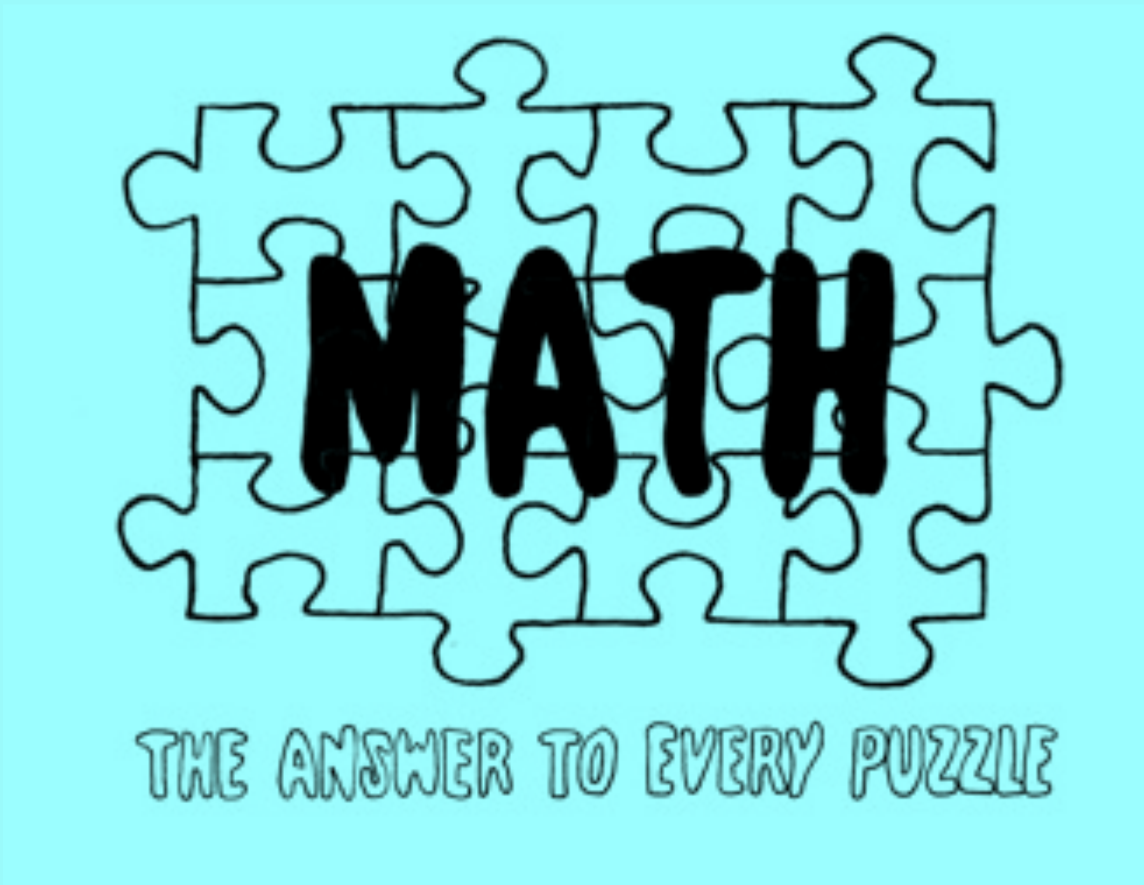
The Centroid



In This Issue:

Official Journal of the North Carolina Council of Teachers of Mathematics
Volume 39 • Number 1 • Spring 2013

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.

News and announcements (president's messages, award winner announcements, professional development announcements, etc.) must be received by December 1 for the spring issue and by July 1 for the fall issue.

Articles 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 most recent edition of the *Publication Manual of the American Psychological Association*. 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 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 and teacher activities 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*.

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.

Contact Information

Address all correspondence and submissions to

The Centroid
c/o Dr. Deborah Crocker, Editor
Department of Mathematical Sciences
Appalachian State University
Boone, NC 28608

or send email to <CrockerDA@appstate.edu>. Please include a return email address with all correspondence.

The Centroid

Official Journal of the North Carolina Council of Teachers of Mathematics
Volume 39 • Number 1 • Spring 2013

Articles

News & Information

Common Core: The Journey Continues

NCCTM 2013 Conference: Oct 31-Nov 1

Koury Convention Center, Greensboro

The 2013 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. Take the time to fill out the online Speaker form and be a part of this annual professional development opportunity. Encourage colleagues to present as well. To present at the 2013 Conference, fill out the online speaker proposal form, available on the NCCTM site.

If you have questions contact Sheila Brookshire <sheila.brookshire@bcsemail.org> .

To submit a proposal, go to www.ncctm.org

NCCTM Spring Leadership Seminar

The Common Core State Standards for Mathematics:
Hopes, Fears and Challenges as We Enter the Brave New World

Koury Convention Center (Guilford Ballroom B)
9:30 AM to 3:15 PM, March 23, 2012
Keynote Speaker: Dr. Steven Leinwand

Keynote Description: There is little question that the new Common Core State Standards for Mathematics (and the PARCC and Smarter Balanced assessments) represent a long-overdue brave new world for mathematics in the United States. We'll take a quick look at the elements and changes represented by these new standards and then turn to their implications for teaching and testing and why we have good reason to be cautiously optimistic about a far more rational approach to mathematics.

Dr. Steven Leinwand is currently a Principal Research Analyst at the American Institutes for Research in Washington, D.C. where he serves as a mathematics expert on a wide range of projects that evaluate programs, develop assessments, and provide technical assistance. He spent 22 years as a K-12 Mathematics Consultant in the Connecticut Department of Education, is a former president of the National Council of Supervisors of Mathematics, and served on the NCTM Board of Directors.

To register, go to www.ncctm.org

NCTM 2013 Annual Meeting & Exposition

Register today for NCTM's 2013 Annual Meeting & Exposition, April 17–20. Sharpen your skills, acquire new techniques, and learn from innovative practitioners and experts in the field. Gain practical solutions to the challenges you face in your classroom, school, or district every day.

To register, go to www.nctm.org/denver

Presidents' Messages

State President

Betty Long
longbb@appstate.edu

I would like to take this opportunity to express my appreciation to everyone who helped make the 2012 State Math Conference a huge success. The attendance was 2818 despite the tight economy. A special thank you goes to Sheila Brookshire and Kelly DeLong (Program Co-Chairs) and Kathleen Lynch-Davis and Chrystal Dean (Conference Co-Chairs) along with the chairs of the various conference committees that include Vincent Snipes (Audio Visuals and Troubleshooting), Karen McPherson (Program Booklet), Becky Caison and Rebecca Hoover (Commercial Exhibits), Wendy Rich and Ana Floyd (First Timers' Sessions), Ryan Dougherty and Michelle Gray (Publicity and Signs), Shana Runge, Melissa Wilson, and Kim Aiello (Marketplace), Kathy Jaqua (NCTM Materials), Marilyn Preddy (Conference Services), Debbie Crocker (Student Exhibits), and Elizabeth Murray, Donna Thomas, and C.E. Davis (Registration Volunteers). Also, I want to thank all of the presenters who shared their knowledge and expertise in the nearly 400 sessions and workshops as well as the NCDPI's Mathematics Consultants who updated us on the Common Core State Standards for Mathematics. There were many more volunteers that assisted at the conference by working at the registration desk, handing out workshop tickets, working at the NCCTM booth (organized by Tracie Salinas and Emily Elrod), helping with the Awards Celebration and Reception, and assisting with whatever needed attention at the moment. I sincerely appreciate everything that everyone did to make this conference a worthwhile professional development experience.

Now that the 2012 State Math Conference is behind us, we turn our attention to the many exciting NCCTM events that will occur this spring. The Second Annual Spring Leadership Seminar will be held on March 22 at the Koury Convention Center in Greensboro. The keynote speaker is Steve Leinwand, a Principal Research Analyst at the American Institutes for Research in Washington, D.C., and author of *Accessible Mathematics: Ten Instructional Shifts That Raise Student Achievement*. Steve will address "The Common Core State Standards for Mathematics: Hopes, Fears, and Challenges as We Enter the Brave New World." He will take a quick look at the elements and changes represented by these new standards and then turn to their implications for teaching and testing and why we have good reason to be cautiously optimistic about a far more rational approach to mathematics. In addition to the keynote address, there will be two rounds of four afternoon breakout sessions each (K-2, 3-5, 6-8, 9-12). Each of these sessions will be led by a team of discussion leaders including Pam Zelando, Ruth Burgin, Windy Taylor, Marta Garcia, Becky Oldham, Talia Swiney, Karen McPherson, Nikki Costello, Kitty Rutherford, Johannah Manor, Michael Gallagher, Barbara Bissell, and others. For more information and to register for this seminar, go to NCCTM.org.

Other NCCTM spring activities include the three regional mathematics conferences, math contests, math fairs, logo contest, Trust Fund Scholarships, and the on-line election for the regional and state vice presidents as well as the state secretary. For more information on all of these activities, go to NCCTM.org. I encourage each of you to get involved in some of these NCCTM activities.

Since my NCCTM Presidency is coming to an end, I would like to take this opportunity to thank all the wonderful folks who helped to make these past two years so special for me. First of all, I want to thank each member of the Board of Directors (Donna Thomas, Elizabeth Murray, Maria Hernandez, Debbie Crocker, Tim Hendrix, Ron Preston, Katie Schwartz, Amy Janning, Lynnly Martin, Wayne Williams, Tony Thompson, Pat Sickles, Vincent Snipes, Melissa McKeown, Amy Travis, Beth Layton, Holt Wilson, Katie Mawhinney, Kim Clark, Marta Garcia, Karen Perry, Karen McPherson, Charles Wallis, Wendy Rich, Ray Jernigan, Barbara McGill (deceased), Kathy Jaqua, and the student representatives) for all you have done. You were always so willing to discuss and patiently resolve each item of business that came before the Board, and many of those discussions led to ideas on how to expand the ways NCCTM can better serve the mathematics teachers and students in North Carolina. Your enthusiasm and devotion to mathematics education has been such an inspiration to me, and I hope you know how much I have enjoyed working with each of you on the Board.

Another group of folks that I want to thank is the approximately 100 NCCTM members who serve as committee chairs, committee members, and other volunteers. The North Carolina Council of Teachers of Mathematics would not exist if it weren't for all the volunteers who so willingly give their time and efforts to this organization. I hope each of you know how important you are to NCCTM and mathematics education. I have thoroughly enjoyed working with each of you, and I appreciate all your help during my term as President.

In closing, I will forever cherish my time as your NCCTM President. Thank you for giving me this wonderful opportunity filled with exciting challenges and experiences. It has been very heartwarming to work with so many people who are dedicated to promoting excellence in mathematics teaching and learning for all. Thanks for the memories!

Eastern Region President
Ron Preston

prestonr@ecu.edu

Have you gotten immersed in the Common Core State Standards for Mathematics? Are you so busy comparing numbers, computing with fractions, dealing with data, that you have forgotten about the Mathematical Practices? Or have they already become an integral part of what students now expect to do in your classroom?

CCSS Mathematical Practices

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and make use of regularity in reasoning

Bear with me for a bit longer as I continue my barrage of questions. Do you regularly have to battle mathematical myths as you work with students, interact with parents, and perhaps even work with other teachers? Imagine some mathematical myths (simply do an internet search if you need to be reminded of some common myths and see if some of them resonate with you). Then consider the myths below and a corresponding “myth-buster” mathematical practice.

Dispelling Mathematical Myths with Mathematical Practices:

- If you can’t work a problem in 10 minutes . . . (#1)
- Using math tools (fingers, calculators, or computers) is cheating or a crutch (#5)
- I never had a good enough memory to be good at math (#7 and #8)
- I’m never going to use this anyway (#4)
- Math is not creative (#3)
- I like math because you don’t have to read or write (#3 and #6)

Are there some mathematical myths that you need to dispel? What mathematical practices (expectations for our students) might be the myth-buster you need?

Now that I have given you some food for thought, let me make a few thank you notes as this is my last column as Eastern Region President. A huge thank you goes to our president, Betty Long, and her leadership these past two years. Thanks to the Debbie Crocker for agreeing to take this important post for the next two years. And then, with respect to the Eastern Region, I applaud and thank the vice-presidents and representatives: Tony Thompson (VP College), Wayne Williams (VP High School), Lynnly Martin (VP Middle Grades), Amy Janning (VP Elementary), and Ryne Cooper and Aaron Trocki (Student Representatives). Finally, I want to thank everyone for giving me the honor of serving as Eastern Region President and particularly to Katie Schwartz for picking up the mantle of president for the coming two years.

