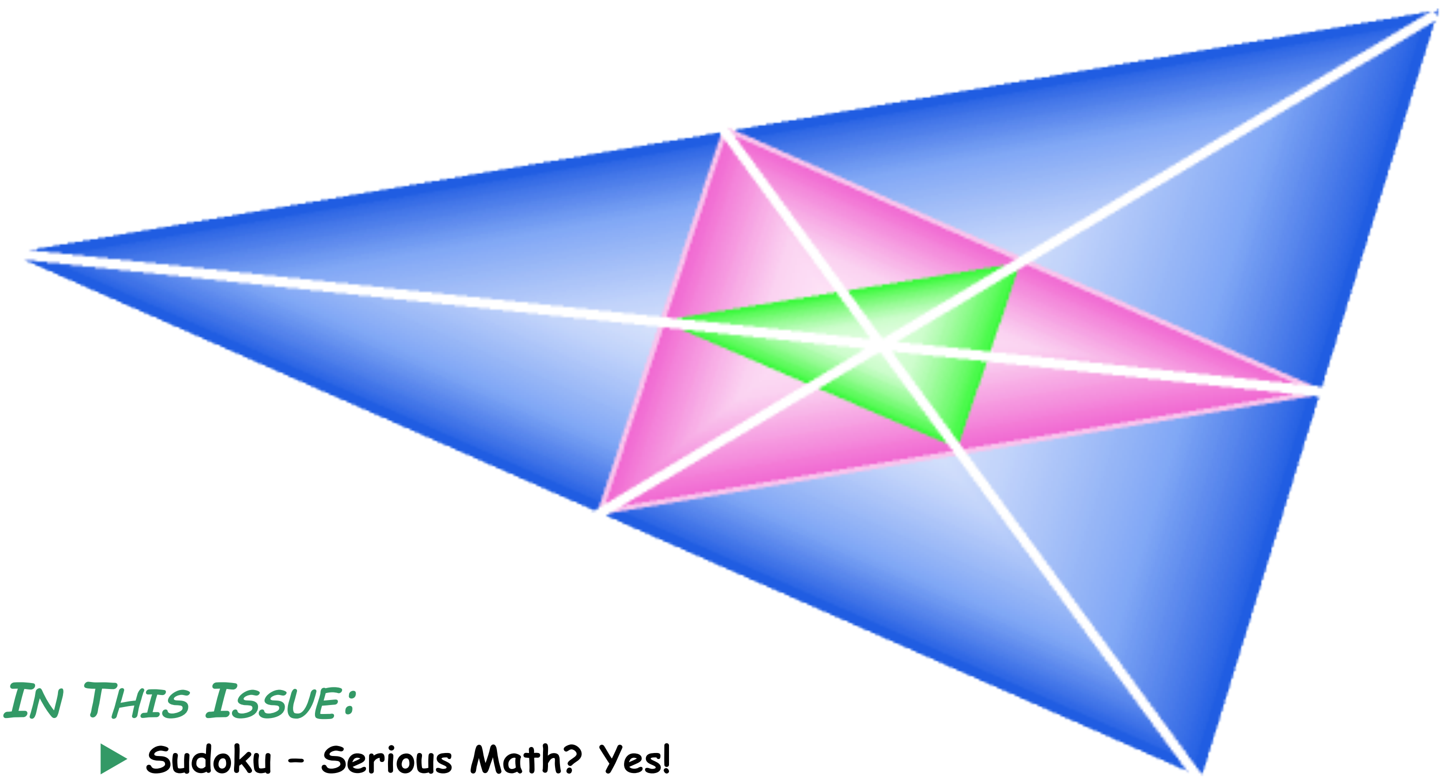
The Centroid



In This Issue:

NCCTM · North Carolina Council of Teachers of Mathematics

Official Journal of the North Carolina Council of Teachers of Mathematics
Volume 33 • Number 2 • Fall 2007

The Centroid is the official journal of the North Carolina Council of Teachers of Mathematics (NCCTM). Its aim is to provide information and ideas for teachers of mathematics—pre-kindergarten through teacher education. *The Centroid* is published in January and August. Subscribe by joining NCCTM; see the Membership Form on the last page.

Submission of Manuscripts

We invite the submission of news, announcements, and articles useful to school mathematics teachers or mathematics teacher educators. In particular, K-12 teachers are encouraged to submit articles describing teaching mathematical content in innovative ways. To be considered for inclusion in an issue, news and announcements must be received by November 1 for the spring issue and by June 1 for the fall issue.

Manuscripts that have not been published before and are not under review elsewhere may be submitted at any time to the address below. Submit one electronic copy via e-mail attachment (preferred) or diskette in *Microsoft Word* or rich text file format. To allow for blind review, the author's name and contact information should appear *only* on a separate title page. Manuscripts should not exceed 10 pages double-spaced with one-inch margins. Figures and other pictures should be included in the document in line with the text (not as floating objects). Scannable photos are acceptable and should be large glossy prints mailed to the editor or minimum 300 dpi tiff files emailed to the editor. Proof of the photographer's permission is required. For photos of students, parent or guardian permission is required.

Manuscripts should follow APA style guidelines from the fifth edition of the *Publication Manual of the American Psychological Association* (2001). References should be listed at the end of the article, and should also follow APA style, e.g.,

Bruner, J. S. (1977). *The process of education* (2nd ed.). Cambridge, MA: Harvard University Press.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

North Carolina Department of Public Instruction. (1999). *North Carolina standard course of study: Mathematics, Grade 3*. Retrieved on October 17, 2005 from http://www.ncpublicschools.org/curriculum/mathematics/grade_3.html

Perry, B. K. (2000). Patterns for giving change and using mental mathematics. *Teaching Children Mathematics*, *7*, 196–199.

Ron, P. (1998). My family taught me this way. In L. J. Morrow & M. J. Kenney (Eds.), *The teaching and learning of algorithms in school mathematics: 1998 yearbook* (pp. 115–119). Reston, VA: National Council of Teachers of Mathematics.

General articles are welcome, as are the following special categories of articles:

- *A Teacher's Story*,
- *History Corner*,
- *Teaching with Technology,*
- *It's Elementary!*
- *Math in the Middle*, and
- *Algebra for Everyone*.

Editorial Board

About the Cover

The Centroid logo is based on the following theorem: The limit of the sequence of midtriangles of a triangle is the centroid of the triangle.

Copyright

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The Centroid

OFFICIAL JOURNAL OF THE NORTH CAROLINA COUNCIL OF TEACHERS OF MATHEMATICS
VOLUME 33 • NUMBER 2 • FALL 2007

Articles

News & Information

From the Editor

Welcome to the On-Line Centroid

Holly Hirst
Appalachian State University
Boone, North Carolina

It is finally here: the first on-line issue of The Centroid. Everyone who returned the form in the last issue will also receive a paper copy of the Centroid. If you wish to receive paper copies in the future, please request that your name be added to the mailing list by sending me and email <hirsthp@appstate.edu>. I will forward it to the business office.

We hope you enjoy the issue. We have included an article on Teaching with Technology that outlines two activities North Carolina high school teachers have used with success in their classrooms. In addition, the results of the NAEP tests for 4th and 8th grade North Carolina students are put in context and compared to U.S. students. We hope you will also enjoy the summary of the Bulleting of the American Mathematical Society article on the mathematics of Sudoku.

As always we are looking for articles to include in upcoming issues. Of particular interest are articles that present proven activities used by teachers in courses in the North Carolina Standard Course of Study in mathematics.

NCCTM State Conference: October 10-12

Koury Convention Center, Greensboro, NC

The 2007 State Mathematics Conference is a wonderful opportunity to share research, classroom strategies, activities, and resources with your colleagues that make mathematics come alive for your students. The complete program and registration information for the 2007 State Mathematics Conference (October 11 and 12) and the Leadership Seminar (October 10) are now at the NCCTM web site <www.ncctm.org>.

On-line registration is now open for both events.

Pre-registration (October 2 deadline)
Current member: $55
Non-member: $95
Full-time student (current member): $0

On-site registration
Current member: $75
Non-member: $115
Full-time student: must join and pay membership fee of $10

Awards Breakfast $20 (October 12)
Workshops $2 each

Leadership Seminar $50

Presidents' Messages

State President
Randy Harter
randy.harter@bcsemail.org

The North Carolina Council of Teachers of Mathematics and its affiliate, the National Council of Teachers of Mathematics, exist for one primary reason, to improve the teaching and learning of mathematics, and it's the learning part that ultimately matters. We cannot be satisfied with our teaching if we are not satisfied with our students' learning, every student's learning.

Mathematics educators in North Carolina should be commended for the significant improvements in students' learning as measured by the SAT and the National Assessment of Educational Progress (NAEP). From 1986 to 2006 while SAT participation in NC increased from 47% to 71%, mean SAT Math scores in the state increased steadily from 465 to 513, closing the gap from 35 points below the national average in 1986 to just 5 points below in 2006. Both national and state means dropped slightly in 2007. On the NAEP exams since 1990, North Carolina's gains at grades four and eight are unmatched.

At the same time there are significant challenges. In a recently released report, we learned that over 30% of the North Carolina students who entered grade 9 in 2003 failed to graduate with their classmates in 2007. What does the future hold for these students? The job market is changing rapidly due to a global economy. Tony Habit, President of the North Carolina New Schools Project, stated in testimony before a congressional committee on April 24, 2007 that "North Carolina has felt acute pain from an unprecedented restructuring of the economy of our state." He went on to say, "In the first five years of this decade, for example, North Carolina lost nearly one-quarter of its manufacturing jobs." In reference to the gains in North Carolina on measures such as the SAT, Habit testified that "While impressive in relative terms, the incremental gains of our high schools are insufficient both in terms of scope and in terms of pace to address a changing economy."

Regarding the pace of change, it will soon be 20 years since NCTM released its working draft of the Curriculum and Evaluation Standards for School Mathematics in October 1987. The first page of that document stated that "most students need to learn more, and often, different mathematics and … the teaching of mathematics must be significantly improved." Other challenges in the Introduction stated "emphasis and topics of the present curriculum should be altered," and "traditions, assumptions, and constraints underlying current educational practice must be changed." A year ago the immediate Past-President of NCTM, Cathy Seeley, one of the most positive and articulate leaders for mathematics education in the country, was the keynote speaker at our NCCTM State Conference and Leadership Pre-session. Looking back over these past two decades and the impact of the publication of NCTM's standards for curriculum and evaluation (1989), teaching (1991), and assessment (1995) and the Principals and Standards for School Mathematics (2000), she observed that there are "pockets of wonderfulness, but little systemic impact." What has been the systemic impact in North Carolina of the national reform efforts over the past 20 years?

