Some spatters indicate aerosol blood. Drugs were found in an amount exceeding normal personal usage.

The body had been dead for approximately one hour when the police arrived. The cigarette butt matched the type smoked by the suspect but not the victim. Saliva on the beer can matched the DNA of the suspect and not the victim. The suspect is 5’10”.

At this time you will investigate a sample of spatters and compare the information gained with the suspect statement and the lab’s autopsy data. This will be distributed at the end of your scene analysis.

Student Forensic Report

Summary of Data:
1. Stains A
2. Stains B
3. Conclusion from data collected at scene
4. Conclusion in conjunction with suspect statement

REFLECTIONS SPRING 2006
E ach year Gifted Precalculus students at Brookwood High School study sinusoidal functions by examining the sound waves of instruments. The learning objectives of the project include develop, graph and apply the six trigonometric functions (QCC) (MAPC_A2001-3), apply transformations to graphs of circular functions (MAPC_A2001-9), and fit and model linear and nonlinear curves to data (QCC) (MAPC_B2001-12). This is a fun, entertaining project that requires students to use creativity in the mathematics classroom.

First students are required to build an instrument of their choice, using everyday items. Students are permitted to use parts of instruments such as tuning pegs or strings but may not use components that are already assembled. Students choose to make string, percussion, or wind instruments that make a minimum of three tones. Instruments are graded on the overall appearance, quality of the workmanship, and creativity. Interesting projects included the appropriately named “guitarpshicord,” which is a cross between a guitar and a harpsichord. This instrument had strings which were struck with keys much like piano keys. Other exceptional instruments have been a stringed instrument with a moving bridge, a lab-top guitar with picks attached to pegs for plucking the strings, and a type of drum made from a ceiling fan and women’s nylons. Popular instruments include flutes and traditional guitars.

After assembling the instruments, students bring them to class for a data recording day. Using a Calculator Based Laboratory (CBL) and TI-82 calculator program, students use a microphone to capture sound waves and record the curve for one tone onto the graphing calculator. The curves are recorded using a series of points that are stored in the calculators’ lists. The TI-82, while not the most current calculator, is used because later versions have regressions for sinusoidal curves and would allow students to rely upon the calculator to find the equation rather than finding it themselves.

Once all data is collected, students trace along the curve to find the ordered pairs for minimum and maximum values. They will use these ordered pairs to fit to their curve an equation of the form \( y = d + a \cos(b(x - c)) \) where \( d = \) vertical displacement, or the line about which the curve is oscillating; \( a = \) amplitude, half the distance from minimum to maximum; \( b = 2\pi / \) period; and \( c = \) horizontal displacement, or phase shift.

For example, suppose a students’ graph appears as follows:

![Graph](image)

The first obvious maximum is located at \((3, -0.5)\), the following minimum at \((4.5, -1.5)\), and the next maximum at \((6, -0.5)\). It follows then that the period of this function, the distance along the x-axis required to complete one full cycle, is three.

Thus, the equation can be found as follows:

\[
a = 1/2(-0.5 - (-1.5)) = 0.5
\]
\[ b = \frac{2\pi}{\text{period}} = \frac{2\pi}{3}. \]
\[ c = 3, \text{ or the x-value of the most easily identified maximum.} \]
\[ d = -1, \text{ halfway point between maximum and minimum.} \]

The resulting equation is then.
\[ y = -1 + 0.5\cos\left(\frac{2\pi}{3}(x - 3)\right). \]

After finding the equation, students do a write-up about how the equation and its graph are related to such elements as the volume and tone of a note. The amplitude is directly related to the loudness or a note; louder notes result in larger amplitude \((a)\). Thus the distance from minimum to maximum increases and the graph is stretched vertically. The opposite would be true for quieter notes. The frequency of a note is the reciprocal of the period, so for the example above, frequency \(= \frac{1}{3}\). A higher frequency will then shorten the period and result in a horizontal compression of the graph.