Central Region President
Pat Sickles

pat@sickles.org

It has been an honor to serve as the NCCTM Central Region President for the past two years. Since this is my last message as president, I would like to take this opportunity to thank the other officers who have served with me. Holt Wilson, Vice President for Colleges, Beth Layton, Vice President for High Schools, Amy Travis, Vice President for Middle Schools and Melissa McKeown, Vice President for Elementary Schools have worked so well together to keep the business of the Central Region moving forward. Congratulations to Vincent Snipes who is the incoming President of the Central Region.

Vincent, along with the other officers have been planning for our Spring Conference. It will be held on Saturday, 23 February 2013 at John Lawrence Elementary School at 6068 Suits Road, Archdale, NC. The theme of the conference will be "Assessment and the Common Core," with Jeane Joyner as the keynote speaker. Our particular focus will be on new and pre-service teachers, but all are welcome. For more information, contact Vincent Snipes at snipesv@wssu.edu. We hope to see you there.

Western Region President
Katie Mawhinney

mawhinneykj@appstate. edu

Mark your calendars! The Western Region Spring Conference will be held on Saturday, 2 March 2013 at Charles D. Owen High School in Black Mountain. The program will include workshops addressing mathematics content that includes probability, statistics, rates of change and functions, along with a continued focus on the Standards for Mathematical Practices and other classroom practices including community building and discourse. Please email me to pre-register (mawhinneykj@appstate.edu).

The Western Region leadership would also like to encourage everyone to take advantage of the wonderful opportunities NCCTM provides including the 2013 Spring Leadership Seminar on Friday, March 22. Further, NCCTM annually awards mini-grants and graduate scholarships to support your efforts in the classroom and your career efforts as a mathematics educator. The mini-grant application deadline is September 15th and the graduate scholarship deadlines are March 1st and October 1st. More information can be found at the NCCTM website (link to "Grants and Scholarships").

I have greatly enjoyed the time that I have served as the NCCTM Western Region President and would like to thank everyone who has worked with me in the numerous NCCTM efforts that are undertaken each year to support mathematics education in North Carolina.

NCCTM Regional Math Fairs

The Eastern Region Math Fair

East Carolina University
March 15, 2013

Deadline: March 1, 2013

For more information contact:

Katie Martin
New Hanover County Schools
6410 Carolina Beach Road
Wilmington, NC 28412
Phone: 910-254-4240
katherine.martin@nhcs.net

The Central Region Math Fair

North Asheboro Middle School
March 23, 2013

Deadline: March 9, 2013

For more information contact:

Melanie Burgess
Southmont Elementary School
2497 Southmont Drive
Asheboro, NC 27205
Phone: 336-625-1558
mburgess@randolph.k12.nc.us

The Western Region Math Fair

Appalachian State University
April 13, 2013

Deadline: March 15, 2013

For more information contact:

Sumer Inman
McDowell High School
600 McDowell High Drive
Marion, NC 28752
Phone: 828-652-7920
Sumer.inman@mcdowell.k12.nc.us

STEM Inquiry on the Neuse River

Allison W. McCulloch, North Carolina State University, Raleigh, NC
Jeremy V. Ernst, Virginia Tech, Blacksburg, VA
Christopher Limer, Orange High School, Hillsborough, NC
Sara Taormina, Knightdale High School, Knightdale, NC

Recently students and faculty of the Department of STEM Education at NC State University partnered with the research faculty at NCSU Center for Applied Aquatic Ecology [CAAE] to develop and pilot the implementation of an integrated STEM project for middle school students in the context of aquatic ecology, specifically estuarine ecosystems. For us, that meant a project in which our students were asked to apply their knowledge of mathematics, scientific inquiry, and engineering principles to address a problem within the context of aquatics ecology. In this article we share our experiences in both the development and implementation of our purposefully integrated STEM project, *Inquiry on the Neuse River*. We detail our struggles and successes and offer recommendations about how our experiences can assist other STEM Education teams.

National standards for mathematics, science, and technology education all highlight the importance of preparing students for college and careers through the integration of science, technology, engineering, and mathematics [STEM] concepts. The *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics, 2000) noted, "The need to understand and be able to use mathematics in everyday life and in the workplace has never been greater" (p.4), emphasizing the importance of students being able to recognize and apply mathematics to science and engineering. The *Common Core State Standards for Mathematics* (2010) also advocated students' abilities to apply mathematics in contexts outside of mathematics through the articulation of mathematical practice standards that state, "students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace" (p. 7). STEM-based understandings and experiences that prepare learners beyond the classroom are of imminent need, as today's STEM students are tomorrow's leaders in science, technology, engineering, mathematics, and education (Prabhu, 2009).

Designing our STEM Project

Our goal was to design a purposefully integrated STEM project. We say "purposefully" because we aimed to assure that each discipline was incorporated to into the project in a meaningful way. For example, we did not want this to turn into a science project in which students used minimal mathematics. Nor did we want this to become a "real world" math problem simply using a superficial science setting. This meant identifying a context that was socially and personally relevant for the students as well as incorporating the processes of all of the STEM disciplines. This was not an easy task.

To meet the need of a socially and personally relevant context for the project we partnered with CAAE. Through this partnership we learned about estuaries and their ecosystems, which are included in the NCSCOS for middle school science and are socially relevant due to their impact on our nation's water and seafood supply. With the context identified we then set out to design a project in which students would be required to go through the processes involved in each of the STEM disciplines - scientific inquiry, technology / engineering design, and mathematical problem solving.

When working with the researchers, they noted the problems they had with their very expensive instrumentation, notably keeping the instruments free from the attachment of harmful barnacles. The barnacle issue ended up as the impetus and challenge for our STEM team project – To design a way for the scientists to protect their instrumentation from destructive barnacles. The expectation was that middle school students would be placed in teams to learn about and work on different aspects of this project in each of their STEM classes.

Implementing the Project

Two prospective mathematics teachers piloted the *Inquiry on the Neuse River* project with four eighth grade students over the course of two Saturdays. The eighth graders met with Mr. Limer and Ms. Taormina, for two sessions of approximately 2.5 hours each. Mr. Limer and Ms. Taormina began the first session with the students by introducing them to the work of CAAE and explained that the researchers had a problem that they hoped the students might be able to help them address—the researchers needed to find a way to protect their water quality testing equipment from harmful barnacles. After the problem was posed, the initial focus was on science concepts, estuary ecology, and barnacle biology. As noted, this project was piloted outside of school. However, the statewide eighth grade science curriculum is such that the students had just completed a unit of study on estuaries in their school science classes. Having the students share what they knew about estuaries while highlighting the concepts that would be central when designing their protective coverings enabled them to apply their knowledge to a problem first hand. For example, since barnacles live in salt water, it was very important that the students understand that the salinity in an estuary can vary dramatically, depending on depth (e.g., salt "wedge" or water layers) and the direction of the wind currents as well as water temperature. As the next step, the students researched barnacles, learning about the family of crustaceans to which they belong, where they live, how they eat, and their life cycles.

Once the students gathered the information needed to understand the context in which they were working and in which their instrumentation protection design would be tested, they had to become more familiar with the actual instrumentation they were challenged to protect. The $20,000 water quality testing instrument is a cylinder that is approximately 4 inches in diameter and 2.5 feet long (Figure 1). Students mimicked the instrument by using an alternative and much less expensive material, PVC pipe of the same dimensions, as a model of the instrument.

Figure 1: Water quality testing instrument

The students drew on their knowledge of science, technology, engineering, and mathematics in the design of their protective packages. Interestingly, the two groups took very different approaches to solving the problem. Group 1 intentionally provided a surface on which barnacles could attach, while Group 2's design goal was to provide a surface to which they could not attach. Group 1, designed a "cage" for the instrument, like a "screen porch" (Figure 2) and explained, "The barnacles will still attach, but not to the instrument and the water will still be able to get to the instrument." Group 2, designed their protection based on a "bed of nails" (Figure 3) and explained, "If there are a lot of barnacles it is going to be hard to connect to the points and they won't bend." These designs were built and then deployed in the estuary by the researchers for approximately one month.

Figure 2: Group 1's project design

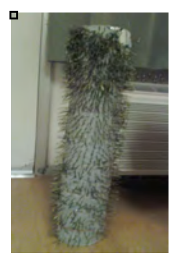


Figure 3: Group 2's project design

The second Saturday session occurred one month later, after the students' projects were retrieved from the Neuse River estuary. The students received the data collected from a CAAE testing platform during the month of deployment (Figures 4-6). These data included water temperature, salinity, and wind speed. Based on these data, students were asked to predict what happened to their designs.

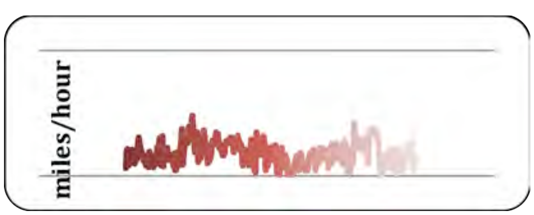


Figure 4: Wind speed during deployment

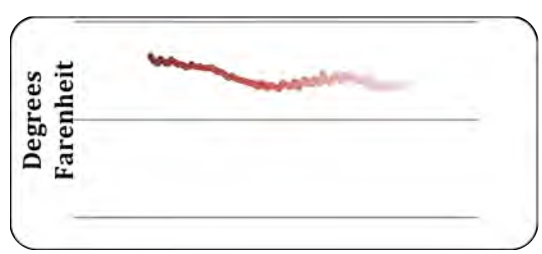


Figure 5: Water temperature during deployment

The students first noted that there was a severe drop in salinity. Based on their knowledge of barnacles (the fact that they are salt water creatures), the students noted that they did not expect to see many barnacles. When asked what might have caused such a severe drop in salinity one student pointed out that “the wind picked up and the water got colder on the same day.” He noted that the wind was close to 25 mph and asked another student, who visits the beach often, if he remembered any big storms. Sure enough, he recalled that was the week that a hurricane was just off the coast of North Carolina. Based on this information, yet another student immediately and excitedly, exclaimed, “Oh! They probably got mutilated!” Next, Mr. Limer and Ms. Taormina led the students outside to inspect their designs. On route they continued to discuss what they expected their projects to look like, they agreed that the nails of Group 2’s design probably tore up the “screen porch” on Group 1’s design. The results were consistent with the students’ predictions, their models were destroyed, especially Group 1’s “screen porch” design (see Figure 7 and 8).

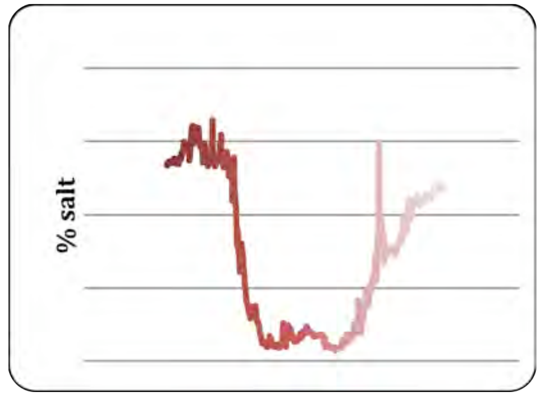


Figure 6: Salinity during deployment

Figure 7: Group 1’s design post deployment

Figure 8: Group 2’s design post deployment

The initial plan was for the students to compare the effectiveness of the protective covering designs by estimating the surface area covered by barnacles. However, since no barnacle growth was observed, this was not possible. Instead of using their actual models, Mr. Limer and Ms. Taormina presented each group with PVC models that had hypothetical barnacle growth marked on the pipes to compare (see Figure 9). The following tools were available in the room: rulers, string, permanent markers, construction paper, ½ inch grid paper, calculators, and computers with Internet access. The two student teams went about estimating the percentage of surface area covered by the hypothetical barnacles quite differently. Their strategies are described next.

Figure 9: PVC model with hypothetical barnacle growth

Group 1's Surface Area Estimation

Group 1 decided they could trace the oddly-shaped growths of barnacles onto grid paper and estimate the area by counting and approximating the number of squares enclosed by the traced growth (see Figure 10). Once they counted the squares contained by the trace, they recognized that they had determined the area in square half-inches. Next they determined the lateral surface area of the instrument model by using string and a ruler to measure the circumference and height of the cylindrical shape, in centimeters, and found the product of the two. Beginning to compare the area of the barnacle growth to the lateral surface area of the instrument, they noticed that they had used different units of measurement. To address this problem, they first converted the square half-inches to square inches. One of the students remembered the ratio between centimeters and inches was 2.54, but they decided to look it up on the Internet to be sure. When they were convinced that the conversion factor was indeed correct, they worked together to convert all of the barnacle growth area measures to square centimeters and correctly found the percentage of their model that was covered by barnacles.