I believe that leaders in the government and business sectors are growing impatient with what they may see as a lack of any sufficient sense of urgency for substantial change coming from within the educational community. Thus we see the nation's governors and business leaders creating The National Diploma Project and Achieve, Inc., a national effort to increase the rigor of high school graduation requirements so that "all students graduate ready for college, work, and citizenship." We see the Burroughs Wellcome Fund, an independent, private foundation located in North Carolina's Research Triangle Park, creating The North Carolina Science, Mathematics, and Technology Education Center "to improve the performance of North Carolina's pre K-12 students in science, mathematics, and technology education." We see the William and Ida Friday Institute for Educational Innovations at North Carolina State University, funded with state and federal grants, private foundations, and corporate partners with a mission "to advance education through innovation in teaching, learning, and leadership". We see Governor Easley and the State Board of Education creating, with substantial funding from the Bill and Melinda Gates Foundation, an independent, not for profit corporation, the NC New Schools Project, "to accelerate the pace of innovation in our state and to ensure that all students have access to high-quality schools that will prepare them for college, work, and life."

The leadership of NCCTM believes that mathematics educators need to collaborate with leaders in government and business to shape a vision and strategic plan for improving the teaching and learning of mathematics in our state, a vision and plan with an appreciation for both the magnitude of change required to meet the demands of the new century and a sense of urgency that recognizes that business as usual in North Carolina schools is not good enough.

Start by making plans to join us for the 2007 NCCTM State Math Conference and Leadership Pre-Session at the Koury Convention Center in Greensboro October 10-12, 2007. The program for Wednesday, October 10 Leadership Pre-Session includes Barbara Reys, Director of the Center for the Study of Mathematics Curriculum at University of Missouri; Jere Confrey, Senior Scholar, Friday Institute for Educational Innovation at NCSU; Sam Houston, President and CEO of the North Carolina Science, Mathematics, and Technology Education Center and Chair of the NC Blue Ribbon Commission on Testing and Accountability; Tony Habit, President of the NC New Schools Project; June Atkinson, J. B. Buxton, and Everly Broadway of the NC Department of Public Instruction. Featured speakers at the main conference on October 11-12 include Barbara Reys; Grayson Wheatley, researcher of students' mathematical thinking and author of innovative instructional materials; Steve Leinwand, former President of the National Council of Supervisors of Mathematics; Doug Clements, researcher, author and a member of the National Math Panel; Richard Rusczyk, founder and CEO of the Art of Problem Solving; Gary Bauer of Montana's SIMMS Project; and Susan Jo Russell, lead author for one of the NSF-funded standards-based K-5 curriculum and Developing Mathematical Ideas professional development curriculum. There are a total of over 300 sessions and workshops, most led by outstanding presenters within our own state. Like all good professional development, the intent is to challenge our current beliefs and practices and send us home with a greater resolve to improve learning opportunities for students across North Carolina. Come join us.

Eastern Region President
Rose Sinicrope

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The Eastern Regional Conference on Saturday, February 17, at North Carolina Wesleyan in Rocky Mount was excellent. Thanks to Gail Stafford for her organization and hospitality at Wesleyan. Refreshments were delicious, the meeting rooms were comfortable and well-equipped, and the Wesleyan students were great with directions and help. Jeane Joyner's opening address was thought-provoking and inspirational. Ray Jernigan and Eleanor Pussey did an outstanding job of procuring speakers and providing a great program. It was a jam-packed morning!

Plans are currently underway for the Spring 2008 Eastern Regional Conference to be held on Saturday morning, February 23. Please check the website <www.ncctm.org> for information and opportunities to present a session. Check out the new web page structure! Also, consider NCCTM opportunities for grants and scholarships for teachers and mathematics opportunities for your students.

The eastern region thanks outgoing officers: President Julie Kolb, Past President Kathy Hill, College Vice President Gail Stafford, Secondary Vice President June Blackwell, Middle Grades Vice President Lucy Kay, Elementary Vice President Carolann Wade, and Secretary Elizabeth Murr. A special thanks to Julie Kolb who will continue to serve the region in the role of Past President. The East also expresses great appreciation to Bobbie Parker, who has diligently served as the director of the East's Math Fair. Please welcome our new regional officers: College Vice President Tim Hendrix, Secondary Vice President Holt Wilson, Middle School Vice President Julie Cazin, Elementary Vice President Kitty Rutherford, and Secretary Katie Stein.

Central Region President
Rebecca Caison

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Greetings to the member of the Central Region. As usual the summer has flown by. I hope you were able to enjoy your summer and are ready for a new and exciting school year. We have implemented the new EOC and EOG tests and we are ready to being the cycle over again with the revision of the curriculum.

I would like to thank Emogene Kernodle for her work as the president of the Central Region. She will continue to serve on the Board of Directors and to assist me during the next year. She has left big footsteps for me to follow.

The spring regional conference was successful as we stepped "outside of the box." We met at the Natural Science Center in Greensboro where we had updates from the Mathematics Staff at DPI and toured the museum's exhibit "Flip It, Fold It, Figure It Out! Playing with Math." Everyone enjoyed the "hands-on" activities in the exhibit just as our students enjoy the hands on activities our classroom. The Math Fair was held the same day at Greensboro College. It was so exciting to see all of the wonderful math projects and the excitement for mathematics displayed by the students from the Central Region. Thanks to Wendy Rich and her committee for their outstanding work in making the Math Fair a successful event for the students.

Your new officers for the Eastern Region are Elementary Vice-President, Donna Boyles; Middle School Vice-President, Pat Sickles; Secondary Vice-President, Adam Reeder; College Vice-President, Vincent Snipes; and Secretary, Ana Floyd. They will serve the organization for two years. We are fortunate to have Melissa Young as our student representative. Melissa is a student at A & T State University.

Please check out all the opportunities on our website. You will find information on the many opportunities for both students and teachers provided by our organization. I hope everyone is planning to attend the annual conference in Greensboro on October 11th and 12th. The Conference Planning Committee and the program chairpersons have been hard at work to secure an outstanding group of speakers. If you have any suggestions for improving our organizations email me or talk to me or to any of your officers at the fall conference. I hope to see you there.

Western Region President

Debbie Crocker

crockerda@appstate.edu

Welcome back to a new school year! I hope it is off to a good start. I am happy to assume the duties of the Western Region President. I want to thank Carmen Wilson for serving in this position for two years. She is still involved as past president. Some of this column concerns activities during Carmen's tenure as president.

The Western Region Math Fair was held at Plemmons Student Union on the campus of Appalachian State University on Saturday, March 31. Participation was the largest ever for the Western Region Fair with 303 students, 231 projects, and 60 schools involved. A huge thank you goes to coordinators Betty Long, Cindy Robinson, and Theresa Compton for all of their hard work! Additionally, a number of parents, teachers, Appalachian students, and other school personnel volunteered time to make the fair a huge success. Thanks to all who volunteered. Mark your calendars! The next Western Region Math Fair will be Saturday, April 12, 2008 at Plemmons Student Union on the campus of Appalachian State University. Get your students started on their projects! Volunteer to judge, help in the student holding rooms, do registration, or be a runner!

The Western Region Conference was held on Saturday, February 24 at Jacobs Fork Middle School. A special thanks to all of the speakers who volunteered their time to make the conference a success! The participation by pre-service teachers was good, but we need to increase participation overall. With that in mind, the next Western Region Conference will be on Saturday, February 23, 2008. A location has not been confirmed and will be announced at a later date. Contact me if you would like to volunteer to speak to either teachers or pre-service teachers at the Western Region Conference this year.

I hope this year will be productive for all of us in the Western Region of NCCTM. You can email me with questions, concerns, or ideas. I hope to hear from some of you! Have a great school year!

NCTM Interprets the Nation's Report Card on Mathematics

NCTM has published *Results and Interpretations of the 2003 Mathematics Assessment of the National Assessment of Educational Progress*, a comprehensive analysis of the NAEP assessment used to measure student learning in mathematics. The report provides a background on NAEP, examines mathematics achievement in different content areas, discusses data about mathematics teachers and school environments, and examines students' perception of mathematics. In addition, the book presents results by race, ethnicity, and gender. It examines the changes in NAEP over the years and what those changes mean for NAEP as a tool for understanding student learning.

To purchase a copy of the report and to read more about the results and other national news related to mathematics education, please refer to the NCTM website.

<www.nctm.org>

Teaching with Technology – Two Teachers' Experiences

Susan Jones
Shelby High School
Shelby, North Carolina

Sumer Lerch
McDowell High School
Marion, North Carolina

Support for the Use of Technology

According to the National Council of Teachers of Mathematics (NCTM) in *Principles and Standards for School Mathematics* (2000), "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning." Additionally, The North Carolina Standard Course of Study for high school mathematics courses states that technology should be used regularly for instruction and for assessment (2003).

Since standardized tests now require more upper level thinking and application of mathematical knowledge, classroom lessons must be adapted to allow students to develop critical thinking skills. Calculators do arithmetic, but they also help students reason mathematically. This aids in preparation for assessment and future job training. Handheld technology allows students to work with mathematics beyond what they would be able to otherwise (Jones, 1995; Seeley, 2004; Waits, 2000).

We have personally experienced these benefits in our classrooms. Our students are more attentive, active, and involved when they are doing calculator activities in addition to observing and taking notes. They are more interested and inquisitive. We have seen students gain confidence and become frustrated less often when they are working with their calculators. Technology makes it easier for them to start over, so students are more willing to try again instead of giving up. They begin to see math as a process and recognize that working through the problem is as important as arriving at an answer.

With graphing calculators, students can explore, hypothesize, and make conjectures. They then can be asked to draw conclusions and make generalizations based on their observations. When students can discover and figure things out for themselves, they have more ownership of the material being taught. As a result, we have seem them become more likely to learn and understand the concepts.

Graphing calculators make representing a problem algebraically, numerically, and graphically very simple. While calculator explorations do not take the place of formal proof, they can help students visualize concepts. Questions can be answered by showing students why something works rather than telling them. Simulations and modeling become powerful tools for clearing up confusion and misconceptions. Calculators are excellent tools for problem solving. They remove some of the tedious computations and allow students to work on real world problems or data that contain 'messy' numbers. With appropriate technology use, interesting math topics can be explored that would otherwise be too difficult for students.

The mathematics classroom changes when technology is used. Teachers and students become partners, and students are more actively engaged in learning (Farrell, 1996; Pugalee, 2002; and Seeley, 2004). The classroom is noisy as students collaborate, question, discuss, and explain to each other. We have found it very exciting to listen and watch as students work through an activity together. Students see mathematics as something that can be active, fun, and exciting rather than rote, boring, and confusing.

Integrating Technology into Teaching

Integrating technology into teaching practice is not an easy process. At first, we found it intimidating. It takes longer to plan for a calculator activity the first time, and there is no guarantee that everything will work as planned. As teachers, we must be willing to give up some control. The explorations and activities open students to ideas that they may question, and they may ask questions that we cannot readily answer.

For us, the key was to start slowly. We added a few new calculator activities and lessons in the beginning. Now, each time we teach a course, we add something new. Our students are making connections and mastering material that we did not realize they could. Taking on this challenge renewed our sense of excitement and joy of teaching. We are having more fun, our students are having more fun, and they are learning more. It has been worth the effort!

We hope you will try some activities in your classes, and to get you started we have included summaries of two activities that we have used successfully: Modeling Free Fall in a Precalculus class; Linear Programming with

Inequality Graphing in an Algebra 1 or Tech Math class. The full activities are available on the Centroid website. Your feedback is welcome.