Once all instruments are complete, data is recorded, and write-ups finished, students present their instruments to the class, and the entire class plays an awkward rendition of “Mary Had A Little Lamb.”

Students typically enjoy this project, and it is very fun to see their creative minds at work. This project has been used in Gifted Precalculus classes at Brookwood High School for many years. Each year students continue to create projects that are unique and insightful. Student responses to the project include the following:

“I loved the fact that we could visually see the actual wave that our homemade instruments produced and could go even further by indicating the actual wave formula.” —K.D.

“This project was fun and I enjoyed it because I like working with my hands, and I like math and physics, and it combined all three!” —P.B.

“I liked using the graphing equipment to find the graphs of our instruments.” —M.B.

“The project helped me to better understand both my Precalculus and physics classes.” —W.A.

“This project was different from any other one I’ve done.” —H.L.

The equipment requirements are TI-82 Calculators with SOUND program, CBL with microphone probe, calculator link.

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**NEXT ISSUE**

**Deadline is June 15, 2006**

**TOPICS:**

Tips for new teachers—How to get started
How to Integrate the Georgia Performance Standards.
Probability and Statistics

**REFLECTIONS SPRING 2006**
PROJECT DESCRIPTION

For an individual project second semester, you will build a musical instrument. You should be able to play three distinctly different pitches, with enough amplification to be heard from the back of the room.

There is a difference between noise and music. Your notes must have a frequency that can be measured using the CBL, a TI-85 calculator, and a microphone probe.

Build a percussion, wind, or stringed instrument. You may not use glasses filled with water at different levels as your instrument. You may not make chimes because of the difficulty in obtaining a good graph.

The instrument may have different parts, but all parts must be related. Don’t bring in three pots or three bottles filled with water to hit with a spoon, and expect a good grade. Remember this is a major test grade, and your project should reflect a considerable amount of work done in order to receive a good grade.

A project write-up must be included with your instrument. On the due date, you will turn in the report and demonstrate the instrument for your class. Your teacher will keep the instrument until all classes have completed the project.

PROJECT WRITE-UP

• Description of instrument.

• Determine the trigonometric equation for one of the pitches of your instrument.

• What is the frequency of the pitch selected in question 2?

• How were the tones of your instrument amplified?

• Discuss how the pitch of a note affects the equation.

• How does the pitch of a note affect the graph of a sinusoidal function?

• Discuss how the loudness of a note affects the equation.

• How does the loudness of a note affect the graph of a sinusoidal function?
<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>WRITE-UP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to distinguish three pitches</td>
<td>Quality of Sound</td>
</tr>
<tr>
<td>8 Three pitches, easily distinguishable</td>
<td>Graph is periodic, sinusoidal, equation is perfect match</td>
</tr>
<tr>
<td>6 Three pitches</td>
<td>Graph is periodic, sinusoidal, equation is close match</td>
</tr>
<tr>
<td>4 Two pitches</td>
<td>Resembles sinusoidal curve, relatively close match on equation</td>
</tr>
<tr>
<td>2 One pitch</td>
<td>Calculator displays a graph of noise.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ability to distinguish three pitches</th>
<th>Appropriate amplitude</th>
<th>Creativity</th>
<th>Effort and Quality of Workmanship</th>
<th>Quality of Sound</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Three pitches, easily distinguishable</td>
<td>Easily heard from back of room</td>
<td>Original thought, extremely creative in idea and appearance</td>
<td>Greatly exceeds expectations in appearance and evidence of work</td>
<td>Graph is periodic, sinusoidal, equation is perfect match</td>
</tr>
<tr>
<td>6 Three pitches</td>
<td>Barely heard from back of room</td>
<td>Creative in idea and appearance</td>
<td>Professional appearance/neat, evidence of a great deal of work</td>
<td>Graph is periodic, sinusoidal, equation is close match</td>
</tr>
<tr>
<td>4 Two pitches</td>
<td>Easily heard from immediate proximity</td>
<td>Minimal creative appeal</td>
<td>Instrument is neat, evidence of required work</td>
<td>Resembles sinusoidal curve, relatively close match on equation</td>
</tr>
<tr>
<td>2 One pitch</td>
<td>Barely audible</td>
<td>Little or no creative thought</td>
<td>Instrument appears messy/hurriedly put together, evidence of little or no work</td>
<td>Calculator displays a graph of noise.</td>
</tr>
</tbody>
</table>
Assessment for Improving Instruction
Exemplars 13th Annual Summer Institute 2006
Gain a Better Understanding of Standards-Based Performance Assessment and Instruction