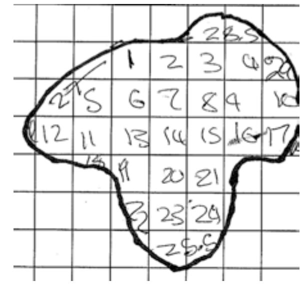


Figure 10: Group 1's estimation strategy

Group 2's Surface Area Estimation

Group 2 demonstrated a different approach. After a short discussion, one young man proposed that the area of barnacle coverage be divided into geometric shapes. They worked together to generate a list of geometrical shapes that they knew area formulas for (e.g., rectangle, triangle, trapezoid, circle). Next, they split the patches of barnacle growth up by drawing geometrical shapes within each patch. They used string and a ruler to measure the dimensions of each shape and then calculated the areas (see Figure 11). After successfully estimating the area covered by each patch of barnacles, they used the string and ruler to determine the circumference and height of the instrument model and used that along with their previous measurements to correctly determine the percentage of the model covered with barnacles.

Figure 11: Group 2's strategy

Reflections and Suggestions

Our goal at the outset of this project was to determine how a team of teachers from each of the STEM fields could work together to design and implement an integrated STEM project. One of the first choices we made was the use of estuary ecology as the context for the project. This was based on our relationship with CAAE. This partnership proved to be invaluable. We suggest that teams of STEM teachers partner with local experts (e.g., informal educators, businesses, researchers) to identify contexts that are both personally and socially relevant to students in which projects could be situated. As we worked toward the identification of the details of the project we needed to work together to understand what each field brings to the context of estuarine ecology and make sure that students are drawing on each discipline meaningfully during the project. We found that focusing on the processes of scientific inquiry, technology/engineering design, and mathematical problem solving to be very helpful in this endeavor and recommend this strategy to others. Students went through the process of scientific inquiry in their design of an experiment to test their designs, they went through the process of engineering design in the design and build of their protective coverings (which will ultimately be redesigned based on the results here), and they not only used mathematics through out the project but went through the process of mathematical problem solving in their estimations of the surface area covered by barnacles post deployment.

The use of a problem-based learning experience for this project led to a lot of uncertainty. This was a bit uncomfortable for the mathematics teachers since a large part of the mathematics portion of the project relied on the outcome of the protective cover design experiment. Mr. Limer and Ms. Taormina planned their project by assuming the worst outcome (no barnacles), and constructed PVC models with hypothetical barnacle growth ready to go if needed. One fear though, was that the students would become uninterested if they were not working with their own design models--this turned out not to be the case. In fact, the students did not hesitate to engage with the hypothetical barnacle models, manipulating and extrapolating while using them.

Conclusion

The initial problem posed to the students was to design a way to protect the water quality instrument from barnacle growth. The weather precluded our actually testing whether or not the designs protected the instrument from barnacles. We were, however, able to test how the designs withstood extreme weather conditions, a factor that was not considered in the students' designs. The primary mathematical concepts that we planned for students to draw upon included measurement, surface area, percent, and estimation. In addition to these planned concepts the students also drew upon their knowledge of ratio, proportion, percent, percent change, interpretation of graphs, and even rate of change. The example presented here stands as evidence that purposefully integrated STEM projects are possible to design and can be done in such a way that students must draw on the knowledge and skills expected in our state curricula.

We are convinced that purposefully integrated STEM projects, such as the project described in this paper, not only help students see how mathematics is related to their lives and STEM careers, but also will result in improved engagement in mathematics and other STEM disciplines in our middle and secondary school classrooms. We base this claim on the responses of the 8th graders who participated in the *Inquiry on the Neuse River* project. Though they had to spend two beautiful Saturdays (due to their mothers' insistence), they finished the last day exclaiming, "We should do this every weekend!" Integrated STEM projects have definite potential to bring exclamations like this to school classrooms.

Acknowledgements

We would like to thank Drs. JoAnn Burkholder and Robert Reed from the NCSU Center for Applied Aquatic Ecology for their time and support during this project. In addition, we would like to thank Chris, Jon, Gavin and Seth for giving up their Saturdays to help us in implementing this pilot project.

References

Common Core State Standards Initiative. (2010). *Common core state standards for mathematics.* Retrieved from http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf

Prabhu, M. T. (November 24, 2009). Obama launches new STEM initiatives. *eSchool News: Technology News for Today's K-20 Educator.* Retrieved from http://www.eschoolnews.com/2009/11/24/obama-launches-new-stem-initiatives/

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

2013 NCMATYC Spring Conference

Haywood Community College, Clyde, NC
March 14-15, 2013.

Early Registration: February 22, 2013. See the NCMATYC website for forms.

Lodging for the 2013 NCMATYC Conference: The Waynesville Inn Golf Resort and Spa (828-456-3551). Tell the Reservation Agent that you are with NCMATYC in order to get the special room rate of $69.00 per person, single occupancy or $39.00 per person, double occupancy. Reservations must be made by March 1, 2013 in order to guarantee the special rate. The group rate will be honored one day prior and one day following our conference if you would like to arrive early or stay afterwards to visit the surrounding areas.

For more information and to register, see ncmatyc.matyc.org/

Mini-grant Report

iMath II: Expansion of an iPod Touch Learning Station to Broaden the Reach of Game-based Learning

James Munn, W.D. Williams Elementary School, Swannanoa, NC

The *iMath II* project sought to further support students with difficulties in mathematics through greater access to engaging applications/ activities that enhance their number sense and fact fluency with basic operations, including initial fraction concepts.

Through NCCTM-supported grants over the past two years, an iPod Touch Learning Station was established in my fifth grade classroom. In 2011, additional devices were purchased, along with a Bretford Security Case to house all 20 devices. The devices were loaded with selected learning apps that focus on building mathematical fact fluency with addition, subtraction, multiplication, division, and initial fraction concepts. Equitable access to the devices was ensured during bi-weekly "math workshop" lessons. During math workshop, three flexible groups of students rotated between the following activities: teacher instruction, paired problem-solving, and iPod Touch Learning Apps (individual use). Each activity lasted approximately 20 minutes. Progress monitoring was maintained through monthly fact fluency assessments in multiplication and division. Students that demonstrated lack of proficiency were provided additional time with the Learning Apps twice a week before school for approximately 20 minutes each session. Additional sessions were also available to all students when expected work was complete.

Impact of the project

At the conclusion of the project and school year, 45 fifth grade students took an online survey using Google Docs and Google Forms to evaluate their use of the iPod Touches as an instructional tool. They took the survey on an iPod Touch using a QR code to access the internet address. The selected students had the greatest exposure to the devices, and were in my class or neighboring fifth grade classroom. This qualitative data can serve as an indicator of the success of the project. When asked, "How often did you use an iPod Touch at school?" 45% of the students responded as using the devices "2-3 times each week" and 53% responded as using iPod Touches "almost every day."

Qualitative Results

As highlighted in Table 1, 86% of students responded positively with "mostly" or "always/very" to survey questions about the utility of the iPod Touch as a learning tool. As evidenced from the students' point of view, using iPods as an instructional tool was highly successful!

Table 1: Survey Results

Survey Question	STUDENT RESPONSES (Out of 45)				
	No	A little	Somewhat/ Kind of	Mostly	Always/ Very
Learning with an iPod Touch is enjoyable.	0	2	---	9	34
I am motivated to learn with an iPod Touch.	0	0	9	17	19
Is an iPod Touch easy for you to use?	0	1	---	12	32
Using an iPod Touch helped me learn addition and subtraction facts.	3	2	5	15	20
Using an iPod Touch helped me learn multiplication and division facts.	3	1	3	15	23
Using an iPod Touch helped me learn fraction concepts.	3	2	3	16	21
Total Percent	**3%**	**3%**	**7%**	**31%**	**55%**

Quantitative Results

Data were gathered to evaluate the impact on student acquisition of basic multiplication and division facts. The numerical scores are shown in Table 2 as PCPM (Problems Correct Per Minute). Students were given 5 minutes to solve 50 multiplication facts and 5 minutes to solve 40 division facts.

As shown in Table 2, the average growth was 81.7% for multiplication facts and 91.3% for basic division facts. Many factors could be attributed to students' growth in basic multiplication and division facts; but I contend that the very high growth can only be attributed to the iMath Project!

Table 2: Pre- and Post-test Results

2011-12	MULTIPLICATION			DIVISION		
Student	Pretest PCPM	Posttest PCPM	GROWTH	Pretest PCPM	Posttest PCPM	GROWTH
1	13.1	14.2	1.1	13.8	21.3	7.5
2	7.8	14.0	6.2	6.4	15.9	9.5
3	4.8	7.4	2.6	2.4	7.6	5.2
4	8.0	15.6	7.6	7.2	12.3	5.1
5	6.0	23.8	17.8	7.2	9.1	1.9
6	3.6	5.0	1.4	0.4	0.6	0.2
7	10.3	19.7	9.4	14.1	21.8	7.7
8	5.0	6.8	1.8	0.2	1.6	1.4
9	8.8	11.6	2.8	3.8	4.2	0.4
10	9.0	19.2	10.2	7.8	12.6	4.8
11	13.1	16.7	3.6	7.4	9.0	1.6
12	10.0	30.3	20.3	11.0	26.4	15.4
13	7.2	10.5	3.3	6.2	12.8	6.6
14	8.8	16.7	7.9	7.0	16.6	9.6
15	6.0	13.9	7.9	7.2	17.1	9.9
16	6.4	10.0	3.6	3.8	7.7	3.9
17	7.2	11.8	4.6	7.0	18.0	11.0
18	8.6	15.0	6.4	8.0	12.6	4.6
19	8.8	17.6	8.8	5.8	12.0	6.2
20	8.0	10.8	2.8	6.2	9.2	3.0
21	4.4	6.4	2.0	0.0	2.8	2.8
22	9.6	20.0	10.4	7.2	13.3	6.1
23	1.8	6.2	4.4	0.2	1.8	1.6
24	11.3	17.6	6.3	9.2	19.5	10.3
	Pretest	Posttest	Growth	Pretest	Posttest	Growth
Average DCPM	7.8	14.2	6.4	6.2	11.9	5.7
	PERCENT GROWTH (Multiplication)		81.7%	PERCENT GROWTH (Division)		91.3%

Math Apps

The devices were loaded with 15 mathematics educational apps. They provided a variety of ways to engage with mathematics, including fact fluency, number lines, fractions, and algebraic representations. Motivation and interest was also maintained in a wide variety of ways. When asked, "What were your top 3 math apps?" the students responded as illustrated in Figure 3. There were 135 total votes. The top two apps, Rocket Math and Pearl Diver / Lobster Diver, are featured here.

Figure 1: Rocket Math Screenshot from iTunes App Store

Rocket Math was the top rated app by the students in this survey. It offered a variety of math concepts. Students had to complete basic math facts to earn money (Figure 1). This money was then used to build and fly their custom created rockets. This combination of math facts and creativity could be attributed to its top rating.

Pearl Diver and *Lobster Diver* are similar games, the difference being the "treasure": pearls vs. lobsters. In these apps, students make a diver swim down to collect pearls/lobsters. There is a number line across the bottom with varied partitions. In Figure 2, the diver must "dive at: 10/4." The partitions have a tall line on the whole number, and a shorter line at the halves. This is a great app for working with rational numbers in a number line context!

Figure 2: Pearl Diver / Lobster Diver Screenshot from iTunes App Store

Student Perceptions

Personal accounts from the students offered additional insight into the effectiveness of the project. Below are few quotes from students answering the question, "how did using an iPod Touch improve your learning?"