Linear Programming with the Inequality Graphing Application

Using the Inequality Graphing Application gives students the ability to deal with a multiple step problem. Students can use the calculator to help with graphing, shading, finding the feasible region, and finding the best corner point, as well as investigating the notion that the corner points yield the best solution to the problem.

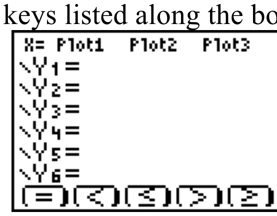
The application comes installed on the TI-84 Plus Family and is available for the TI-83 Plus and Silver Edition for a fee. You can find the application on the Texas Instruments Education web page.

First I have the students solve several problems that are already set up mathematically to get the students used to using the calculator.

Example: Find the maximum for $P = 3x + 2y$ subject to the constraints: $\begin{cases} x \le 5 \\ y \le 4 \\ x \ge 0, y \ge 0 \end{cases}$

Open the Application Inequalz by choosing it from the App Menu.

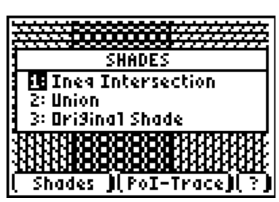
Go to the graphing window and notice the soft keys listed along the bottom of the window.



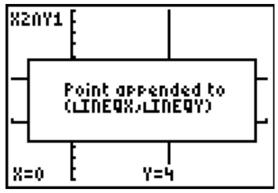
The soft keys are mapped to the function keys (F1 through F5). With this application once you turn it on you must go back and turn it off if you do not wish to see the inequality soft keys on the graphing screen.

You can enter the usual formulas (solved for y), and also any x inequalities by moving up to the X= option (top left corner of the screen). Once you enter a formula, move over to the equality symbol and use the soft keys to change to the appropriate inequality. Press graph, and then adjust the window if needed. I normally discuss with the class how to decide what limits would give a good picture, that trial and error is fine, and that there is more than one good fit. I make a point to talk about the soft keys at the bottom of the screen; we need to account for this not to cover up parts of the graph that would be needed. I like using an initial window of xmin= -2, xmax =10, ymin = -5 and ymax = 10 when the variables are both constrained to be ≥ 0.

Once the window is set press GRAPH and then the appropriate soft key (F1 or F2) to invoke the Shades menu; we care about the Ineq Intersection.

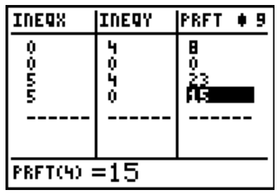


The students can watch the shadings take place and then the non intersection shadings removed. This catches their attention, and they begin to understand the process more. The next step in finding the maximum for this problem is to find the corners. To do this, use the intersection point tracing, PoI-Trace, feature of the program, soft keys F3 or F4.



You can use the arrow keys to jump from point to point. Notice that in the top left corner it tells you that this point is at the intersection of the line in X2 and Y1. If you press STO▶ at the intersection points the calculator will store the values into *x* and *y* lists called INEQX and INEQY.

The reason to store the points into lists is to allow the students to use list operations for the number manipulations to find the maximum. Go to the STAT menu and choose Edit. The special lists INEQX and INEQY will be there. Build another list and set it equal to the objective: “3 * INEQX + 2 * INEQY” choosing the variables out of the list menu.



Students can easily see from the PRFT list above that the point (5,4) yields the maximum value for this problem. The profit formula can be entered without quotes but if you wanted to you can go back to the graph and store other points to the list you need to quotes for the formula to work for the new values. It is good to go back and test other points on the graph and to let students prove to themselves that the corner points do give the maximums and minimums for the problem.

I have found that students can feel more successful working these problems from scratch given the opportunity to use this application. It also gives more time for discussion about the problems because students do not get bogged down in the multi-step nature of the problem. Allowing students to quickly test other points in and out of the feasible region allows them to discover that corner points yield the best answers.

Modeling Free Fall in Precalculus

In Precalculus, vertical free fall motion can be studied as a modeling exercise for quadratic functions. Students who are successful with quadratic functions have little trouble with the algebra necessary to answer the usual questions associated with these problems. They can build the function given the initial height and initial velocity, and they can answer questions about maximum height and how long it takes the projectile to hit the ground. Many students, however, have difficulty distinguishing between the path of the falling object and the parabolic graph of the quadratic function they have written.

The student who has watched a football trace a parabolic path after it leaves the foot of the punter in Friday night’s game or thrown a ball as high and hard as they can for the dog to fetch will have a tendency to over generalize. They often assume that since the graph of the function they have written is a parabola, that parabola must also represent the path of the object in free fall.

Parametric graphing can help alleviate this misconception. In this activity, students toss a ball vertically and use a CBR™ to measure the ball’s distance above the device. They observe a plot of data points generated by the CBR™ and calculate the quadratic function that models height as a function of time. Because the students observed the ball move straight up and straight down, they have seen the *y*-position change and the *x*-position remain constant, and they can conclude that the parabolic graph of the distance-time function is not the path of the ball. Setting up two pairs of parametric equations, one that allows *x* to change with time and one that keeps *x* constant, demonstrates for the students how the path of the ball they tossed relates to the graph of the parabola generated. This activity can be used as a demonstration for whole class instruction or, if enough space and equipment are available, as an exercise for small groups.

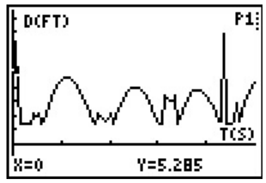
Set the CBR either on the floor or on a table with enough space around it to toss the ball straight up several feet, and connect the CBR to a calculator. Open the Applications Menu and select the CBL/CBR option, and then choose RANGER. Start by choosing SETUP/SAMPLE in the main menu.

On the SETUP/SAMPLE screen, do the following:

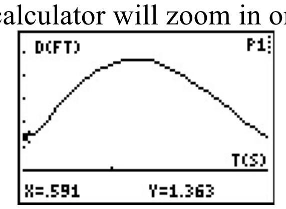
REALTIME: no
TIME(s):5
DISPLAY: DIS
BEGIN ON: [ENTER]
SMOOTHING: none
UNITS: FEET

Move the curser to START NOW and press ENTER.

Press ENTER and toss the ball straight up and catch it several times. The CBR will transfer the data to the calculator and plot a graph of the ball's height over the five second time interval. It may take several tries to get a good toss. If you are unsatisfied with the graph, repeat the sample. Stop when there is at least one nice parabola on your graph. The graph should look something like this.

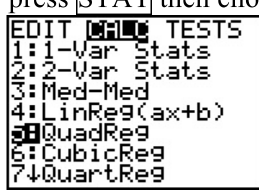


Now we will select only the nicest parabola in the graph. Press ENTER, choosing PLOT TOOLS, then SELECT DOMAIN. Set a left and right bound, and the calculator will zoom in only on the data points selected.

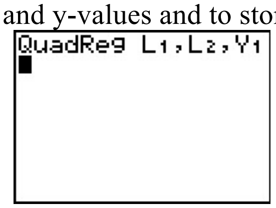


The calculator stores the data for time (L1), distance (L2), velocity (L3), and acceleration (L4). We are interested only in the data in L1 and L2 for this activity. The calculator has graphed a stat plot of the time and distance data. TRACE will allow you to move the cursor from point to point on the graph. At this point, a discussion of what variables X and Y represent is appropriate to be certain that students understand the graph.

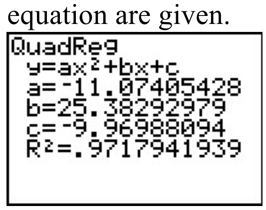
To calculate an equation for the data points, press STAT then choose 5: QuadReg.



Tell the calculator where to find the data for x- and y-values and to store the equation in Y1.



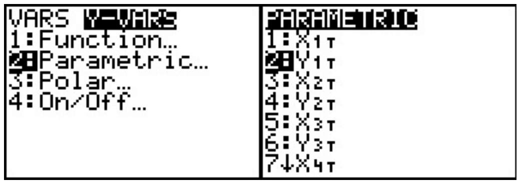
Press ENTER and coefficients for the quadratic equation are given.



GRAPH will overlay the graph the curve on the plot of the data set.

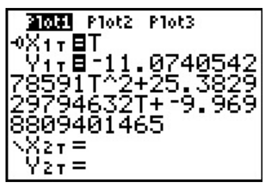
Discuss with students that this parabola is a graph of the height of the ball versus time. Ask how the ball moved as it was tossed. Did its path look like this? Was there movement right and left as it was tossed up and down? No. The ball moved up and down but not side to side. So there was change in the Y-position but no change in X-position.

To be able to see the ball's motion, we need to use parametric graphing. Run quadratic regression again but this time store the equation in Y_{1T}, pulling it from VARS:

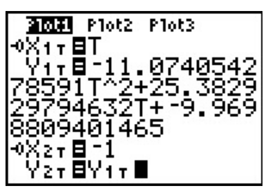


Change the MODE to parametric and simultaneous.

The calculator automatically writes the equation using the variable X, so press GRAPH and change the X's to T's in Y_{1T}. Set $X_{1T} = T$:

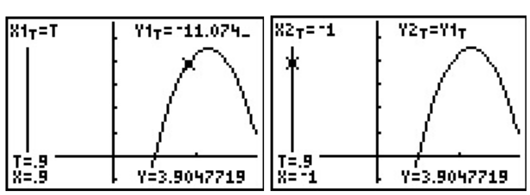


Graphing now will result in the same graph as before (distance versus time). We will use a second pair of equations for the path of the ball: X_{2T} and Y_{2T}. Choose a position for the graph of the (vertical) path of the ball; I use X= -1 for this, since the graph of the distance over time will not have negative X-values. Set $X_{2T} = -1$ and $Y_{2T} = Y_{1T}$.



Window settings will need to be changed. The Xmin should be something less than -1, Tmin should be 0, and Tmax should be 5. If the graph is drawn too quickly, reset the Tstep to a smaller number. Be sure to turn off the stat plot if you don't want to see the original data points.

Graphing both of these parametric equations allows students to watch the quadratic function graph on the right side of the Y-axis while the path of the ball is traced on the left side of the Y-axis. Tracing will allow further investigation and discussion. Use ▲ and ▼ to toggle between graphs.



References

Demana, F. & Waits, B. K. (1990). Enhancing mathematics teaching and learning through technology. *Teaching and Learning Mathematics in the 1990's,* 1990 Yearbook, Cooney, Thomas I. & Hirsch, Christian R. (Eds.) 212-222, Reston, VA: National Council of Teachers of Mathematics.

Farrell, A. M. (1996). Roles and behaviors in technology-integrated precalculus classrooms. *Journal of Mathematical Behavior, 15*, 35-53.

Heid, M. K., et al (1995). *Algebra in a technological world (pp. 1).* Reston, VA: National Council of Teachers of Mathematics.

Henningsen, M. & Stein, M. K. (2002). Supporting students' high-level thinking, reasoning, and communication in mathematics. In J. Sower & B. Schappelle, (Eds.). *Lessons learned from research* (pp. 27-35). Reston, VA: The National Council of Teachers of Mathematics.