The Broad Agenda
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• Make the link from assessment to instruction
• Use assessment results to improve performance
• Discuss results with students and parents

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Your school may bring exactly four students who will compete against other Georgia middle schools. The purpose of the tournament is to foster interest in mathematics among middle school students.

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To register, visit the competition link at gctm.org.
In the last issue of *Reflections*, I shared some geometry activities from Japanese elementary school mathematics textbooks. In this article, I would like to focus my attention on the use of pictorial representations in Japanese elementary school mathematics textbooks and describe how they gradually develop representations across grades to help students to understand more sophisticated and abstract mathematical ideas such as division of fractions in higher grade.

With respect to representations, the K-5 Georgia Performance Standards state that, “students will create and use pictures, manipulatives, models, and symbols to organize, record, and communicate mathematical ideas.” Then, starting in Grade 6, students are expected to “select, apply, and translate among mathematical representations to solve problems,” and “Use representations to model and interpret physical, social, and mathematical phenomena.” These expectations are consistent with what you find in Japanese textbooks. For example, in the discussion of division of fractions in Grade 6, a textbook series gives the following problem:

With $\frac{3}{4}$ dl of paint you can paint $\frac{2}{5}$ m$^2$ of board. How many square meters can you paint with 1 dl of paint?

The textbook includes the following diagram (Grade 6, Volume 1, p. 17) to represent the problem situation. The same diagram was used in discussion of division of whole numbers and decimal numbers; therefore, from the diagram, students are expected to realize that this problem situation is also a division situation.

The textbook includes the following problems and diagrams (p. 18) to establish the division algorithm. These examples illustrate that by Grade 6, Japanese mathematics curriculum expects students to be able to use a sophisticated representation system to “model” and “interpret” various phenomena and to “solve” problems. In the remainder of the article, I would like to take you on a quick tour of a Japanese elementary mathematics textbook series (Sugiyama & Hironaka, 2006) to illustrate how it attempts to develop students’ ability to use increasingly more sophisticated representations.

In Grade 1, as we might expect, the textbook series uses many pictures of actual objects involved in problems as representations of quantities. However, even from the very beginning, the series encourages children to use concrete materials along with the actual objects (Grade 1, p. 10). As students continue with their study of arithmetic operations, the text-
books will include both the pictures of actual objects and manipulatives children may use (p. 40). Later in Grade 1, for some problems, the textbook includes only the pictures of manipulatives (p. 62). Finally, at the end of Grade 1, the textbook introduces drawings, instead of pictures of manipulatives, to represent quantities (p. 97). See Figure 1 for a summary of the use of pictorial representations in Grade 1.

Starting in Grade 2, the textbook series develops more and more sophisticated, and abstract, representations such as the double number line discussed above. However, this development is gradual and carefully sequenced. In Grade 2, you see the beginning of the development of what Japanese mathematics educators call “tape diagram.” On p. 12 (Grade 2, Vol. 1), you see a diagram in which circular counters are lined up and surrounded by ‘tapes.’ A little later, on p. 20 (Vol. 1), you see a similar diagram, but, since the problem is asking for the missing addend, there is no counter in one segment of the tape. Through these examples, the textbook tries to help children become comfortable representing discrete quantities using a continuous diagram.