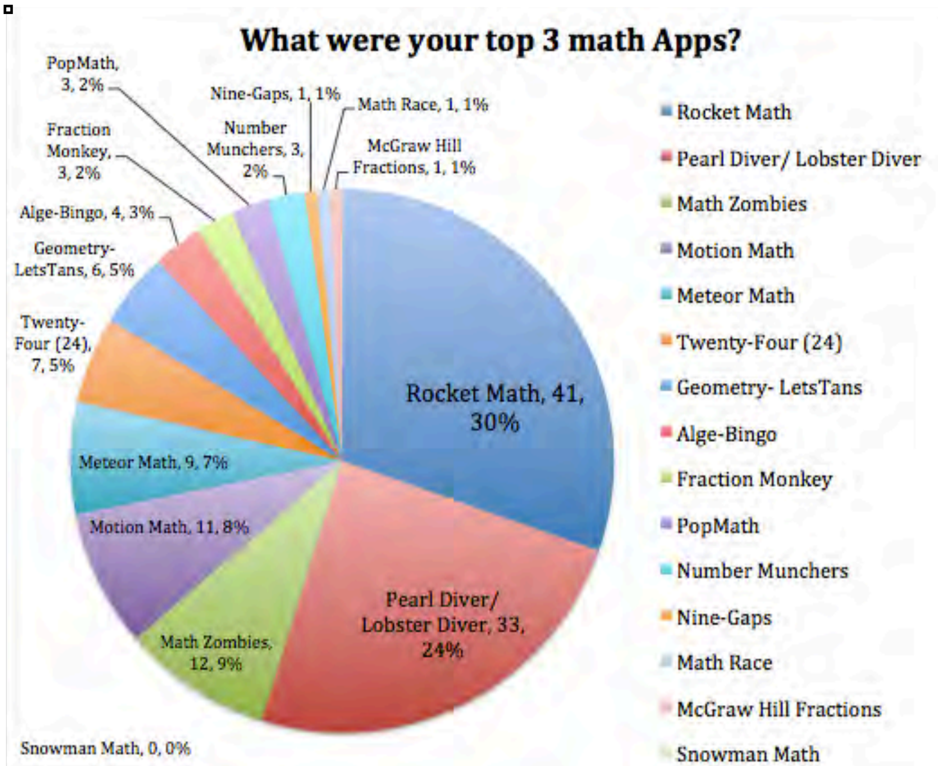


Figure 3: Students' Favorite Apps

- *"It helped me be more accurate with my multiplication and division. Also it is a fun way to learn my math facts instead of just writing on paper and going over it."*
- *"Well I like the idea of using creativity and working on basic math skills and using the money you earn wisely."*
- *"It massively helped me with geography and I feel so much smarter. All in all, using an iPod Touch was [a] privilege I will never forget about."*
- *"I learned a lot of fractions and to multiply faster than I did last year."*
- *"It's a way to improve my math and reading skills, but in a fun way. I think it helped me develop more important facts and information. Being able to scan codes and go to fun, informative, and safe websites is amazing to me! I love that my teachers are caring enough to do this!"*
- *"Well when I get something wrong it tells me and when I get something right it tells me that I get it right."*
- *"The devices helped me learn by slowly progressing into my brain."*

- *"I have trouble remembering things that I learn; it has been easier to learn when playing with [iPod Touches] because having fun helps things stick in my brain."*

Lessons Learned

1. *Time*. It required more time than anticipated to update devices and keep them charged each day.
2. *Organization*. "Name" the devices by numbering them on the back. When syncing the devices, name them on iTunes, too. When students checked-out a device, they wrote their name on a card assigned to the specific numbered device. This helped with accountability, too!
3. *Security*. Put apps and access to settings in a separate folder labeled "teacher only." Set up "restrictions" so that apps cannot be added or deleted. Also turn off YouTube and other unnecessary apps. Organizing the devices by number in an iPod Security case made accounting for the devices much simpler. A simple lock was used to secure the devices in the case when not in use. Lastly, enabling internet access ensured that if an iPod is "lost" it can be located using the Find My iPod function on a computer.
4. *Consequences*. Students signed a general internet use agreement at the beginning of the year. In addition to this, an iPod Touch agreement should be used in the future to ensure proper use of the devices (see item 5). Students who use the device inappropriately, will loose the ability to use it in the future.
5. *Proper Use*. Insist that students: a) Use the device for only the specified purpose. b) Keep the protective case on the device. c) Do not peal back or remove the screen cover. d) Do not move, add or delete apps or folders. e) Do not change settings. f) Write their name on the check-out card when using a device, and return the device to the specified location and mark their name off when returned.
6. *QR Codes*. Scanning a QR code with a device is a great way for students to access a desired, specific website. Before assigning the code with students, ensure devices will access the intended QR code. You can utilize a QR code to access a Google Doc (or Google Form) also.
7. *Data Memory*. Clearing the history of App use and internet use can be time consuming. Currently, it must be done by hand on each device. A trustworthy student can be assigned this task to assist the teacher. Hopefully in the future, a more effective way to clear data from multiple devices at once will be invented.
8. *Final Survey*. The Google Doc/Form was a great way to gather and evaluate the data. Next time, we will evaluate math Apps and non-math Apps in separate questions. Using a Google Doc Form via a QR Code worked great! Only one student expressed difficulty with entering data on the iPod keyboard; she then took the survey on a regular computer instead.
9. *Sharing Devices*. Once the media center started using the devices, it became difficult to utilize the devices on a regular basis in my own classroom. Teachers who plan to use the devices on a regular basis really need their own set.
10. *Ideal Number of Devices*. Of course, a 1:1 ratio is ideal, but a 1:2 ratio (one device for two students) for devices works well. This way pairs can share a device for research or gathering information. For classroom rotations, this ratio provides half the class with devices, while the teacher can work with the other half.
11. *Storage*. The Bretford Security Case was wonderful for storing 20 devices! It locked and kept them organized by number. Charging devices with the case was also very easy. Each device plugs into the case, and the case is plugged into one wall plug. To reflect the "ideal number of devices" from #10 above (approximately 10-12), a different type of storage case must be explored. It should include a way to lock the case and organize them neatly and safely. Another option is to store 20 devices in one case and a grade level or pair of teachers will check out the case from a central location.
12. *Readability*. The small display on an iPod Touch is great for apps specifically designed for the device. On the other hand, when using the devices to access the Internet for research, the small screen was problematic. Increasing the text size was great, but was then very difficult for some students to read on the small screen. Having some iPads would give equitable access to all students, specifically struggling readers.

Unexpected Outcomes

An unexpected outcome was collaborating with fellow teachers. A fellow fifth grade teammate was a key component on weekly lessons incorporating the devices into lessons. Together, we designed innovative uses of the devices that enhanced student learning in all subject areas: science, social studies, math, and reading. The media specialist was able to utilize the devices with multiple grade levels in innovative ways. This truly became a model pilot program!

Sustainability Plans

To sustain the current project, more screen protectors are necessary to ensure the protection of the touch screen. The estimated cost of this replacement would be small: around $20 for all the devices. New apps to meet/support instructional goals will also be added as deemed necessary. The devices have a one-year warranty from Apple, which will expire this fall. One device had a faulty "home" button last year and was replaced free of charge by Apple. I am hopeful that the devices will continue to work properly for many years to come to provide more successful results for student learning!

Applying for NCCTM Mini-grants

NCCTM provides funding for North Carolina teachers as they develop activities to enhance mathematics education. This program will provide funds for special projects and research that enhances 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. The mini-grants are awarded by each of the three regional organizations to members ***within their geographic boundaries***. A total of $15,000 is available each year for mini-grants, with each region awarding approximately $5000 in grants to its members. In recent years, approximately 30-35 proposals have been funded, for an average grant of just less than $800.

Directions

The application is available on the NCCTM website. Read all directions carefully, and fill out the application and cover sheet completely. Failure to correctly list the NCCTM region and membership number will cause your application to not be considered. Grant proposals must be postmarked or emailed by September 15, and proposals selected for funding will receive funds in early November. You will receive an email confirmation of receipt of your proposal. If you do not receive a confirmation within one week, follow up with the Mini-grant Coordinator. Be sure that your NCCTM membership is current and active for the upcoming year! Each year we have applications that cannot be considered because of the membership requirement.

To apply, go to www.ncctm.org

Donating to the NCCTM Trust Fund

If you wish to memorialize or honor someone important to you through a donation to the NCCTM Trust Committee, please send your donation to:

Rebecca Hoover, NCCTM Business Manager
P.O. Box 4604
Cary, NC 27519

Contributions (checks) should be made payable to Pershing LLC for the NCCTM Trust Fund. Please provide the name of the person being honored or memorialized through the donation and the name and address of the person that NCCTM should notify of your gift. For more information, contact John Kolb, Trust Fund Chair.

Mini-grant Report

Setting up a School Store Using Mini-grant Funds

Tammy Applegate, Asheboro High School, Asheboro, NC

During the 2010-2011 school year while teaching at Randleman Middle School, I received an NCCTM mini-grant to start a school store. Operating a store seemed like a fun way to introduce the principles of inventory management and basic accounting to my eighth grade math students, as well as provide a much-needed service to our school community.

Getting Started

My first class of the day was an elective called AVID (Advancement via Individual Determination, a college prep and coaching program). Since the store was to be open during the 20 minutes before the morning bell, it made sense for my AVID students to set up and operate the store. We decided to place the store in the lobby of the gym, where students gather in the mornings. Although the administration suggested running the store from the concession stand, we wanted to have a stand-alone operation. We also decided that the store would be a "break-even" venture, with prices equal to our average unit cost for each product.

I found a used locking display case for $60, then bought some paint, wheels and a vinyl banner to customize it. The students and I had fun deciding which products we should carry. Since our school requires each student to maintain a three-inch three-ring binder, we decided to carry binders plus associated products like tabs and sheet protectors, as well as pencils, pens, and paper. We decided upon a launch date for our store and made posters and price lists to publicize it.

The office manager at our school set up a separate line item named "School Store" in the school's accounting system. The cost for items we ordered through the school system could then be deducted from our account. If I purchased inventory elsewhere, I turned in my receipts for reimbursement. Cash deposits were given to our office manager to be credited to the "School Store" account. The start-up costs for the store were:

Glass display case	$60
Paint, wheels	$35
Vinyl banner	$30
Posters, etc.	$10
Inventory	$350
TOTAL	$485

Running the Store

After much planning and publicity, we were ready to launch our school store. We scheduled two students to work at the store each morning. We operated on a weekly accounting cycle. On Fridays, we took inventory and counted our cash. These figures were put into a simple Excel spreadsheet (the shaded cells in Figure 1). The spreadsheet used our beginning inventory figures to calculate how many of each item we sold, then multiplied that by the price to get the sales revenue, which was added to our beginning cash figure to determine what our ending cash should be. This figure was compared to our actual ending cash to determine whether we were "short" or "over":

$$\text{For each product: (beginning inventory} - \text{ending inventory)} \times \text{price} = \text{sales revenue}$$
$$\text{Beginning Cash} + \sum \text{(sales revenue for each product)} = \text{ending cash}$$

Our ending inventory numbers, plus any purchases, became our beginning inventory numbers for the following week. Our ending cash figure, minus the amount given to our office manager for deposit, was our new beginning cash. Things flowed very smoothly using this simple accounting system, and our ending cash was usually within a dollar or two of the calculated value.

SCHOOL STORE INVENTORY WORKSHEET Week Ending **4/15/2011**

	Price	Beginning Inventory	Ending Inventory	Number Sold	Amount of Sales
Binders (each)	$3.00	40	17	23	$69.00
Pencils (each)	$0.10	54	52	2	$0.20
Sheet Protectors (each)	$0.125	65	65	0	$0.00
Binder Tabs (pack of 5)	$1.00	12	10	2	$2.00
Mechanical Pencils (each)	$0.25	39	15	24	$6.00
Pens (each)	$0.15	40	40	0	$0.00
Cap Erasers (each)	$0.05	52	49	3	$0.15
Graph paper (pack of 10)	$0.25	3	0	3	$0.75
Notebook paper (pack of 25)	$0.25	10	5	5	$1.25
					$79.35
TOTAL VALUE OF INVENTORY		$148.13			

ENDING CASH	$140.45	(deposited $90.00)
BEGINNING CASH	62.05	
DIFFERENCE	$78.40	
TOTAL WEEKLY SALES	$79.35	
Amount Over/(Short)	($0.95)	

Reflection

The students really enjoyed running the store. Our greatest challenge was keeping enough inventory to meet demand, especially the three-ring binders. The other best-selling item was mechanical pencils, which outsold the wooden variety by a margin of twenty to one.

Some unanticipated problem-solving opportunities arose. One Friday, after weeks of having our cash reconcile to within a dollar, our weekly accounting showed a cash shortage of about 15 dollars. Not wanting to believe that someone had dipped their "hand in the till," I asked the students to think of other explanations for the shortage. After some discussion, they realized that the error might be related to our inventory records, not our cash count. One student remembered that when we received a new shipment of 50 binders earlier that week, we did not count the binders before we added them to the inventory. What if, she pondered, the shipment didn't contain the full 50 binders? I asked how that would make a difference. Well, she proposed, if we added 50 binders to our inventory records, but in fact there were fewer binders, then our ending inventory would lead us to believe that we sold more binders than we actually did; thus, our cash would be short. Sure enough, a few days later, our office manager called my classroom to let me know that she had a box of five binders that had been overlooked when we picked up our order. From that point on, we knew to always verify our shipments before adding them to our inventory!

In summary, the school store was a fun way to bring real-life lessons into the classroom, as well as provide a valuable service to our school. Students had the opportunity to enhance their financial literacy, as well as gain experience using Excel and practicing basic accounting and inventory management. Our "Tiger Tools" store will continue to offer reasonably-priced school supplies to our students for many years to come.