Jones, P. L. (1995). Realizing the educational potential of the graphics calculator. In Lewis Lum (Ed.) *Proceedings of the Sixth Annual International Conference of Technology in Collegiate Mathematics.* New York: Addison-Wesley, 212-217.

National Council for Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: Author

Public Schools of North Carolina. (2003). *North Carolina Standard Course of Study*. Retrieved July 4, 2006, from http://www.ncpublicschools.org/curriculum/mathematics/scos/2003/9-12/index

Pugalee, D. K. (2001). Algebra for all: The role of technology and constructivism in an algebra course for at risk students. *Preventing School Failure, 45*(4), 171-176.

Seeley, C. (2004). Twenty-first century mathematics. *Principal Leadership (High School Edition), 5*(2), 22-26.

Schwarz, B. B., & Hershkowitz, R. (1999). Prototypes: Brakes or levers in learning the function concept? The role of computer tools. *Journal for Research in Mathematics Education, 30,* 363-389.

Steen, L.A. (1999). *Twenty Questions about Mathematical Reasoning.* Reston, VA: National Council of Teachers of Mathematics.

Waits, B. K. (2000). The power of visualization in calculus. *2000 Yearbook*. Reston VA: National Council of Teachers of Mathematics.

Mini-grants

The North Carolina Council of Teachers of Mathematics through its mini-grant program, provides incentive funding for North Carolina teachers as they develop activities to enhance mathematics education. This program will provide funds for special projects and research, which will enhance the teaching, learning, and enjoyment of mathematics. There is no preconceived criterion for projects except that students should receive an on-going benefit from the grant. Available to current members of NCCTM, the mini-grants are awarded by each of the three regional organizations to members within their geographic boundaries (If you incorrectly identify with the wrong region, your proposal will be ineligible for funding). A total of $15,000 is available each year for the state's mini-grants, with each region awarding approximately $5000 in grants to its members. In recent years, approximately 30-35 proposals have been partially or fully funded, for an average grant of just less than $800.

Grant proposals must be postmarked by September 15 (or emailed on that date), and proposals selected for funding will receive their funds as soon as possible after the state conference. You will receive an email confirmation of receipt once your proposal has been received. If you do not receive a confirmation within one week, it is your responsibility to follow-up with the Mini-grant Coordinator.

Directions

The directions and application are available on the NCCTM website. Please read all directions carefully and fill out application and cover sheet completely, as directed. Failure to correctly list the NCCTM region and membership number will cause your application to not be considered. Be sure that your NCCTM membership is current and active for the 2007-2008 school year! Be sure that it is a NCCTM membership and not NCTM or some other organization. Each year we have applications that cannot be considered because of the membership requirement.

<www.ncctm.org>

Sudoku – Serious Math? Yes!

Holly Hirst
Appalachian State University
Boone, North Carolina

4	6	5	9	3	8	2	7	1
7	2	9	4	5	1	8	3	6
3	8	1	6	7	2	4	9	5
5	3	7	8	1	6	9	4	2
2	4	8	5	9	3	1	6	7
9	1	6	2	4	7	3	5	8
6	5 9	4	1	8	5 9	7	2	3
1	7	2	3	6	4	5	8	9
8	5 9	3	7	2	5 9	6	1	4

Figure 1. The “solved” Sudoku.

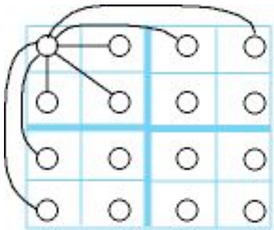


Figure 2. Part of the graph representing a 2-by-2 subgrid Sudoku puzzle.

[illegible] the Centroid, we included a Sudoku puzzle for you to [illegible] discovered, that puzzle has multiple solutions. We can see this in Figure 1; there is a “cycle” in this puzzle – choosing either 5 or 9 in one of the four cells containing both numbers and alternating numbers clockwise (or counterclockwise) around these four cells will each generate a solution.

When does a puzzle have one solution? This question and several others related to Sudoku puzzles are answered in the recent article by Agnes Herzberg and M. Ram Murty in the June/July 2007 issue of the Notices of the American Mathematical Society (Herzberg & Murty, 2007).

Their investigation into Sudoku puzzles led them to some very interesting mathematics. They first show that Sudoku puzzles can be recast as regular graph coloring problems allowing the broad, well-developed theory of graphs to be utilized.

A Sudoku puzzle grid can be represented by a graph as follows: Each cell in the puzzle corresponds to a vertex in a graph. The vertices are connected by edges if the cells in the puzzle are in the same row, column, or 3-by-3 subgrid. Figure 2 shows part of the graph resulting from the less complicated 2-by-2 subgrid Sudoku puzzle. Each vertex is connected to the other three in the subgrid and the other three in the row and in the column. Not counting duplicate edges gives seven edges for each vertex.

For a traditional 3-by-3 subgrid Sudoku puzzle, such as the one in Figure 1, each vertex is connected to the eight other vertices in the 3-by-3 subgrid, and the six additional vertices in the row and in the column, giving 8 + 6 + 6 = 20 edges for each vertex. The number of edges incident to (i.e., touching) a vertex is the degree of the vertex. All vertices in the 2-by-2 subgrid Sudoku graph have degree 7; all vertices in the 3-by-3 subgrid Sudoku graph have degree 20. A graph for which all vertices have the same degree is called *regular*, so Sudoku graphs are regular graphs.

Now that we have a graphical equivalent to the 3-by-3 subgrid Sudoku, what is the graphical equivalent of putting the digits 1 through 9 in the cells so that the rule is followed? The rule states that each digit can appear only once in any row, column, or subgrid. This is equivalent to coloring the vertices of the graph with 9 colors such that no vertices connected by an edge are the same color—or in graph theory terminology finding a *proper 9-coloring* of the graph. The number of ways to color a graph with *n* colors is a well known formula that is a function of the number of colors and the number of vertices.

Of course, a Sudoku puzzle already has some cells in the grid filled in, so we would be starting with a graph with some vertices already colored. Herzberg and Murty call this a *partial coloring* of the graph and prove three theorems for general *n*-by-*n* subgrid Sudoku graphs that lead to the following consequences for the 3-by-3 subgrid Sudoku graph.

- The minimum number of colors needed to color a graph, called its *chromatic number*, is equal to 9 for the 3-by-3 subgrid Sudoku graph.
- If we have a partial coloring of 3-by-3 subgrid Sudoku graph that can be extended in only one way to a proper coloring of the entire graph, then the partial coloring must use at least (chromatic number – 1) = 8 colors. So any puzzle without at least 8 different digits shown can not have a unique solution.

Even more interesting are the questions that Herzberg and Murty raise that are not yet answered:

- The need to have at least 8 different digits is not enough to ensure uniqueness. The puzzle in Figure 1 from the last issue of the Centroid has all 9 digits listed and many numbers filled in; yet the solution is not unique.

Is the "cycle" in this puzzle the only way that non-uniqueness occurs if at least 8 different digits are used in the starting configuration?

- Assuming 8 different digits are used in the starting configuration, how many numbers total must be shown in the starting configuration to ensure a unique solution? This is not known; many puzzles with 17 entries are known to have a unique solution. There are no known puzzles with 16 or fewer entries that have unique solutions. Does one exist? Would the answer be different if all 9 digits are used in the starting configuration?

I invite you to read the article in the Notices; Herzberg and Murty discuss connections to Latin squares, marriage theorems, and scheduling problems, hinting at the possibilities for further plumbing Sudoku squares mathematically. The adventurous among you might consider tackling one of the unanswered questions. Or you can continue like me to enjoy them simply as number-logic puzzles for fun mental exercise!

References

Herzberg, A.M. & Murty, M.R. (2007). *Sudoku squares and chromatic polynomials.* Notices of the American Mathematical Society, 54 (6), 708-717.

Awards

Lothar Till Dohse
The NCCTM Innovator Award Winner

Reported by John Parker
Northeast Consultant, NC New Schools Project
Nags Head, North Carolina

At the annual NCCTM Conference held in Greensboro in October, the 2006 Innovator Award for an individual who has made a noteworthy contribution to mathematics education by having founded, initiated, pioneered, or developed some program in mathematics education to a geographical region of the state or to the state as a whole, was presented to Lothar Till Dohse.

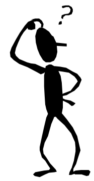
After receiving a B. S. from the University of New Orleans, Till earned his M. S. and Ph. D. degrees from NC State University. He then worked in a variety of research and scholastic jobs. Among these were jobs as a Research Associate at the Universite Laval in Quebec and as a Software Engineer with IBM. Since 1985, Till has been a professor at UNC-Asheville. From 1992–1998, he served as Mathematics Department Chair and since then has worked on the development of internet based statistics courses. As part of his work in this area, he has led three major grant projects that have contributed to improvements in the delivery of statistics instruction through web-based delivery systems, done a number of presentations at AMS-MAA meetings, and sponsored three student research projects. While teaching and engaging in scholarly research at UNC-A, Till has represented the mathematics education community throughout the larger university community by serving on tenure review committees, chairing the faculty senate, working on the Academic Policy Committee, and chairing the Committee of Tenured Faculty.

In addition to his scholarly and professorial work, Till has found time to ensure high school students have the opportunities to compete in state and regional math contests by coordinating the UNC-Asheville Algebra 1, Geometry, and Algebra 2 math contests and coordinating the runoff competitions in the Western part of NC. During his work with math contests, he has written one or more of the tests for 13 years. His work in coordinating math contest competitions has also included 13 years of service on the NCCTM State Mathematics Contest Committee.

A colleague in the mathematics education community says of Till, "He has served throughout his career as a mathematics educator who has always been extremely effective in advancing and promoting mathematics education throughout NC."

Congratulations, Till, on receipt of the 2006 Innovator Award and for all this represents!

Problems to Ponder



Fall 2007 Problems

Gregory S. Rhoads
Appalachian State University
Boone, North Carolina

Grades K–2 Susie started writing some numbers down in a pattern. She spilled some water on her paper and some of the numbers washed away. She was left with

1 1 4 ___ 7 7 ___ ___ ___

where the blanks are missing numbers. Write down the entire list of numbers.

Grades 3–5 Water runs out of your outdoor hose at a rate of 1 gallon every 15 seconds. If your outdoor pool holds 180 gallons, how many minutes will it take to fill the pool using your hose?

Grades 6–8 Harry walks twice around a circular track with diameter 56 feet. Jill walks three times around a square track where each side has length 40 feet. Who walks further and by how much?

Grades 9–12 Everyone is voting for either Spot or Rover for class president. After 65% of the votes are counted, Rover has 60% of the votes and Spot has 40%. What percentage of the remaining votes must Spot get in order to catch Rover?

Directions for submitting solutions

1. Neatly print the following at the top of each solution page:
   - Your full name (first and last)
   - Your teacher's name
   - Your grade
   - Your school

2. Submit one problem per page.

Students who submit correct solutions will be recognized in the next issue of The Centroid. We wish to publish creative or well-written solutions from those submitted. If you would rather not have your solution published, please so indicate on your submission. Keep in mind that proper acknowledgement is contingent on legible information and solutions.