Up to this point, children were only asked to fill in some numbers in a diagram that was already completed for them. However, near the end of Grade 2, there is a unit where one of the foci is for students to become able to draw these diagrams by themselves. The textbook includes some examples to illustrate how children might draw tape diagrams such as the one shown on p. 51 (Vol. 2), where children were given the following problem:

*We have a box of oranges. We gave away 16 of them. Now we have 18 oranges. How many oranges did we have at first?*

Some readers may have noticed that this particular textbook series is not using any number line representation up to this point. The series does use number lines, but they are primarily to illustrate the relative positions of numbers. Another interesting way the series use number lines is to represent elapsed time. So, as students are introduced to the notion of elapsed time in Grade 2, the textbook includes a number line representation (Vol. 1, p. 4). Then, in Grade 3, number lines are used again to deal with elapsed time problems (Vol. 1, p. 55). Soon after the book discusses elapsed time, the series starts using the combination of a tape and a number line to represent multiplicative problem situations.

In Figure 3, you see a series of this particular form of diagram in Grades 3 through 5, finally culminating in the use of double number line in Grade 5. Clearly, this is a rather quick tour of the whole elementary grade textbooks. However, I hope that you were able to get a glimpse of how carefully this particular textbook series develop pictorial representations across elementary grades.

Helping children develop the ability to create and use pictorial representations is an important curricular goals. However, such an ability does not develop automatically. As the examples from the Japanese textbooks have shown, it takes careful and intentional planning. The way the Japanese textbooks attempts to develop children’s representation, suggest three major principles:

- Start with using completed representations to creating representations of their own.

CONTINUED ON PG. 26
Cognitive Computer Tools in Mathematics

Online materials, computer-based tutoring, and adaptive testing are increasingly popular applications of computing technology in academics, but it is the impact that computers have on classroom learning experiences that is reshaping mathematics teaching and learning. The Technology Principle, as described by the National Council of Teachers of Mathematics (2000), states that the use of technology is essential in mathematics because it enhances student learning. How can computer technology be used appropriately so that it facilitates higher-level thinking? The answer may involve understanding the role of technology as a cognitive tool.

A cognitive tool can be any technology that amplifies mental capabilities by taking on low-level tasks so that high-level thinking and learning can be supported. When properly implemented, these tools can support the exploration and development of mathematics concepts. They assist in creating opportunities for cognitive processes that engage individuals in constructing their own knowledge. Paper, writing instruments, slide rules, manipulatives, graphing calculators, and software programs are just some of the technologies that have revolutionized the way information is stored, analyzed, synthesized, and communicated. Each one of these items has challenged educators to rethink how to approach problem solving by using these tools.

Roy Pea (1987) suggests that there are five general characteristics that are identified with cognitive technology tools as they may appear in mathematics education:

- Tools should promote learning how to learn.
- Tools should encourage the learning of necessary problem-solving methods.

A cognitive computer tool is a software application that assists the user in performing cognitive tasks through reorganization or representation of ideas and information (Landauer, 1988; Schoenfeld, 1988). A few of the most common types of computer cognitive tools in the teaching of mathematics are spreadsheets, geometry software, and Computer Algebra System.

Spreadsheets may be considered a cognitive tool when they are used properly for amplifying and reorganizing mental functions into an easy to read table of information. The information can also be translated into graphs and compiled with formulas and user-defined programming to make use of the information in a way that solves a specific problem. Spreadsheets can help students move from thinking in terms of specific cause-effect relationships to a more general implementation.
of rules or functions. Sutherland and Rojano (1993) looked at how spreadsheets impacted cognition when they were used to solve algebra problems. They concluded that the use of the spreadsheets contributed to helping students move from thinking in terms of specific cause-effect relationships to a more general using of rules that could be represented both in a spreadsheet and in symbolic notation.