Intentional Listening: Formative Assessment To Link Teaching and Learning

Jeane M. Joyner, Meredith College, Raleigh, NC

Teaching at every level is challenging, and intentional listening is a formative assessment strategy to address this challenge. Walk into any mathematics classroom and you will observe students who have a variety of interests and expertise as well as widely differing experiences and levels of confidence as learners. This is true whether the class is second grade, seventh grade or college algebra.

To be effective, teachers must address this diversity as they guide students in learning new mathematics. Teachers need to understand mathematics content, have strategies for presenting that content to students, and capitalize on the prior knowledge of students in the class. Quality instruction also requires that teachers be reflective about what sense students are making of the mathematics and be flexible in planning instruction.

Formative Assessment: A Collection of Strategies

Research indicates that formative assessment can support quality instruction and positively impact student learning (Black & Wiliam, 1998). Currently, formative assessment is being brought to the forefront as a means of improving student achievement, yet it has been in educational literature for decades (Fuchs & Fuchs, 1986; Grouws, 1992; Hiebert, 1997; Pinchok & Brandt, 2009). The term is used to denote a variety of activities from individual student interviews to district-created benchmark tests. Formative assessment can be described as a collection of strategies that are employed *during*, rather thanat *after*, instruction to provide information that teachers need to support the many decisions they make daily and to encourage students in taking greater responsibility as partners in learning.

Assessments are only as powerful as the quality of the information they provide and the manner in which that information is used. Benchmark tests, for example, can be very helpful if they are structured in a way to provide insight as to *why* students miss an item, not just *that* they miss an item. Teachers need time to analyze these data and then to plan lessons that use the information gained in benchmark tests to address the students' misconceptions or incomplete knowledge.

The difficulties related to formative assessment come in its implementation. Because formative assessment involves multiple strategies that morph across grades to match the growing independence of learners rather than being one set "program," the strategies lack political glamour. Formative assessment can neither be purchased off a shelf nor identified as the product of one publisher or guru. Formative assessment does not come in a shinny box at an amazingly high cost per teacher. Likewise, there are not four easy steps to implementing formative assessment that can be checked off one at a time.

Rather, implementation of formative assessment takes place as individual teachers modify the ways they relate to their students based on their beliefs about facilitating learning. What changes is not so much what the students do, but rather what actions that teachers take in response to evidence they collect. When teachers decide that not every assignment requires a grade, some assignments are likely to be scored for types of errors or quality of explanations. Students may be asked to work collaboratively, to give feedback to each other, and to help each other make sense of mathematics ideas and develop solutions. Everyone recognizes that all assignments or discussions can provide information about students' understanding - or lack of understanding - of the mathematics in lessons. Consider the four problems from a third grade student's worksheet in Figure 1.

49	53	18	38
14	19	26	78
26	47	34	27
+ 32	+18	+55	+19
112	137	133	153

Figure 1. Sybil's Column Addition

Marking the sums correct or incorrect would result in a grade, but the score would do nothing to help Sybil understand why some of her work is correct and some is incorrect. Marking answers right or wrong is not a strategy for uncovering thinking or advancing understanding. However, when Sybil's teacher asked her to "think out loud" and demonstrate how she arrived at the answers, he discovered that she consistently applied her own rule for addition: If the sum is greater than 9, write down the smaller number and carry the larger one (Joyner & Muri, 2011).

As teachers include more formative assessment strategies into their daily routines, what happens in the classroom – how mathematics lessons unfold – is likely to change. Rather than having students call out answers to the previous day's homework problems and then instructing them to begin the next assignment, many teachers plan more time and different opportunities for students to work together, to talk about their ideas, and to share different solution strategies. Teachers are more likely to probe students' understanding and to focus on uncovering misconceptions before the next quiz. Teachers include feedback to students that tells them what they are doing that is correct and points them in more productive directions when they make errors.

There are many reasons that teachers state for not implementing formative assessments as a routine part of their instruction. Some have concerns that if some assignments are not given a grade, students will not make an effort. Others worry that there is not enough time to implement formative assessment strategies because of the need to adhere to pacing guides. Other teachers view formative assessment as an "add on." However, some teachers want to implement formative assessments and use the information they gain to inform their planning, but they wrestle with how to begin and maintain consistent practice.

Highlighting Intentional Listening

One powerful starting point for formative assessment that every teacher can employ is to become an *intentional* listener. Intentional listeners seek to uncover the thinking and mathematical reasoning that is behind students' responses rather than just focusing on whether answers are correct or incorrect. Questioning becomes a tool for the intentional listener to clarify what they learn about students' thinking.

Hearing students explain why and how they arrive at a given response also means that teachers may recognize correct but incomplete understanding. If the nature of misconceptions that form the basis for a student's wrong answer is known, the teacher is able to address the cause of problem – not just the results. Probing how students know their solution is correct may uncover misconceptions that are masked by the task itself and would cause difficulty in the future. For example, when a student says the median for the set of data (28, 9, 24, 32, 30) is 24 because 24 is the middle number, we recognize that the student is likely to have an incomplete understanding of this measure of center. But if the data set were different (12, 16, 24, 20, 28) and the correct median 24 happened to be third data point in the set, we might believe the student had a complete understanding of median even though the student may not realize that data need to be ordered when determining the median.

Many teachers began relying on correct answers on tests as the primary evidence of learning over past years of high stakes accountability. Tests, often multiple-choice, followed instruction, and grades became the primary feedback for students and teachers. Conversations and class discussions continued to exist, but were used as assessment strategies less and less frequently. Today, teachers have opportunities to change this. *Intentional listening* can be incorporated into every teaching style and used by both novices and seasoned teachers.

Intentional listening means making an effort to do less telling, more asking, and more focusing on the logic behind students' responses. A sign posted in the teachers' lounge or in grade books that says "talk less, listen more" provides good advice. Intentional listeners attend carefully to what students are saying rather than think about what they are going to say next. As tasks are debriefed, teachers listen to students' comments in order to infer what students know and what sense students are making of the mathematics. They try to ascertain when there are misconceptions and when students are just "not there yet."

When a question is posed, intentional listeners are comfortable with silence to allow time for students to think. As students respond, teachers decide if they are communicating their misunderstandings or miscommunicating their knowledge. How confident are students in their solutions? Can students explain why their solution solves the problem and justify their responses? Is their reasoning valid or are they simply repeating steps in a procedure without understanding of what the steps mean? Asking students to clarify or "say more" is a partner strategy for intentional listening.

Class discussions take on a different dynamic when value is placed on students' thinking and reasoning, not just on their answers. An emphasis on *why* and *how* – and the time that must be allocated for discussions - reflects teachers beliefs that their intentional listening results in better decisions about "what next." Sharing of different strategies and reasoning often makes clear content that students at first did not understand. Wait time during discussions also allows students to reflect on and measure others' ideas against their own thoughts. Misconceptions and mistakes become opportunities to rethink and revise ideas.

Teachers who are intentional listeners serve as role models for students. They demonstrate the importance of not interrupting, of restating what others have said in order to clarify the ideas, and of disagreeing with dignity. Students begin to feel comfortable sharing solution strategies and expressing their opinions when they know that their ideas are valued even when they are not totally correct. They learn to clarify their thinking and craft arguments as they convince themselves and then others that what they believe is correct.

Intentional listening requires preparation. As teachers plan tasks, they need to identify the critical mathematics in the lesson, the common misconceptions, and how they will address these. Preparation also includes identifying what constitutes evidence of understanding. What are students able to do and to explain when they have acquired the conceptual and procedural knowledge related to the mathematics in the lessons? What mistakes have students made in the past when the content was taught? What are students likely to say or do when they are headed in the right direction but have not yet solidified their understandings? What will be evidence of depth of learning?

Teachers need to be good at eavesdropping on conversations between student partners and small groups. Teachers often hear thinking of students who are too shy or are not confident to share with the class as a whole. Taking brief notes as partners are talking reminds teachers to follow up on areas of weakness (Figure 2) or note students who are ready for more challenge. These notations inform future planning. While students work is a time for teachers to use information from intentional listening to probe individual student's thoughts, ask for clarification of written work, pose "what if" questions, and focus on what individual students know and can demonstrate.

Need to address the meaning of the negative sign with Josh, Tomeka, Meghan, Wilson, Ethan, Courtney

Figure 2. Sample Teacher Note

As with all learning, becoming an intentional listener is a generative process. That is, skills must be developed and supported by beliefs, knowledge, and experiences. This means thinking about what mathematics is foundational to each lesson. It means making a concerted effort to listen more carefully to students' responses and to seek answers to questions like these:

- *Do I know what thinking prompted this student's answer?*
- *Why did the student say (or do) this?*
- *What question can I ask so that I get a more complete picture of why this student has taken this action?*
- *Is the student solid in his or her understanding or is this a guess?*

Becoming an intentional listener will not ensure that the students' mathematics achievement will soar. However, when teachers become intentional listeners, they are more likely to be able to plan lessons, orchestrate discussions, and choose tasks that will better match the strengths and needs of their students. Lack of confidence as a learner of mathematics is a problem for many students. When they become intentional listeners and put together clues from their students' conversations and written work into effective instruction, teachers create opportunities for all students to develop both competence and confidence. If the adage that 'success breeds more success' is true, every effort to better understand and respond to students' thinking through intentional listening is worthwhile.

References

Anderson, N., Chapin, S., & O'Connor, C. (2011). *Classroom discussions: Seeing math discourse in action* [multimedia professional learning resource]. Sausalito, CA: Math Solutions

Bransford, J. (2000). *How people learn: Brain, mind, experience, and school* (expanded ed.). Washington, D.C.: National Academy Press.

Bright, G. W., and Joyner, J. M., eds. (1998). *Classroom assessment in mathematics: Views from a National Science Foundation conference*. Lanham, MD: University Press of America.
Black, P., Harrison, C., Lee, C., Marshall, B., & Wiliam, D. (2004). Working inside the black box: Assessment for learning in the classroom. *Phi Delta Kappan, 86*(1), 8-21.
Black, P., & Wiliam, D. (1998). Inside the black box: Raising standards through classroom assessment. *Phi Delta Kappan International, 80*(2), 139-144.
Busick, K. U., & Stiggins, R. J. (1997). *Making connections: Case studies for student-centered classroom assessment* (2nd ed.). Portland, OR: Assessment Training Institute.
Chapin, S. H., O'Connor, C., & Anderson, N. C. (2003). *Classroom discussions: Using math talk to help students learn*. Sausalito, CA: Math Solutions Publications.
Chuska, K. R. (1995). *Improving classroom questions*. Bloomington, Ind.: Phi Delta Kappa Educational Foundation.
Fuchs, L. S., & Fuchs, D. (1986). Effects of systematic formative evaluation: A meta- analysis. *Exceptional Children*, *53*(3), 199–208.
Grouws, D. A. (1992). *Handbook of research on mathematics teaching and learning*. New York: Macmillan.
Hiebert, J. (1997). *Making sense: Teaching and learning mathematics with understanding*. Portsmouth, NH: Heinemann.
Heritage, M., & Niemi, D. (2006) Toward a framework for using student mathematical representations as formative assessments, *Educational Assessment*, *11*(3-4), 265-283.
Joyner, J. M. & Muri, M. (2011). *INFORMative assessment: Formative assessment to improve math achievement*. Sausalito, CA: Math Solutions Publications.
Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding it up: Helping children learn mathematics*. Washington, DC: National Academy Press.
National Council of Teachers of Mathematics. (1980). *An agenda for action*. Reston, VA: Author.
National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA: Author.
_ National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.
Pellegrino, J. W., Chudowsky, N., & Glaser, R. (2001). *Knowing what students know: The science and design of educational assessment*. Washington, DC: National Academy Press.
Pinchok, N., & Brandt, W. C. (2009). *Connecting formative assessment research to practice*. Washington, DC: Learning Point Associates. Retrieved from http://www.learningpt.org/pdfs/FormativeAssessment.pdf
Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics. In D. A. Grouws (ed.), *Handbook of research on mathematics teaching and learning* (pp. 334-370). New York: Macmillan.
Shavelson, R. J., Baxter, G. P., & Pine, J. (1992). Performance assessments: Political rhetoric and measurement reality. *Educational Researcher*, *21*(4), 22-27.
Sierpinska, A. (1994). *Understanding in mathematics*, London: The Falmer Press Ltd.

NCTM Illuminations

Equations, Expressions, Inequalities

The Common Core State Standards require all students in K 12 to engage in algebraic thinking. Young students, for example, are asked to find the missing whole number in equations like 8 + ? = 11, while high school students use equations to model situations and solve problems. *Illuminations* has resources that promote algebraic thinking in every grade band.