Send solutions by 1 November 2007 to:

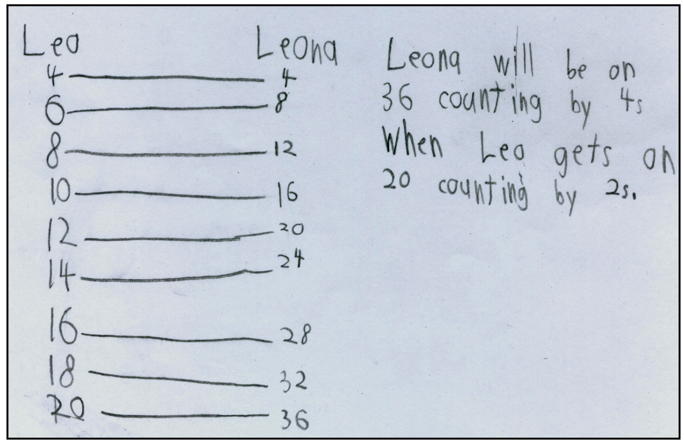
Problems to Ponder
c/o Dr. Greg Rhoads
Dept. of Mathematical Sciences
Appalachian State University
Boone, NC 28608

As these problems are intended to stimulate independent thinking, it is expected that a submitted solution indicates the student completed a significant part of the work. Please try to have the students use complete sentences when they write up their solutions to promote effective communication of their ideas.

Grades K-2 Spring 2007 issue

Leo and Leona start at the number 4 and count together, Leo counts by twos and Leona counts by fours. When Leo is at the number 20, what number will Leona be at?

Solution: By Bradley Hodson, 2nd grade, **Hemby Bridge Elementary** (Teacher: Ms. Stanley).



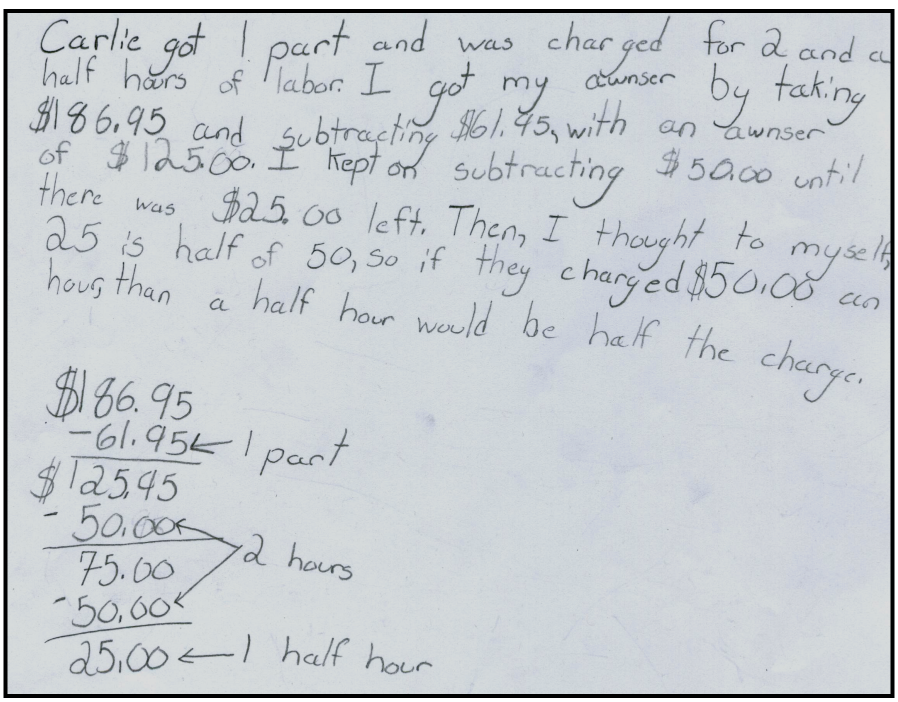
Editor's Note: This was a good exercise in counting multiples and all students did it in this way.

Correct Solutions were received by:
Drake Smith, Alexander, Dalton, Junaid, and Katie of **Antioch Elemtary**, Millen Marie M. Sanqui of **Hardin Park Elementary**, Mia Cushing, Matthew Daines, Bailee Eason, Hannah Gordon, Bradley Hodson, Bridget Longacre, Andrew Lyons, Brad Nicholls, Alex Saenger, Justin Seybuck, and Shelby Wallace of **Hemby Elementary**, Drew Cognac of **Marvin Elementary**, Randy Johnson of **Pines Elementary**, Ashlee Brackett, Serena Gonzalez, Marleen Jefferson, Jackson Orr, Ellie Rose, Owen Sondergar, and Anna Shaye Thompson of **Red Oak Elementary**, and Brennan Halkidis of **Sardis Elementary**.

Grades 3-5 Spring 2007 issue

Carlie's bill from the auto mechanic was $186.95. If the mechanic charged $61.95 for parts and $50.00 for each hour of labor, then how many hours of labor did they charge Carlie?

Solution: By Gabrielle Hubert, 3rd grade, **Waxhaw Elementary** (Teacher: Mrs. Smith).



Editor's Note: The idea is to subtract the cost of the parts to see the total cost of the labor, then subtract the hourly rate to see how many hours.

Correct Solutions were received by:
Kristen Brown, Griffin Childs, Wyatt Daziel, Ella Ferguson, Camille Griffith, Chandler Harrison, Jessica Mrugalski, Madison Murphy, Alyssa Ohmstede, Alexander Poulimenos, Sammy Sheaffer, Morgan Smith, Patrick Snyder, and Abby Wilson of **Antioch Elementary**, Grade Christenbury, Mackenzie Foust, Tabor Sykes, and Kathleen Taylor of **Gaston Day School**, Ashley Canteu, Jesse Illich, Justin Pope, Matt Rice, and Jake Stansberry of **Green Valley Elementary**, Mari Joe M. Sanqui of **Hardin Park Elementary**, Caleb Ayres, Casey Bigham, Matthew Bond, Steven Bortkowski, Brian Callihan, Alex Cheek, Emily Cheek, Austin Dacier, Collin David, Emily Deason, Anna Garwood, Andrew Gillogly, Aidon Neil Gimon, Griffin Grotti, Kaitlyn Harper, Cameron Hightower, Kelsey Kasza, Michaela Locklear, Jonathan Marino, Mallory Marks, Bryce Nielsen, Matt Pachopa, Jeffrey Paterson, Lori Riendeau, Matt Rollyson, Alexis Russell, Cary Hall Titus, Alexandria Kay Treadway, Ryan Wandling, Jake Whitaker, Madeline White, Jaclyn Woodlief, Evan Wright, and Hannah Young of **Marvin Elementary**, Brooke Conley, Erika Douros, Christopher Eason, Lori Ann Kesten, Tia Lloyd, Crystal Mandel, Cora Nash, Natalie Owen, and Kelly Wilson of **Moyock Elementary**, Sophia Barsanti, Melissa Gonzalez, and Celia Pagliaro of **Pines Elementary**, Brandon Dominguez, Ryan Flowers, Bobbi Jones, Krupa Parikh, and Grace Wallace of **Porter Ridge Elementary**, Michala Barnes, Amanda Davis, Lauren Dugas, Luke Edwards, John Lynch, Joshua Mallory, Isabel Marrero, Christopher Riddle, Myra Slep, Haley Smith, and Cierra Williams of **Red Oak Elementary**, Nathan Bailey and Brennan Halkidis of **Sardis Elementary**, Autumn Fincher and Abagail Higgins of **Valle Crucis Elementary**, and Brittany Cooke, Brandon Cruey, Katherine Davidson, Levi Diggins, Cameron Dion, Bailey F., Gabrielle Hubert, C. J. Johnson, Sebastian Martinez, Olivia Speck, Neil Svedberg, Anika Van Milligan, Emily Whitehead, Trevor Wilson, Devin Winters, and Will of **Waxhaw Elementary.**

Grades 6-8 Spring 2007 issue

Irvin was driving from Boone to Wilmington to go to the beach, a distance of 320 miles one way. He has the choice of 2 cars, a Bummer which looks cool but only gets 13.2 miles per gallon, and a Flugo which gets 38.4 miles per gallon. If gas currently costs $2.35 per gallon, how much will Irvin save for the entire trip (both ways) if he chooses to drive the Flugo instead of the Bummer?

Solution: By Jarvas Faison, 8th grade, **Southwestern Middle** (Teacher: Ms. Alicia Small).

Given:
Boone to Wilmington to the Beach:
Boone to Wilmington = 320 miles (one way)
Two cars = Bummer- 13.2 miles/gal
Flugo- 38.4/gal
Cost of gas = $2.35/gal
Required: Amount saved if Flugo was used in two ways
Solution:
Total miles traveled from Boone to Beach and back passing by Wilmington.
320 miles x 2 = 640 miles

Bummer: 640 miles/13.2 miles/gal = 48.48 gals x $2.35 gal = $113.93 cost of gas

Flugo: 640 miles/38.4 miles/gal = 16.67 gals x $2.35/gal = $39.17 cost of gas

113.93 – cost of gas using Bummer
-39.17 – cost of gas using Flugo
$74.76 amount saved using Flugo

Editor's Note: This one was more difficult for many reasons. There were a number of different answers based on where the student rounded during the solution. Many students had trouble with the calculations and found the cost of the gas to be in the thousands of dollars. One thing we like to teach is to have students look at their answers to see how reasonable they are in the context of the problem.

Correct Solutions were received by:
Annabeth Barnes, Makayla Benfield, Madison Bostic, Bryant Chapman, Kristin Collins, Maggie Curry, Garrett Dupuis, Sara Kate Ferguson, Zane Harrington, Mikhayla Jarrett, Harrison Jenkins, Reba Martin, Luke Watt, and Faith York of **East Alexander Middle**, Cara Allison, Antuanette Anglon, Roshan Chacko, Kleyder Gregorio-Sanchez, Aushequa Harris, Will Huffalser, Matthew Knott, Rebecca Lee, Jenna Talley, Lucas Tanthorey, Kyle Watkins, and Patrick Whitt of **North Granville Middle**, Andrey McLeggan and Asia Randall of **Southview Middle**, Dimetris Anderson, Ta'lonti Askew, Brandon Barnes, DiAsia Basnight, Tykevis Bazemore, Maggie Belangia, Laquita Benfield, Shakeila Bond, David Brown, Pierce Bryant, Fontasia Cherry, Jamai Cherry, Atlas Cobb, Chalai Corbett, Lauren Cuttino, Tiara Dolberry, Amelia Evans, Leah Evans, Jarvas Faison, Salaat Faulkner, Dwayneisha Gilliam, Brandon Gordon, Jay Greene, Whitney Harden, Holley Harrison, Savannah Harvey, Kiara Heckstall, Lester Heckstall, Gabrielle Jenkins, Misty Keown, Sameakia Lee, Dayquan Maxwell, Raquel McArthur, Tyia Mills, Ashley Moody, Riketta Norfleet, Lyndsee Peele, Kierra Smallwood, Devonte Snead, Jaleesa Stocks, Jamesha Thompson, Tiffany Thompson, Danielle Vaughan, Carmen Villamor, Pearl Vines, Precious Vonwolfolk, Dyleezia Warren, Cody White, Martynez White, Phillip Colin White, DaMonta Wiggins, and Tia Woodard of **Southwestern Middle**, Chris Alberti, Meredith Ball, Julianne Blackburn, Jamie Leigh Bradley, Sydney Brooks, Aidan James Burk, Andrew Thomas Johnson, Eliza Salazar, Sophie Thompson, and Elizabeth Wooten of **Turrentine Middle**, and Jamilla Benton, Deshawn Ingram, Wyatt Stephen Joyner, and Haleigh Rierson of **Walkertown Middle.**

Grades 9-12 Spring 2007 issue

What is the smallest value of n such that 2007! is divisible by 34^n?