Cognitive computer tools are also used to assist in the exploration of geometry concepts. Software packages such as Geometric Supposer and Geometer’s Sketchpad allow for the drawing, measuring, and exploring of geometric shapes and figures. Yerushalmi (1990) found that Geometric Supposer assists secondary students in making conjectures. The numerical data and visual information produced with the computer tool provided a basis for a conjecture. After the conjecture was made, the students focused more on the ideas supporting the conjecture and less on the software generated data.

Another type of software that can qualify as a cognitive computer tool is a Computer Algebra System (CAS). A CAS has the capability to perform numerical, graphical, symbolic, and logical operations that are inherent in algebra. Some examples of commonly used CAS include Derive, Mathematica, Maple, and MathCAD. The integration of graphs, tables, algebraic equations, and verbal mathematical models can be integrated using these software programs, which creates opportunities for thorough analysis to take place. Students can develop creative problem solving strategies in solving complex mathematical tasks that require high-level thinking. The research that exists regarding a CAS usage varies in scope and often is focused on handheld devices with more restricted capabilities than the previously mentioned software. For example, Keller and Russell (1997) found that undergraduate calculus students using the CAS on a TI-92 calculator chose correct methods for solving problems at a higher rate than students who did not.

There are many implications for the teaching of mathematics when cognitive technology tools are utilized. Authentic assessment and meaningful educative experiences must be used to teach students how to use the knowledge that resides in the information technologies of today. Students must understand how to use technology mindfully in problem solving processes and learn to interpret the information. Technology rich curriculums must be devised that match and then challenge student understanding, which in turn promotes further cognitive development through the construction of knowledge. This implies that in addition to already existing responsibilities, teachers are now faced with playing the role of an instructional designer, as considerable amounts of time must be spent developing materials and collaborative explorations for students.

References

CONTINUED ON NEXT PAGE
Multiple Representations contd from pg. 23

- Use representations to think about problem situations and mathematical relationships.

- Consider using the same representations for mathematically similar situations, such as multiplicative situations.

Finally, I also want to point out the importance of carefully selecting problem contexts to support children’s ability to create and use pictorial representations. If you look at Grades 4 and 5 examples, you notice that all of the problems involved items like ribbon and iron pipes, which might be more natural for children to represent using a tape or line. In contrast, the division of fraction problem discussed at the beginning of this article dealt with the amount of area someone can paint. However, in that context, area models were used to develop the division algorithm. Thus, there was again a match between the problem context and the type of model being utilized. Finally, careful and intentional selection of problem contexts may be an important factor to consider as we attempt to help our students develop more sophisticated representations.

Reference

Cognitive Computer Tools contd from pg. 25


GCTM Awards for 2006

Nominations Due May 15

Do you know a mathematics educator who deserves to be honored by our professional organization? Each year, GCTM sponsors five awards that are presented at the Georgia Math Conference at Rock Eagle in October:

Gladys M. Thomason Award for Distinguished Service
This award is given for distinguished service in the field of mathematics education at the local, regional, and state levels, where the service is significant, is beyond normal job requirements, and is primarily for the improvement of mathematics instruction.

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Three awards, one each for elementary, middle, and secondary levels, are given to excellent teachers who have strong content foundation in mathematics appropriate for their teaching level, show evidence of growth in the teaching of mathematics, and show evidence of professional involvement in GCTM and NCTM.

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GCTM recognizes one outstanding new teacher in the state each year who has no more than 3 years experience at the time of the nomination and who demonstrates qualities of excellence in the teaching of mathematics.

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This award is presented to a member of GCTM who demonstrates excellence as a full time post secondary educator and/or district supervisor. The recipient is someone who is an inspirer, a mentor, and an advocate of mathematics and mathematics education.

Dwight Love Award
This award is presented to a teacher in Georgia who models excellence in the profession and in life and gives much to others beyond the classroom as mentor, teacher and leader. The awardee is a master teacher, professionally active, and promotes GCTM and its mission.

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and follow the instructions to honor great mathematics educators.
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