- In the lesson ***Block Pounds***, elementary students use scales to determine the weight of spheres, cylinders, and prisms. illuminations.nctm.org/LessonDetail.aspx?ID=L167
- Students use manipulatives, explore linear equations, and solve for x in the middle school lesson ***Geology Rocks Equations***. illuminations.nctm.org/LessonDetail.aspx?id=L786
- High school students love to dangle BarbieTM dolls over a wall when learning about slope with the ***Barbie Bungee*** lesson. illuminations.nctm.org/LessonDetail.aspx?id=L646

It's Play Time: Enhancing Computational Skills and Strategy Development Through Mathematical Games

Crystal Hill Morton, Indiana University Purdue University at Indianapolis, Indianapolis, IN
Daniella Ann Cook, University of South Carolina, Columbia, SC
Jan A. Yow, University of South Carolina, Columbia, SC

"I learned that math games can help you too. I learned the game 'get to a 1,000' will help you count and add."

"I love to play Mancala because it is really fun and because you can come with new strategies and it is really challenging."

"I learn how to play new games and learn at the same time."

The voices of African American fourth and fifth graders who participated in the Minority Access To Revolutionary Instructional eXtensions (MATRIX) program reflects the power of games to support the mathematical learning of students. The MATRIX project had two components: a unique mathematics curriculum and parent/community advocacy training. This article provides an overview of the MATRIX mathematics curriculum and describes the potential of the curriculum to positively impact students' computational skills (paper/pencil and mental) and strategy development.

The MATRIX Curriculum

The MATRIX mathematics curriculum employs progressively more difficult games with the goals of: (1) supporting students' development, use, and articulation of multiple strategic approaches to master game challenges; (2) challenging students to learn mathematical facts; and (3) building students' computational and reasoning skills. MATRIX provides students the opportunity to support their learning and the learning of others through their participation in intellectual teams. In addition, students responded to writing prompts associated with each game challenge to extend and deepen their understanding and to provide them with the opportunity to articulate and defend their mathematical thinking. The optimal format for MATRIX is to place students in teams of four, although students could play in larger teams. The intellectual teams are comprised of students who are roughly on the same level. We determined students' mathematical abilities in two ways. Students were given a pre-test on the first day that included released items from the North Carolina End of Course Math exams focusing on number sense and problem solving. In addition, MATRIX teachers used observations of students' performance and interactions during the first two days of game play. The teachers noted students' computational skills and abilities to reason through game challenges, articulate their thinking, and work collaboratively.

Games chosen for MATRIX were structured to allow students to build on their existing knowledge. The curriculum consisted of six game challenges presented to students in the following order: 'Oh No! 99!,' 'Get to 1000,' Gridworks, Sudoku, Mancala, and Mastermind. The first two games played ('Oh No! 99!' and 'Get to a 1,000') focus on computational skills and strategy development, and the curriculum then builds up to complex games that focus heavily on logical deduction, such as Gridworks and Mastermind. This article focuses on the two games ('Oh No! 99!' and 'Get to 1,000') that center on computational skills.

Using Games to Strengthen Students' Mathematical Skills

In third through fifth grades, a major goal for students is the development of number sense, including computational fluency with whole numbers. Students should become efficient and accurate in computations both mentally and in recorded thinking (National Council of Teachers of Mathematics, 2000). Mental mathematics serves as a tool to sharpen students' computational fluency (Rubenstein, 2001). In each game discussed in this article, students were completing arithmetic calculations without the use of a calculator or paper and pencil as well as thinking divergently to generate strategies to win the game challenge.

In 'Oh No! 99!' (Bresser & Holtzman, 1999), students practice mental addition and subtraction of small numbers. In this two-person card game, players attempt to force their opponent to push the sum over 99 of all cards played. In preparing to participate in this game challenge, students paired off within their intellectual teams. The teacher played a sample game, explaining how to handle each card: two through ten add their face value to the sum; aces add one; jacks subtract 10; queens are wild and can represent any card in the deck; kings add zero. After the teacher played a sample game with the class, students were instructed to play at least five games to determine a winner of the game challenge. Students completed addition and subtraction mentally and were given the chance to think strategically about the necessary moves to force their opponent to be the one who plays the card taking the sum over the value of 99.

As students played multiple games, they began to realize that it was more beneficial to hold on to certain cards until the accumulated sum reached a value over 80; students who were playing Kings, Queens, Jacks, and Aces when the accumulated sum was low realized that this was not the most optimal strategy to win the game challenge. See the ‘Oh No! 99!’ Activity at the end of this article for suggestions on how to use this game in class.

In ‘Get to 1,000’ (Bresser & Holtzman, 1999), students practice adding numbers and multiplying by powers of 10. In this two-person game, students roll a die ten times and multiply each number that comes up by 1, 10, or 100. Students then add the ten products; the total may be over or under 1,000 and the player closest to 1,000 wins the game. As the teacher played a sample game against the class, students were encouraged to complete their calculations using mental math.

As students found the sum of their ten rolls, it became clear that some students had a weak understanding of the base 10 number system. For example, when adding 5 + 60 + 600 some students got 1700 instead of 665, treating all the values as hundreds instead of hundreds, tens, and ones. As students continued to play the game, they started to realize that there were errors in their thinking. Through repeated game play and communicating with team members, students began understanding the relationships between ones, tens, and hundreds, thereby refining their computational skills. Although some students were not calculating properly and had gaps in their understanding of place value, students still attempted strategies in order to win the game challenge, thus strengthening their skills. Typically students multiplied by 100 with their first few rolls and then shifted to multiplying the value on the dice by 1 and 10. See the ‘Get to 1000’ Activity at the end of this article for suggestions on how to use this game in class.

After playing multiple games of ‘Oh No! 99!’ and ‘Get to 1,000’ students were asked to respond to writing prompts, including *what strategies did you use when playing against your partner* and *why did you use these strategies*. The written responses provided students an avenue to articulate and defend their thinking while providing teachers additional insight into students’ thought processes.

Conclusion

In this article, we discuss how games provided students with an engaging opportunity to develop their computational and strategy development skills. Additionally, the games used in the MATRIX curriculum can be implemented in classrooms for minimum cost. Playing cards and dice are inexpensive “technologies” that parents can afford and thus play these games at home with their children. As students and parents play these games, parents can become active participants in helping their children continue to develop and refine their mathematical understanding. To assist parents in effectively playing these games with students at home, a parent guide was provided to parents that contained the game instructions and materials needed for games played within the MATRIX Curriculum.

Teachers can modify the games presented in this article to further challenge students and address other mathematical concepts. For example, when playing ‘Oh No! 99!’ the red cards could represent negative integers and the black cards represent positive integers or the teacher could create a card deck with equations which students solve to determine the value of the card ($3 + \square = 10$—the value of the card would be 7). When playing ‘Get to 1,000,’ students could multiply by numbers such as 5, 15, and 25 or by decimals and fractions.

As noted in NCTM’s 2000 *Principles and Standards for School Mathematics*, “When students leave grade 5, they should be able to solve problems involving whole-number computation. . . .They should be able to solve many problems mentally…and to compute fluently with multi-digit whole numbers” (p.149). ‘Oh No! 99!’ and ‘Get to 1000’ provided students the opportunity to think strategically and articulate and defend their mathematical thinking through writing and participating in mathematical discourse within and between their intellectual teams.

References

Bresser, R., & Holtzman, C. (1999). *Developing number sense*. Sausalito, CA: Math Solutions Publications.

Hill, D., & Cook, D. (2007). *Minority access to revolutionary instructional extensions math curriculum.* (unpublished report). Chapel Hill, NC: University of North Carolina at Chapel Hill Institute of African American Research.

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

Rubenstein, R. N. (2001). Mental mathematics beyond the middle school: Why? What? How? *Mathematics Teacher*, 94 (6), 442-446.

'Oh No! 99!' Activity - *excerpt from Hill & Cook (2007)*

This game provides students with the opportunity to practice mental addition and subtraction of small numbers. In this two-person game, players attempt to force their opponent to be the one to push their accumulating score over 99. Students practice computation with addition and subtraction, and students are given the chance to think strategically. You can vary the game by having four people playing and adjusting the accumulating score to values less than 99 for younger age groups.

Materials Needed: a deck of playing cards (jokers removed) for each pair of students. Card values and operations:

2-10	add face value to the sum
Aces	add 1
Jacks	subtract 10
Queens	wild cards that can represent any other card in the deck
Kings	add zero

How to Play:

1. One player shuffles the cards and deals four cards to each player. The remaining cards are placed in a stack, face down.
2. Players take turns playing one card at a time, adding or subtracting the value of their card to or from their jointly accumulating sum.
3. Each time a player plays a card, he or she must replace it with the top card on the face down stack.
4. Play continues until one-player forces his or her partner to go over the score of 99.

Common Core Standards Addressed:

- Grade 3: Use place value understanding and properties of operations to perform multi-digit arithmetic.
    1. Use place value understanding to round whole numbers to the nearest 10 or 100.
    2. Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.
- Grade 4: Use place value understanding and properties of operations to perform multi-digit arithmetic.
    4. Fluently add and subtract multi-digit whole numbers using the standard algorithm.

Suggestions for Teaching: The introduction of this game should begin with a sample game played between the teacher and the entire class. Begin by placing students in the optimal classroom arrangement to observe the demonstration of the game; this could be a circle or semi-circle. Write the title of the game on the board and explain the rules of the game. Tell students the value of each playing card and write the value of each card on the board. It is helpful to create a set of index cards with card values and operations. Students must understand that the queen can only be a value represented in the deck. Asking students if a queen can equal zero, 15, or 100 could help clarify the rule that the queen has to represent the value of a card in the deck. Students must understand that a king is adding or subtracting zero.

For the demonstration game, use the overhead transparency cards or regular playing cards. If regular cards are used deal four cards face up to yourself and four to the class, but emphasize that when students play with their groups they should keep their cards faced away from their opponent. You should demonstrate an entire game with your students. As you play the sample game, question students as to why they decide to play a particular card.

Writing Activity: Provide students with hypothetical situations such as the total score is 85, you have four cards: a six, three, queen, and a two. Which card should you play next and why? Another potential writing prompt is what strategies the students used when playing against their partner. Have students share their written responses with the entire class.

'Get to 1000' Activity - *excerpt from Hill & Cook (2007)*

Get to 1,000 is a two-person game that gives students practice with adding numbers and multiplying numbers by powers of 10. Players roll a die ten times and multiply each number that comes up by 1, 10, or 100. Players add the ten products, the total may be over or under 1,000 and the player who is closer to 1,000 wins the game. You can vary this game by having players multiply by other factors such as 5, 25, and 50.

Materials needed: one die for each pair of students; paper and pencil

How to Play:

1. Players, in pairs, take turns rolling the die. Each player should roll the die five times. On each roll, each individual player decides to multiply the number by 1, 10, or 100.
2. Each player records his or her products on a piece of paper.
3. Players continue to roll, multiply, and add the ten products on their paper.
4. Each player finds the sum of his/her products and the player who is closest to 1,000 whether over or under is the winner.

Common Core Standards Addressed:

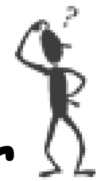
- Grade 3: Use place value understanding and properties of operations to perform multi-digit arithmetic.
    1. Use place value understanding to round whole numbers to the nearest 10 or 100.
    2. Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.
    3. Multiply one-digit whole numbers by multiples of 10 in the range 10–90 (e.g., 9 × 80, 5 × 60) using strategies based on place value and properties of operations
- Grade 4: Generalize place value understanding for multi-digit numbers.
    1. Recognize that in a multi-digit whole number, a digit in one place represents ten times what it represents in the place to its right. For example, recognize that 700 ÷ 70 = 10 by applying concepts of place value and division.
    3. Use place value understanding to round multi-digit whole numbers to any place
- Grade 4: Use place value understanding and properties of operations to perform multi-digit arithmetic.
    5. Multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers, using strategies based on place value and the properties of operations. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.
- Grade 5: Understand the place value system.
    1. Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left.
    2. Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power.

Suggestions for Teaching: Play a sample game for students with the teacher against the class. Have each student keep track of the products and accumulating total for the class. Explain that the purpose of the game is to get as close to 1,000 as possible after 10 rolls and emphasize the final total can be greater than or less than 1,000. You can use overhead or regular die. Roll the die and explain your thinking as to why you multiplied by 1, 10, or 100 and ask the class to explain why they multiplied by 1, 10, or 100. Keep track of your ten products. Encourage students to do multiplication and keep track of their accumulating total score in their head. After completing 10 rolls, have students calculate the class sum individually. It is good to have different students place their work and total score on the board. If students have different answers, have a class discussion to determine which total score is correct and why.

Have students play in groups of two while you walk around to observe if students are playing the game correctly and keep a list of strategies you observe them using and any comments they make about why they are using a particular strategy.

Writing Activity: Have students discuss the strategies used in an attempt to win the game and if those strategies worked.