Solution: A number is divisible by 34^n if it is divisible by 17^n and 2^n. So we'll see how many factors of 17 are in 2007! (these are rarer than factors of 2). First, we see than 2007 lies between 17*118 and 17*119, and each multiple of 17 smaller than 2007 will contribute at least 1 factor of 17 in 2007!. However, every multiple of 17*17=289 will contribute an extra factor of 17 and there are 6 multiples of 289 smaller than 2007. Therefore, there are 118+6 = 124 factors of 17 in 2007! which means that 17^{124} will divide 2007! and so 34^{124} will divide 2007! The answer is $n=124$.

No correct solutions were received.

Lesson Plans at LearnNC.org

Learn NC, an on-line repository sponsored by the UNC Chapel Hill School of Education, has many resources for teachers and students. Check out the lesson plans available on the site. You can search by grade or key word. Have a good activity that you have refined and improved for use in your classes? Consider submitting it to the repository!

<http://www.learnnc.org/lessons/>

Exceptional Students Shine at State Math Contests and ARML

Reported by
John Goebel, State Mathematics Contest Chair
North Carolina School of Science and Mathematics
Durham, North Carolina

The 29th Annual State Math Contest was held on April 19th at the School of Science and Mathematics. One hundred three students from across NC competed in the Comprehensive Finals, having first placed in the top 7% at one of the qualifying sites that make up the State Math Contest Network. The top senior, Mikhail Lavrov, won a $500 cash prize from the EMC Corporation of the Research Triangle and a full-tuition scholarship for four years to Duke University.

Comprehensive Finals Results

Place	Student	School	Teacher
First	Mikhail Lavrov	W. G. Enloe	John Noland
Second	John Berman	J. T. Hoggard	Colleen St. Ledger
Third	Arnav Tripathy	East Chapel Hill	Shannon McGinnis
Fourth	Jeremy Hahn	East Chapel Hill	Shannon McGinnis
Fifth	John Pardon	Durham Academy	Andrew Ferarri

At the Awards Ceremony Frank Vrablic of Manteo High School was given the State Math Contest's Coaches Award. For nearly 20 years Frank has coached his students, attended all of the contests in the Eastern Region, and served several terms on the State Math Contest Committee as a Teacher Representative. This past year he had more students qualify for the State Comprehensive Finals than any other school in the state.

On May 3rd, the finals in Algebra I, Geometry, and Algebra II were held at UNC-Asheville, UNC-Greensboro, and North Carolina Wesleyan. One hundred four students competed in Algebra I, 85 in Geometry, and 73 in Algebra II. The EMC^2 Corporation has provided generous funding to support these Regional Finals.

Algebra I Results

Place	Student	School	Teacher
First	Nick Tobey	W. G. Enloe	Mr. Wilson
Second	Thomas Lu	The Academy at Lincoln	Terra Savage
Third	Allen Yang	West Cary Middle	Edward Bruce
Fourth	David Wang	Valley Springs Middle	Debbie Cudd
Fifth	David Spencer	Southwest Middle	Alycia Nikolaus

Geometry Results

Place	Student	School	Teacher
First	Christine Hong	Arendell Parrott Academy	Kim Henderson
Second	Yash Neeraj Agrawal	Martin Middle	Lucy Kay
Third	Jessie Duan	Ligon Middle	Jason Batterson
Fourth	Shutong Zhan	Watauga High	James Eichmiller
Fifth	Peitong Duan	Davis Drive Middle	Kathy Vincent

Algebra II Results

Place	Student	School	Teacher
First	Bryce Taylor	Hanes Middle	Billie Stamp
Second	Jenny Chen	Arendell Parrott Academy	Kaye Mooring
Third	David Lucia	Providence Day	Jeff Lucia
Fourth	Brendan Fletcher	Charlotte Home Ed.	Kathy Fletcher
Fifth	Stephen Hunt	J. T. Hoggard High	Jan Baysden

The top student in each division at each site was awarded a scholarship for an "Art of Problem Solving" online course. Funding for these scholarships was provided by the EMC^2 Corporation. Additional EMC^2 Scholarships will be available to students. Students and teachers should check the NCCTM website for details and application forms.

To qualify for the State Mathematics Contest finals, a student must first compete at one of the qualifying sites spread across the state: Appalachian State University, Catawba College, Chowan University, Coastal Carolina Community College, East Carolina University, Elizabeth City State University, Elon University, NC A & T State

University, the University of North Carolina at Charlotte, the University of North Carolina at Wilmington, Wake Forest University, Wake Technical Community College, Western Carolina University, Wingate University, and Winston-Salem State University. Interested teachers, parents, or students should check our website <www.ncctm.org> for a list of these sites and then contact the contest director at one or more sites. Some sites restrict participation to their immediate geographical location, others do not.

The top 15 students at the Comprehensive Finals were selected to represent North Carolina at the American Regions Mathematics League (ARML) Meet at Penn State in early June. This year there were 118 teams from the United States, Taiwan, the Philippines, Turkey, and Columbia. The A Team placed 4th out of 37 teams in Division A, the premier division intended for the most competitive teams. The B Team, consisting of younger, less experienced students, placed 4th in Division B out of 79 teams. Archie Benton of North Buncombe High School, John Noland of Enloe, Kathy Hill and Deanna Lancaster of Athens Drive, and Ken Thwing of Freedom High School coached and accompanied the teams to Penn State. The Duke Energy Foundation provided generous funding to supplement the funding that NCCTM provides for our teams.

Rankin Award Nominations

The Rankin Award is designed to recognize and honor individuals for their outstanding contributions to NCCTM and to mathematics education in the State. Presented in the fall at the State Mathematics Conference, the award, named in memory of W. W. Rankin, Professor of Mathematics at Duke University, is the highest honor NCCTM can bestow upon an individual.

If you have nominated someone in the past who has not received the award to date, or if you would like to nominate someone new, please submit as much of the following information as possible!
Nominations are accepted at any time.

Please submit the following information. Use as many typewritten pages as needed. If possible, attach a vita of the nominee.

- Name of the nominee
- Current position
- Your relationship to the nominee (e.g. principal, co-worker, etc.)
- The nominee's contributions to mathematics education, NCTM, NCCTM, etc. (Please include information on specific offices held and honors received by the nominee.)
- Any information about contributions to the community, teaching, and education that would be of value to the Rankin Award Committee in its deliberations
- Other relevant information
- Letters of endorsement from other colleagues may be included.
- Date of nomination

Nominator* Name
Current position; Business or educational institution
Preferred mailing address; Preferred telephone number

*The Rankin Award Committee reserves the right to use portions of nomination information in the presentation of the award if the candidate is selected.

Send to: Ms. Jan Wessell
23 Shore Drive
Wrightsville Beach, NC 28480

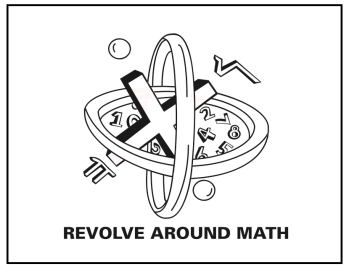
2007 NCCTM Math Logo Contest Winners

Reported by
Rebecca Caison, Central Region President and Logo Contest Coordinator
Williams High School
Burlington, North Carolina

From a field of approximately 1,700 entries, twelve logos submitted by the following students were judged to be the winners in the 2007 Logo Contest.

State Winner

Justin Allen, Grade 11
Halifax Academy
Roanoke Rapids, NC
Teacher: Mrs. Kessinger
Eastern Region



Eastern Regional Finalists

Candice Parker, Grade 5
Colerain Elementary School
Colerain, NC
Teacher: Phyllis Urquhart

Kelsy Fuller, Grade 8
Dillard Drive Middle School
Raleigh, NC
Teacher: Mrs. A. Mitchell

Jessica Bolton, Grade 11
Ridgecroft School
Ahoskie, NC
Teacher: Jenks Johnson

Justin Allen, Grade 11
Halifax Academy
Roanoke Rapids, NC
Teacher: Mrs. Kessinger

Central Regional Finalists

Victoria Slone Dickson, Grade 2
Moncure Elementary School
Moncure, NC
Teacher: Maureen Prys

Matthew Hrabosky, Grade 5
West End Elementary
West End, NC
Teacher: Mrs. Dora Lancaster

Kamron Lindo, Grade 8
Southview Middle School
Hope Mills, NC
Teacher: Don Elliott

William Lee, Grade 9
East Chapel Hill High School
Chapel Hill, NC
Teacher: Beth Neill

Western Regional Finalists

Emma Brock, Grade 2
Wesley Chapel Elementary School
Monroe, NC
Teacher: Brenda Todd

Kathryn Macomson, Grade 4
Norris S. Childers Elementary
Lincolnton, NC
Teacher: Denise Smith

Kayla Holland, Grade 8
Northwest School of the Arts
Charlotte, NC
Teacher: Amy Baker

Kathleen Elkins, Grade 9
Woodlawn School
Davidson, NC
Teacher: Mrs. Armstrong

NAEP and the EOGs in North Carolina: What do these assessments reveal about fourth- and eighth-grade students' mathematical achievement?

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Wilmington, North Carolina

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Appalachian State University
Boone, North Carolina

Recently, the U.S. Chamber of Commerce made an attempt to grade all 50 states on their K-12 school systems in order to identify both leaders and laggards in school performance. In the final report North Carolina was given a "C" in academic achievement. The Chamber claimed "student performance in North Carolina is middling" (U.S. Chamber of Commerce, 2007). This finding was based on their assessment of reading and mathematics data from the National Assessment of Educational Progress (NAEP).

For some, NAEP (usually pronounced "nape") may be more than a tool to monitor pre-college student performance in a variety of subject areas. Although the assessment was developed in the 1960's for that purpose, it is quickly becoming "the gold-standard of scholastic achievement in the United States" (Zuckerbrod, 2007, ¶ 8). NAEP has gained prominence over the last few years due to the fact that the No Child Left Behind (NCLB) legislation of 2001 specifies that it may be used as a benchmark to assess the extent to which state assessments are adequately determining student progress toward the achievement goals in that legislation. Individual states and government officials are using NAEP results to determine whether students meet those benchmarks and how students compare to others throughout the nation.

This article takes a closer look at NAEP and what it tells us about student achievement in mathematics. It discusses North Carolina fourth- and eighth-grade students' NAEP results and considers how they compare with state assessment results.

NAEP Background

The first NAEP mathematics assessment was completed in 1973 with additional mathematics assessments following in 1978, 1982, 1986, 1990, 1992, 1996, 2000, 2003, and 2005. NAEP's original design assessed 9, 13, and 17 year old students as well as 17 year-olds and adults, ages 26 to 35, who were no longer in school. However, in 1990, to make the testing process less burdensome for schools, NAEP moved from assessing students by age to assessing by grade level. Thus, current NAEP results are based on students enrolled in grades 4, 8, and 12.

NAEP is designed so that participating students are tested for approximately one hour and take only a small subset of the items available for their level. By pooling results from all students, it is possible to document progress for the nation as a whole. NAEP is considered to be the most representative indicator of the mathematics skills that it tests in the United States because of the large sample size and the fact that the sample includes a range from the lowest to highest achieving students.

The mathematics NAEP has evolved over time into three separate assessment programs: Main NAEP, State NAEP, and Long-Term Trend NAEP. Main NAEP has always been the primary program, revealing results that were representative of the entire nation. However in 2003, Main NAEP and State NAEP were integrated into one testing program. State NAEP reported achievement for fourth- and eighth-grade on a state-by-state basis using a sample of students in each state that is different from the sample tested on Main NAEP. It began on a trial basis in eighth grade in 1990 and is now an integral part of NAEP. Long-Term Trend NAEP has used the same items since the 1980s and thus allows for comparison of student performance now to that of 20 to 30 years ago (Kenney & Kloosterman, 2007). One of the main drawbacks of Long-Term Trend NAEP is that because it uses items that are 20 to 30 years old, it fails to adequately assess more recent additions to the curriculum including statistics, algebraic thinking, and complex problem solving.

When looking over the NAEP data, it is important to understand that NAEP was not designed to provide information on individual students, teachers, schools, or school districts. The purpose of NAEP is to evaluate the condition and progress of education by making information related to student performance available to policymakers at the national, state, and local levels. NAEP guarantees the privacy of individual students and their families and only collects information related to academic achievement.

National NAEP Results

Since 1986, NAEP results have been reported as a scale score that is an overall indicator of student achievement at each grade level tested. Scores in the NAEP scaling system can range from 0 to 500 and are independent of grade level. This scaling system, based on item response theory (see Braswell, Lutkus, Grigg, Santapau, Tay-Lim, and Johnson, 2001), allows scores on NAEP multiple choice and constructed response (short answer and open-ended) items of varying difficulty to be combined into a single, meaningful, overall score. In 2005, performance by fourth-grade students throughout the nation increased to the highest level ever recorded by NAEP. The composite scale score for fourth-grade students was 237, up significantly from 234 in 2003 ("significantly" means statistically significant at the $p < .05$ level). In fact, scores have gone up for each of the years that the current NAEP assessment framework has been in place starting with 1990 when the composite score for fourth-grade was 212. Unfortunately, there is a small problem when comparing scores prior to 1996 at the national level and prior to 2000 at the state level in that 2005 scores include students with disabilities who would not have been tested by NAEP had they been in school in earlier years. However, including these students only changes scale scores by one or two points and thus comparisons are often made.

Although there is no easy way to interpret the 25 point gain in fourth-graders' scores from 1990 to 2005, a method described by Kloosterman, et al. (2004) is to think about average gain per year in the NAEP scaling system. In 2005, the average score for eighth-grade students was 278 or 41 points higher than the score for fourth-grade students. Thus, there is an average gain of about 10.25 points per year between fourth- and eighth-grade with the NAEP system. Nationally, the average score for fourth-grade students went from 212 in 1990 to 237 in 2005. Using the 10.25 points per grade level scale, one could argue that fourth-graders achieved more than two grade levels higher in 2005 than their 1990 counterparts.

National results for eighth-grade students were similar. The average scale score increased from 262 in 1990 to 278 in 2005, which was also significant. The average gain per year between eighth and twelfth grade using the 2000 NAEP data was about 6.5 points per grade, so the sixteen point gain from 1990 to 2005 again represents growth of approximately two grade levels.

North Carolina NAEP Results

North Carolina's average 2005 scale score for fourth-graders was 241, which was four points higher than that of the nation's public schools. This score was slightly lower than in 2003 (242), but significantly higher than North Carolina fourth-grade scores in each of the other years that North Carolina participated in State NAEP (1992 and 2000). The eighth-graders' score of 282 was also higher than the national average of 278. This score was not significantly higher than the 2003 score, but it was significantly higher than scores in 1990, 1992, 1996, and 2000. In brief, trends in results in North Carolina parallel those of the nation as a whole – showing substantial improvement over time.

Content Areas

Like Main NAEP, State NAEP mathematics results are available for five separate content areas – number properties and operations, measurement, geometry and spatial sense, data analysis and probability, and algebra. The classification of items into content areas is not always easy, but it helps to ensure that important mathematical concepts and skills are assessed in a balanced way. The NAEP content areas are similar to the National Council of Teachers of Mathematics (NCTM) content strands, but are not the same.

A detailed breakdown of student performance in each content strand since the 1990 assessment is provided in Table 1. In brief, the national 2005 scores were higher than any previous NAEP administration in all content areas at both fourth- and eighth-grade levels. Gains in North Carolina scale scores were lower than the national average in 1990 and 1992 but somewhat higher than the national average from 1996 to 2005. The data in Table 1 are from public school students only. Data from 1990 and 1992 have no accommodations for students with disabilities or limited English proficiency whereas in 1996, 2000, 2003, and 2005 accommodations were provided for students who needed them.

Achievement Levels

Student achievement on NAEP can also be reported in terms of the number of students who meet the proficiency levels defined by the National Assessment Governing Board (NAGB). In brief, students at the "basic" proficiency level indicate evidence of understanding the mathematical concepts and procedures in the five NAEP content areas, students at the "proficient" level consistently apply integrated procedural knowledge and conceptual understanding to problem solving in the content areas, and students at the "advanced" level apply integrated procedural knowledge and conceptual understanding to complex and non-routine real-world problem solving in the five NAEP content areas**.** (For a more complete description of those levels at each grade level assessed by NAEP, see NAGB, 2004.)

Table 1: Scale scores of fourth-grade and eighth-grade students in each NAEP mathematics content area.

	1990	1992	1996	2000	2003	2005
National, 4th Grade						
Numbers and Operations	209*	216*	220*	222*	232*	235
Measurement	217*	223*	223*	224*	233*	236
Geometry	212*	221*	223*	225*	233*	236
Data Analysis, Statistics, and Probability		219*	223*	227*	237*	241
Algebra and Functions	213*	218*	226*	229*	240*	243
North Carolina, 4th Grade						
Numbers and Operations		210*	220*	227*	240	239
Measurement		217*	226*	230*	240	240
Geometry		216*	227*	231*	240	239
Data Analysis, Statistics, and Probability		215*	226*	232*	245	245
Algebra and Functions		212*	229*	236*	248	248
National, 8th Grade						
Numbers and Operations	266*	271*	271*	272*	276	276
Measurement	258*	265*	266*	268*	274	274
Geometry	259*	262*	267*	270*	274*	275
Data Analysis, Statistics, and Probability	262*	267*	268*	274*	279*	280
Algebra and Functions	260*	266*	269*	274*	279*	281
North Carolina, 8th Grade						
Numbers and Operations	256*	262*	269*	275	279	278
Measurement	242*	254*	261*	274*	277	279
Geometry	249*	255*	267*	277*	281	281
Data Analysis, Statistics, and Probability	248*	258*	269*	277*	283	282
Algebra and Functions	251*	260*	271*	278*	285	286

* significantly different than 2005 ($p < .05$)

Figure 1 shows the percentage of North Carolina and U.S. fourth-grade students performing at the below basic, basic, proficient, and advanced levels in 2005. By combining the percentages of basic, proficient, and advanced one can see that the 83% of North Carolina fourth-grade students were at or above basic, which is a significant increase from 50% in 1992. Nationally, 79% of students were at or above basic in 2005. Similarly, figure 2 shows the percentage of North Carolina and U.S. eighth-grade students performing at the below basic, basic, proficient, and advanced levels in 2005. Seventy-two percent of North Carolina eighth-graders were at or above the basic level in 2005, which is a significant increase from 38% in 1990. Nationally, 68% of students were at or above basic in 2005. NCLB requires that all students meet state-defined proficient levels by 2014. Although there have been remarkable gains in North Carolina as well as the nation as a whole, it is easy to see that the rate of improvement is still much to slow to meet the requirements of the NCLB legislation.

NAEP and the North Carolina End-of-Grade Test

Because North Carolina End-of-Grade (EOG) tests are administered to every student enrolled in grades 3 through 8 in North Carolina and are used to determine adequate yearly progress and NCLB goals, it is not unreasonable to want to compare NAEP scores and EOG scores. Due to differences in what each assessment measures, the goals of the assessment, and the motivation of students to complete and do their best, comparisons of NAEP and the EOGs are difficult (Martin & Black, 2007). Even though NAEP and the EOGs cover many of the same topics their purposes are different. NAEP provides information on student performance as well as weaknesses in curriculum. In fact, NAEP often includes items which go beyond the grade level of the student tested. The purpose of the EOG is to test the specific objectives in the North Carolina Standard Course of Study at each particular grade level.

However, it is important to consider the results on both tests to determine how our students are achieving in mathematics. In 2006, the EOG in mathematics was changed to meet the new mathematics standard course of study. In fact, the formula for calculating growth was revised in 2006 and unlike before, school districts can now provide growth information on individual students (Public Schools of North Carolina, 2006). To be considered proficient in North Carolina, students must score a level III or above, in the 2004-2005 school year 87.3% of students enrolled in grades 3 through 8 scored at or above level III in mathematics. However, with the new *ABCs* (Public Schools of North Carolina, 2006) formulas in 2005-2006 only 63.4% of students scored at the proficient level. In fourth grade in 2004-2005, 91.8% of students were proficient, whereas in 2005-2006 65% of fourth-graders were proficient. In eighth grade, 2004-2005, 87.3% proficient and 2005-2006, 63.4% proficient. These percentages do seem to suggest that students' scores have decreased in mathematics. However, it is important to realize that the formula used to compute scores has changed and the curriculum being tested has changed (Public Schools of North Carolina, 2006).

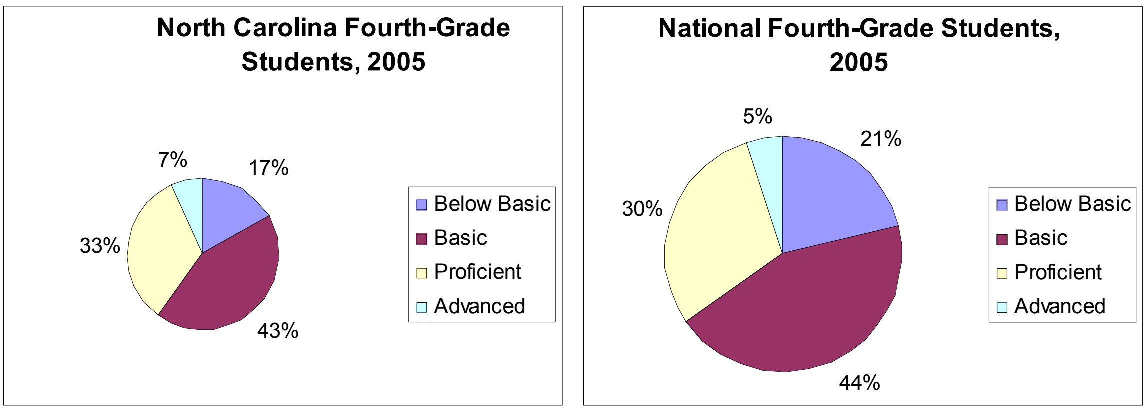

Figure 1. Percentage of fourth-grade students in North Carolina and the United States scoring in each achievement level on the 2005 NAEP mathematics exam.