Problems to Ponder



Spring 2013 Problems

Holly Hirst, Appalachian State University, Boone, NC

Grades K–2: Sha'Nica has beads to string on a necklace. There are 7 green beads. There are 3 fewer yellow beads than green beads. There are 2 more red beads than yellow beads. How many beads are there of all colors combined?

Grades 3–5: The average of 4 numbers is 32. What would the fifth number in the average have to be to bring the average down to 30?

Grades 6–8: Replace each blank with an operation to make the following statement true:

$$100 = 1 \_ 2 \_ 3 \_ 4 \_ 5 \_ 6 \_ 7 \_ 8 \_ 9$$

Grades 9–12: In Zona-Lata Land, each married couple is expected to continue having children until they have either one child of each sex or a total of four children. What is the average number of children born to each couple in Zona-Lata Land?

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.

Proper acknowledgement is contingent on legible information and solutions.

Send solutions by 1 June 2013 to:

Problems to Ponder, c/o Dr. Holly Hirst
BOX 32068 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.

SOLUTION: Grades K–2 Fall 2012 Issue

Grandma keeps 10 chickens in her farm yard. Three of them laid eggs. They laid 6 eggs each. A fox stole 7 eggs. How many eggs are left?

Example Correct Solution by Victoria Eckman (Grade 1 at Badin Elementary (Ms. Burleson)).

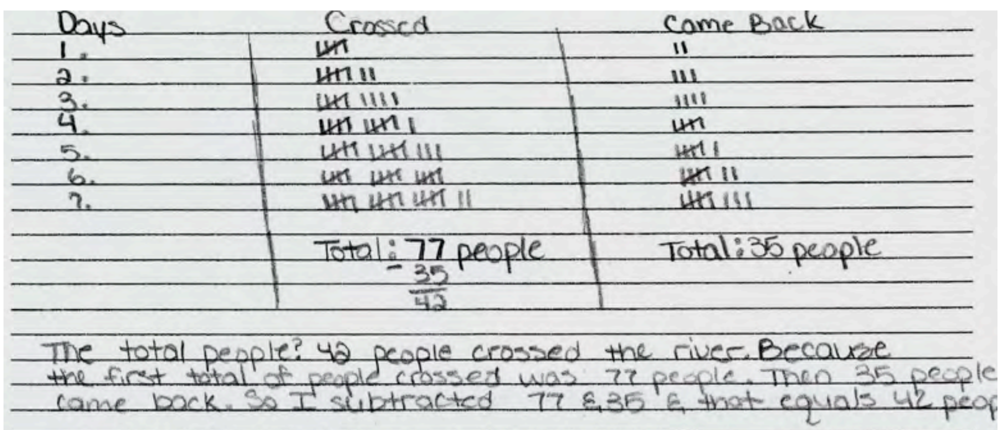
Correct Solutions were submitted by

- **Badin Elementary** (Ms. Burleson): Abigail Storms; Victoria Eckman

SOLUTION: Grades 3-5 Fall 2012 Issue

People come to the state park to camp and must cross a river to get to the best camp sites. On the first day 5 crossed over and 2 came back. On the second day, 7 crossed over and 3 came back. Then 9 crossed over and 4 came back. If this pattern continues for a total of 7 days, how many people would be across the river at the end of the week?

Example Correct Solution by Jaylen Smith (Grade 5 at Ahoskie Elementary School (Mrs. Bright)).



Correct Solutions were submitted by:

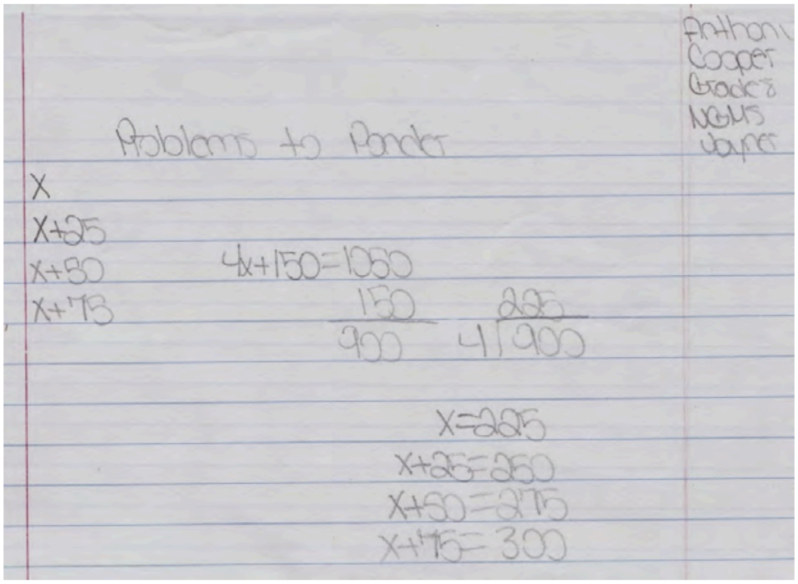
- **Agape Christian Academy** (Ms. Forkner): Logan Richardson; (Ms. Graham): Max DeNamar
- **Ahoskie Elementary School** (Ms. Brown): Brianna; (Mrs. Bowser): David Spraill, Kenton Valentine, Kyree Pitt, Tyler; (Mrs. Bright): Ashanti Ridley, Jacob Branch, Jaylen Smith, Ty Britt; (Mr. Pitpit): Ashlee Weaver, Michael Bradley; (Ms. Roscoe): Blake Byrum, Jada Perry, Xzayviere; (Ms. Watford): Annabea Smallwood, Brianna Outlaw, Cheyenne Sutton, Christopher Langston, Daryl Wilson, Elisha Sinson, George Earl Freeman, Gregory Carter, Jasmine Devel, Jayme Watson, Jenice Huguley, Kareem Warren, Maurice Garrett Jr, Morgan Chadwick, Na'Shya Smith, Trinity Everett
- **Normandy Park School (New Jersey):** Scott Marvin

Editor's Note: Many students recognized the pattern, but reported 9 – the number who stayed on day 7 – instead of the total number of people who stay (3+4+5+6+7+8+9).

SOLUTION: Grades 6-8 Fall 2012 issue

A biologist caught a total of 1050 lightening bugs on four consecutive nights. Each night she caught 25 more than on the night before. How many did she catch on each night?

Example Correct Solution by Anthony Cooper (Grade 8 at Northern Granville Middle School (Ms. Joyner))



Correct Solutions were received from

- **Ahoskie Elementary School** (Ms. Chlomoudis): Amijah Beverly, Angel Rascoe, Dashunda, Kaleb Jones, Lydell Carter, Nicholas Ellis, Ny'Aigah Cooper, Victoria Harrell, Zack Wise; (Ms. Hines): Alyssa Lockwood; (Mr. Kenon): Ashley Lassiter, Camille, Christopher Smith, Ja'Juan, Justin Goodwin, Kalyssa Ortiz, Orrin Gatling, Steven Hollingsworth, Tia Thompson, Zaria Hunter
- **Bertie Middle School** (Ms. Brittenham): Armani Speller, Bailey Mizell, Damian Morgan, Jason Cohan, William Corey; (Mrs. Carlton): Aaliyah Askew, Austin Burkett, Carrington Dudley, Charlie Jenkins, David Ratzlaff, Demetrice Futiell, JaQuila Cherry, Jayson Jones, Norman Razor, Tattianna Cofield, Trejon Watford; (Mrs. Jefferson): Angel Baker, Ashton Earls, Elijah White, Emily Spivey, Jordan Simmons; (Mrs. Lee): C.J. Williams, Jacob Brumley, Lauren Farless, Latavia Coffield, Shanique Demery, Tatyana Taylor, Trenton Hayes; (Mrs. Ruffin): Ashley Bell, Jania Leary, Jaylynn Dama, Nyasia Slade, Shaylene Andino; (Mrs. Sauls): Tyrek Perry; (Mrs. Smallwood): Aniya Williams, Antwan Askew, Cartrell Speller, Cody Burton, Darius Davis, Ebony Slade, Emma Hughson, Haley Belangia, Imunique Mann, Jonathan Powell, Justin Cowan, Lance Freeman, Marcilla Demry, Marquez Wiggins, Megan Williams, Shakira Bond, Sha'Nidra Smallwood, Zachary Pearson; (Mrs. Tyson): Amira Greer, E'Nijena Waring, Ja'Kiese Freeeman, Raquan Whittingham, Rashaad Edney, Raven Stokes, Zackias Williams
- **Northern Granville Middle School** (Mrs. Joyner): Alexis Pifer, Amber Wilkerson, Brittany Johnson, Brian Clary, Dominic Madden, Dustin Holmes, Isaac Saleh, Jack Rivers, Kristie Lumpkin, Mariam Assaedi, Matthew Davis, Maya Burwell, Monica Botros, Myra Arrington, Nicarda Fields, Patrick Koshadu, Sabrina Parker, Shymora Stewart, Zoe Lewis
- **South Asheboro Middle School** (Mr. Cagle): Erin Devilbiss, Julia Cruz, Makenzie Perdue, Taylor Shae Fields; (Mrs Myers): Edith Mata, Emma Trotter, Jacob Lawrence, Laney Cooper, Mason Corey, Matthew Agudeo, Morgan Brower, Noah Deaton; (Mrs. Runnfeldt): Angel Zheng, Ashley Allred, Audrey Havens, Austin Callicutt, Destiny Townsend, Gage Burlingame, Garrett Harvell, John Cernava, Kalyn Alvarez, Michael Cornelison, Saul Badillo, Taylor Phillips, Whitney H., Zoe Roberts

SOLUTION: Grades 9-12 Fall 2012 Issue

The four numbers $a < b < c < d$ can be paired in six different ways. If each pair has a different sum, and if the four smallest sums are 1, 2, 3, and 4, what are all possible values of d?

Partial Correct Solution by Addison Higgins (Grade 7 at South Asheboro Middle School (Mr. Cagle)).

Editor's Note: Addison found one of the two solutions. Can you see where the other solution comes from?

a<b<c<d

paired six different ways

a+b

a+c

a+d

b+c

b+d

c+d

a+b=1
a+c=2
a+d=3
b+c=4

4 smallest sums are 1, 2, 3, 4

What are all possible values of d?

Solve for c

b+c=4

b-b+c=4-b

c=4-b

Solve for a

a+(4-b)=2

a+4-b=2

a+4-4-b=2-4

a=b=-2

Add the two:

a+b=1

a-b=2

a+a+b-b=-2

2a+0=-1

2a=-1

divide by 2:

2a/2=-1/2

a*(2/2)=-1/2

a*(1)=--1/2

a+d=3

-1/2+d=3

-1/2+1/2+d=3+1/2

d=3+1/2

d=3.5

Awards

2012 Outstanding Secondary Mathematics Teachers

Each year principals of North Carolina schools were encouraged to nominate the teacher they believe does the most effective job teaching mathematics in their school. From those nominated, each LEA selects one teacher to represent the best in mathematics teaching from the entire school system.

This recognition cycles each year between the grade levels. This year the teachers being recognized are secondary mathematics teachers.

Heather Stephan, Alamance Burlington
Elisabeth Turner, Alexander
Christina Pennington, Ashe
Michael Hynd II, Asheboro City
Laura King, Avery
Christina Petty, Beaufort
Stephanie Wild, Bertie
Sherry Autry, Bladen
Laura Hickman, Brunswick
Stefanie Buckner, Buncombe
Katherine Caraway, Burke
April Wingler, Cabarrus
Dawn Janee' Lowman, Caldwell
Katie Salter, Carteret
Alina Castillo, Chapel Hill/Carrboro
Adia McEachin, Cumberland
Lindsey Cahoon, Currituck
Tom Haske, Dare
Billie Bauer, Durham
Rhonda Tynch, Edenton/Chowan
Armenia Davis, Franklin
Martha Marshall, Guilford
Kamisha Smith, Halifax
Tisa Futch, Henderson
Queen Esther Hollingsworth-Shaw, Hoke
Cindy Ensley, Jackson
Kelly Stanforth, Johnston
Molly Charles, Kannapolis City
Cheryl Rouse, Lenoir
Lori Haight, Lincoln
Steven Kennedy, Charlotte/Mecklenburg
April Daywalt, Montgomery
Michael Apple, Moore
Lisa Oliver, Mooresville City
Kimberly Parker, Nash/Rocky Mount
Susan Robbins, New Hanover
Ashley Leary, Pamlico
Daniel Henrikson, Pender
Kimberly Tyson, Perquimans
Anita Koen, Pitt
Talia Swiney, Richmond
Daniel Herring, Rowan/Salisbury
Amy Owens, Rutherford
Dara Hyatt, Scotland
Kimberly Williams, Stokes
Jenny Barnes, Surry
Philip Fisher, Transylvania
India Joyce Kingsberry, Vance
Lauren Brooks, Wake
Michael Jones, Washington
Stephanie Long, Watauga
Gail Rena Mason, Wayne
Jessica Llewellyn, Wilkes
Carol Taylor, Winston-Salem/Forsyth
Jackie McCarn, Yadkin
Kristin Martin, Orange Charter School

2013 NCTM Annual Meeting

Denver, CO, April 17-20, 2013

Come to NCTM's annual meeting to learn more about current math education topics, such as the Common Core, response to intervention, assessment, research, reasoning and proof, technology, and STEM. More than 700 sessions, workshops, and burst presentations await you in the Mile-High City. Take home tools and strategies that you can immediately apply to help your students grow and succeed. This is ***THE*** math education event you can't afford to miss.