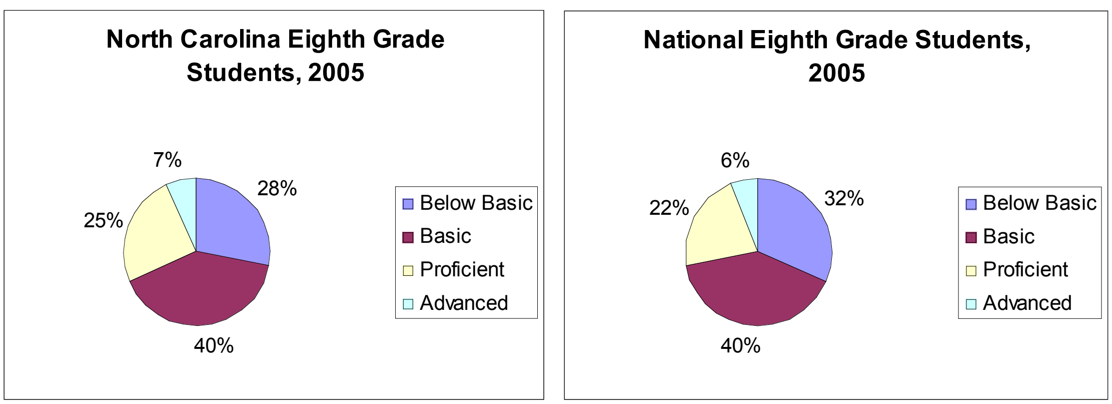

Figure 2. Percentage of eighth-grade students in North Carolina and the United States Scoring in each achievement level on the 2005 NAEP mathematics exam.

Conclusion

When reviewing NAEP and EOG scores, it is important to remember that how well students are doing depends on what is considered proficient. Not only did North Carolina receive a "C" in academic achievement in the U.S. Chamber of Commerce report mentioned earlier, the state received a "D" in truth in advertising about student proficiency. The North Carolina report card states that "the state identified large percentages of its students as proficient in math and reading on 2005 state exams, smaller percentages posted proficient scores on NAEP in 2005" (U.S. Chamber of Commerce, 2007, Truth in advertising about student proficiency section). When considering the number of students achieving proficiency on the 2006 EOG, North Carolina students' performance is now more reflective of their NAEP proficiency levels. Although the students scored lower on the EOG, the scores are closer to the "truth" when advertising student proficiency.

In addition, fourth- and eighth-grade students in North Carolina are clearly improving. They are consistently earning higher scale scores than the national average on the NAEP mathematics assessment and in each mathematics content area. Higher percentages of fourth- and eighth-grade students in North Carolina perform at or above the basic achievement level on NAEP than students across the nation. So, it does not make sense that the state would receive a "C" in academic achievement in the Chamber's report. While there is still progress to be made, mathematics achievement on the NAEP is much higher than at any time in history and gains over time are greater in mathematics than in any other subject area (Kloosterman, 2003). Efforts to improve mathematics instruction and assessment in North Carolina have certainly paid off.

References

Braswell, J.S., Lutkus, A.D., Grigg, W.S., Santapau, S.L., Tay-Lim, B.S-H., & Johnson, M.S. (2001). *The nation's report card: Mathematics 2000.* Washington, DC: National Center for Educational Statistics. (NCES publication #2001-517). Available for download at nces.ed.gov/pub-search/pubsinfo.asp?pubid=2001517/.

Kenney, P. A. & Kloosterman, P. (2007). The 2003 NAEP mathematics assessment: An ending and a beginning. In P. Kloosterman & F.K. Lester (Eds.), *Results and Interpretations of the 2003 Mathematics Assessment of the National Assessment of Educational Progress* (pp. 1-22). Reston, VA: National Council of Teachers of Mathematics.

Kloosterman, P., Warfield, J., Wearne, D., Koc, Y., Martin, W.G., & Strutchens, M. (2004). Fourth grade students' knowledge of mathematics and perceptions of learning mathematics. In P. Kloosterman & F.K. Lester (Eds.), *Results and Interpretations of the1990-2000 Mathematics Assessments of the National Assessment of Educational Progress* (pp. 71-103). Reston, VA: National Council of Teachers of Mathematics.

Martin, W. G. & Black, J.W. (2004). NAEP and state accountability measures. In P. Kloosterman & F.K. Lester (Eds.), *Results and Interpretations of the 1990-2000 Mathematics Assessments of the National Assessment of Educational Progress* (pp. 419-434). Reston, VA: National Council of Teachers of Mathematics.

National Assessment Governing Board (2004). Mathematics Framework for the 2005 National Assessment of Educational Progress. Washington, DC: National Assessment Governing Board. Available for download at http://www.nces.ed.gov/nationsreportcard/mathematics/whatmeasure.asp.

Public Schools of North Carolina State Board of Education. (2006). *ABCs 2006 accountability report background packet*. Retrieved from http://www.ncpublicschools.org/docs/accountability/reporting/abc/2005-06/0506abcsbackgroundpacket.pdf.

U.S. Chamber of Commerce (2007). Leaders and laggards: A State-by-State Report Card on Educational Effectiveness. Washington, DC: U.S. Chamber of Commerce. Available for download at www.uschamber.com/reportcard.

Zuckerbrod, N. (2007). Should academic standards be the same across U.S.? *Wilmington Star News.* Retrieved April 19, 2007, from http://www.wilmingtonstar.com/apps/pbcs.dll/article?AID=/20070114/NEWS/701140375&SearchID=73282148020248

Innovator Award Nominations

The North Carolina Council of Teachers of Mathematics accepts nominations for the Innovator Award at any time. The purpose of this award is to recognize and reward individuals or groups who have made an outstanding and noteworthy contribution to mathematics education and/or NCCTM by having founded, initiated, pioneered, or developed some program in mathematics education of service to a geographic region of the state or the entire state. Further, this program must have been sustained for a period of at least three years. A number of organizations have made significant contributions to mathematics education in North Carolina; the Committee encourages the nomination of organizations as well as individuals. Any NCCTM member may submit nominations by sending in the form below. Nominations will be retained in the active file for at least three years.

NOMINATION FORM

Name of Nominee: ____

Present Position: ____

Outstanding contributions to mathematics education in North Carolina which serves as the basis for this nomination:

Additional information that would be of value to the selection committee:

Signature: ________________________________ Date: _______________

Name (print/type): ____

Position: ____

Business or Institution: ____

Address: ____

Phone: Business ____________________ Home: __________________________

Email: ____

Send to: John Parker
316 West Soundside Road
Nags Head, NC 27959

NCCTM Trust Fund Scholarship

North Carolina Council of Teachers of Mathematics

$500 scholarships are available from NCCTM to financially support North Carolina teachers who are enrolled in graduate degree programs to enhance mathematics instruction.

Applicants must be:

- Currently employed as a pre-K - 12 teacher in North Carolina;
- Currently an NCCTM member (for at least one year) at the time of submitting this application;
- Currently enrolled in an accredited graduate program in North Carolina;
- Seeking support for a mathematics or mathematics education course in which they are currently enrolled or have completed within the previous four months of the application deadline.

Applications will be reviewed biannually, and the deadlines for applications are:

- **March 1**
- **October 1**

Send completed applications to:
NCCTM Trust Fund Chairperson
6520 West Lake Anne Drive
Raleigh, NC 27612

Direct inquiries to:
John R. Kolb, Chairperson
phone: (919) 787-8116
e-mail: JKolb1@nc.rr.com

(Please print all information.)

PERSONAL INFORMATION:

Name: ______________________________

Home address: ______________________________
Street

______________________________, NC ______________
City Zip

Home phone: ______________ Home e-mail: ______________

NCCTM membership number: ______________________________

EMPLOYMENT INFORMATION:

How many years of teaching experience? ______________________________

Currently employed in what school system? ______________________________

School name: ______________________________

School address: ______________________________

School phone: ______________ School e-mail: ______________

Current teaching assignment: ______________________________

Principal’s name: ______________________________

COURSE INFORMATION: (One course only)

Institution of higher education: ______________________________

Graduate degree program in which you are currently enrolled: ______________________________

Course name:______________________________ Course number: ____________

Dates of enrollment: *(circle one)* Fall semester Spring semester Summer session Year: ____________

Name of course instructor: ______________________________

PROFESSIONAL ACTIVITIES WITHIN PAST 5 YEARS WITH EMPHASIS ON ACTIVITIES RELATED TO MATHEMATICS EDUCATION:

BRIEF STATEMENT OF FUTURE PROFESSIONAL GOALS:

REQUIRED SIGNATURES:

Applicant signature: ______________________________ Date: ____________

Principal's signature: ______________________________ Date: ____________

Instructor signature (if currently enrolled): ______________________________ Date: ____________

REQUIRED ATTACHMENTS:

Please attach a copy of

1. A letter of acceptance to an accredited graduate program in North Carolina;
2. Official verification of enrollment in the graduate course described in the COURSE INFORMATION above if the course is currently being taken, **OR** official transcript containing the grade awarded to the applicant if the course described in the COURSE INFORMATION above has been completed.

NOTE: Applications must be complete to be considered. If your application is approved, an official course grade report must be submitted to verify successful completion of the course before scholarship funds will be issued.

NORTH CAROLINA COUNCIL OF TEACHERS OF MATHEMATICS

MEMBERSHIP – NORTH CAROLINA COUNCIL OF TEACHERS OF MATHEMATICS

Name: ______________________________ Home Telephone: (___) - _____

Address:______________________________ School Telephone: (___) - _____

City: _____________ State: ________ Zip: _________ E-mail: ______________________

School System: ______________________________

POSITION
- ❑ Teacher
- ❑ Department Chair
- ❑ Supervisor/Administrator
- ❑ Full-time College Student
- ❑ Retired
- ❑ Other __________________

LEVEL
- ❑ K-3
- ❑ 4-6
- ❑ Junior High/Middle School
- ❑ Senior High
- ❑ 2-Year College/Technical
- ❑ 4-Year College/University

MEMBERSHIP STATUS
❑ New ❑ Former/Renewing Member # _________

MEMBERSHIP DUES
- ❑ 1 year: $20.00 ___________
- ❑ 3 years: $50.00 ___________
- ❑ Full-time Student: $10.00 ___________
- ❑ Contribution to Trust Fund: ___________

Total Payment Enclosed: ___________

Payment by ❑ Check ❑ Visa ❑ MasterCard

Card # ______________________

Exp. Date ______________________

Signature ______________________

Please make your check or money order payable to NCCTM. Send this form and your payment to
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