To learn more and register, go to www.nctm.org/denverreg/

Awards

2012 Outstanding Mathematics Education Students

Reported by Bampia Bangura, NC A&T State University, Greensboro, NC

Each Fall, NCCTM sponsors the selection of three Outstanding Mathematics Education Students. It is the task of the Special Awards Committee to identify the most outstanding mathematics education student from each region. Nominations are requested from all colleges and universities in North Carolina with teacher preparation programs. Top award winners are recognized at the Awards Program at the State conference in the fall.

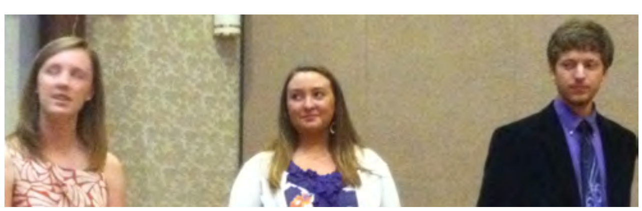
The recipients of this year's awards are: Timothy (Ryne) Cooper from East Carolina University in the Eastern Region, Sandra Weiss from Elon University in the Central Region, and Hannah Watson from Western Carolina University in the Western Region.

TIMOTHY (RYNE) COOPER is a double major with in mathematics education and mathematics at East Carolina University. A Mathematics Teaching Fellow, Mr. Cooper has been very active in the Mathematics and Mathematics Education related activities at ECU. He is a member of the NCCTM student chapter at ECU, and an NCCTM student board member representing the Eastern Region. He resented at the 2011 NCCTM Fall Conference in Greensboro. He has a passion for Mathematics. His professors described him as an exceptional student and a natural scholar. He plans to teach in a STEM high school.

SANDRA J. WEISS is a mathematics education major at Elon University. Ms. Weiss has been involved in many aspects of the mathematics and mathematics education program. She is a member of the Math Education Advisory Committee and a student member of the Teacher Education Committee. She has not only provided tutoring for elementary and high school students in mathematics, she has also acted as a Teaching Assistant for a university math class. She has completed a two-year case study, the results of which she plans to present at this NCCTM Fall conference. She also has extensive involvement in the community. She is described by her professors as a very bright, caring, and highly motivated individual who seeks to deepen her understanding beyond the classroom.

HANNAH WATSON is a senior at Western Carolina University completing a degree in mathematics with a concentration in secondary mathematics education. Ms. Watson is very active in the mathematics and mathematics Education programs at Western Carolina. She made a presentation on the History of mathematics at the Smoky Mountain Undergraduate Research Conference. As a result of that presentation, she was invited to publish her paper in the MAA online journal. In addition to attending talks and group activities, she also participated in the 2011 NCCTM Fall Conference in Greensboro. She has been an active volunteer in working with students through after school activities. In addition to her mathematics related activities, Ms. Watson participated in several other campus activities including events with the WCU Mountain Heritage Festival in 2009. Her professors indicate that in everything Hannah does she demonstrates responsibility, organization, and commitment to hard work.

Congratulations to these students!



Sandra J. Weiss, Hannah Watson, and Timothy (Ryne) Cooper
(photo courtesy of Tracie Salinas)

Awards

2012 W. W. Rankin Award Winners
Dr. Ann Crawford and Dr. Deborah A. Crocker

Reported by: Lee Stiff, North Carolina State University, Raleigh, NC

At its 42nd Annual State Mathematics Conference held in Greensboro, NC on 25-26 October 2012, the North Carolina Council of Teachers of Mathematics (NCCTM) presented Dr. Deborah Ann Crocker, Appalachian State University, and Dr. Ann Crawford, University of North Carolina at Wilmington, with the W. W. Rankin Memorial Award for Excellence in Mathematics Education. The Rankin Award is the highest honor that NCCTM can bestow upon an individual.

Rankin Award Recipients
Ann Crawford (right) and Deborah Crocker
(photo courtesy of Tracie Salinas)

Ann Crawford

Dr. Crawford was recognized for her 40 years of service to the profession and NCCTM, especially in the realm of curriculum development. She was cited as never failing "…to provide up-to-date, creative, and inspiring materials and lessons for professional development that were immediately applicable in the classroom." She was also recognized as a scholar, an outstanding teacher of mathematics, and a person whose service to NCCTM and mathematics education has been exemplary.

Dr. Crawford is perhaps best known for her outstanding service to the state via her contributions as the Director of the NC MATH Algebra Project, a statewide in-service project that served many hundreds of North Carolina mathematics teachers; the Assistant Director of the Center for Mathematics and Science Education; and the Director of NC Success in Algebra Institute of the NC Department of Public Instruction.

Of Dr. Crawford it was said, "I can honestly think of only a handful of mathematics educators who have been so consistent a force for positive change in…North Carolina schools." Dr. Crawford "…is committed to teachers and teacher candidates, and is someone who represents the best that mathematics education has to offer in North Carolina."

Deborah Crocker

Dr. Crocker was recognized as a tireless and effective mathematics educator with more than 30 years of service to the profession. As an expert in using graphing calculators, programming, and computers to enhance mathematics instruction, and through her publications and workshops, she has helped mathematics teachers in North Carolina to make effective use of 21st Century technologies. Dr. Crocker has authored numerous scholarly publications and has presented or co-presented more than 100 sessions and workshops at NCCTM and National Council of Teachers of Mathematics (NCTM) meetings.

Dr. Crocker is perhaps best known for her outstanding service to the state via her contributions to NCCTM for which she has served in numerous leadership positions, including NCCTM Regional President, Annual Conference Chair, NCCTM Representative to NCTM Caucuses and Delegate Assembly, Co-editor of the NCCTM publication, the Centroid, and President-Elect of NCCTM.

Of Dr. Crocker it was said, "…her singular focus on improving the education experiences of mathematics students by assisting both pre-service and in-service teachers in improving their practice…demonstrates her untiring devotion to helping improve mathematics education in North Carolina."

Awards

2012 NCCTM Innovator Award Winner: The NCCTM Celebrations (Math Logo Contest) Committee/Coordinators

Reported by: Janice Richardson, Elon University, Elon, NC

The purpose of the NCCTM Innovator Award is to recognize and reward individuals or groups who have made an outstanding and noteworthy contribution to mathematics education and/or NCCTM. This award honors the individual or group who has founded, initiated, pioneered, or developed some program in mathematics education of service to a geographic region of the state or the entire state. Also, the program must have been sustained for a period of at least three years. This year's recipient is the Celebrations (Math Logo Contest) Committee and the coordinators over the years.

The recipient of the Innovator Award is a group that has made significant contributions to the entire state for almost 30 years by coordinating the math logo contest. Typically, four finalists are named each year from each of the three geographic regions in the grade bands of K-2, 3-5, 6-8, and 9-12. From these 12 finalists, a state winner is selected. All you have to do is just look around you and you will see how this group has influenced the spread of "math love" across all classrooms of North Carolina, kindergarten to the twelfth grade. Here is a sample of the winning logo captions:

Math is Shaping Our World
Math Exercises the Mind
Math and You…a Great Combination
Get Hooked on Math
Build a Solid Foundation with Math
Math: The Sign of the Times of Math the Wave of the Future
Get Rooted in Math
Math Rules!
Math a Tune You can Count On
Climb New Heights with Math
"SUM" of My Best Friends Study Math
Math is the Universal Language
Math Makes the World Go Round
Revolve Around Math
Math Makes Wonders

Can you visualize these phrases with some really good artwork? Let me give you some stats over the years. Did you know that in 1984, the Centroid reported that there were more than 3,000 entries received? And there were 50 billboards with the logo *Math Adds up to a Brighter Future*. And the Centroid reports in 2005 that there were approximately 3,600 entries—does anyone remember the logo and color of that shirt? *Math Makes the World go Round*, and the color was medium blue.

We thank this committee and the coordinators for all they have done to spread such enthusiasm throughout the state. It makes us all proud to see the good work of our students, not just the winners, but all who participated.

Recent Coordinators, pictured from Left to Right: Emily Elrod, Tracie Salinas, Jan Wessell, Lisa Carnell, Vickie Moss, Amy Travis *(photo courtesy of Tracie Salinas)*

Awards

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 the online form. Nominations are accepted at any time.

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

For more information, please see the website or contact:

Lee V. Stiff
326-D Poe Hall, Box 7801
North Carolina State University
Raleigh, NC 27695-7801
lee_stiff@ncsu.edu

Innovator Award Nominations

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. NCCTM accepts nominations for the Innovator Award at any time.

For more information, please see the website or contact:

John Parker
316 West Soundside Road
Nags Head, NC 27959

For nomination forms and additional information, see www.ncctm.org/awards.cfm

NCCTM Trust Fund Scholarship

North Carolina Council of Teachers of Mathematics

$600 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 Chair
1302 Oakview Dr.
Greenville, NC 27858

Direct inquiries to:
Robert Joyner, Chair
phone: (252) 756-6803
e-mail: rjoyner3@suddenlink.net

(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.

Internal Revenue Information for Grant Recipients: Please be aware that NCCTM is required to report all grants of $600.00 or more to the Internal Revenue Service. In such a case you will receive an IRS Form 1099-MISC from NCCTM. However, you should be able to avoid the payment of any income tax on this. NCCTM has been advised that, if you receive one of the NCCTM grants, you must include the grant proceeds in income unless you made a binding commitment to have the proceeds paid directly to the sponsoring school.

NCCTM Board

Officers

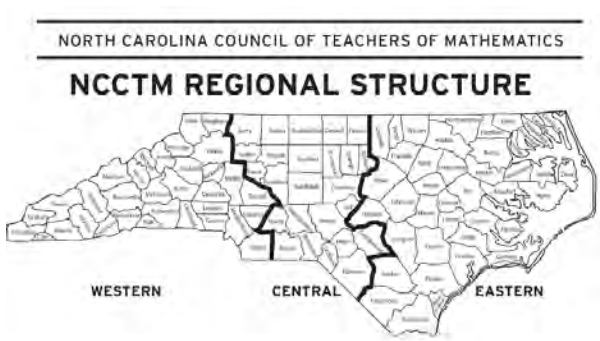
	State	Eastern Region	Central Region	Western Region
President	Betty Long LongBB@appstate.edu	Ron Preston prestonr@ecu.edu	Pat Sickles pat@sickles.org	Katie Mawhinney mawhinneykj@appstate.edu
Elementary Vice President	Donna Thomas dthomas@hcs.k12.nc.us	Amy Janning amyjanning@wcps.org	Melissa McKeown mmckeown@randolph.k12.nc.us	Marta Garcia marta.garcia@bcsemail.org
Middle Grades Vice President	Elizabeth Murray elizabeth.murray@nhcs.net	Lynnly Martin lynnlym@aol.com	Amy Travis hatravis@bellsouth.net	Karen Perry perryk@wilkes.k12.nc.us
Secondary Vice President	Maria Hernandez hernandez@ncssm.edu	Wayne Williams wwilliams@dpi.state.nc.us	Beth Layton blayton@wsfcs.k12.nc.us	Karen McPherson karen.mcpherson@bcsemail.org
College Vice President	Debbie Crocker crockerda@appstate.edu	Tony Thompson thompsonan@ecu.edu	Holt Wilson phwilson@uncg.edu	Charles Wallis wallisc@brevard.edu
	Tim Hendrix hendrixt@meredith.edu, Secretary	Ryne Cooper cooperti09@students.ecu.edu, Student Representative	Toi Jones tdjones4@ncat.edu, Student Representative	Bridget Metcalf metcalfbr@appstate.edu, Student Representative

Committee Chairs

Centroid Editors	Holly Hirst, hirsthp@appstate.edu, and Debbie Crocker, crockerda@appstate.edu
Centroid Ads	Ray Jernigan, jernigan@suddenlink.net
Computer Services	Bill Scott, wejlscott@carolina.rr.com
Convention Services	Marilyn Preddy, mbpreddy@uncg.edu
Financial Chair	Jan Wessell, jwessell@ec.rr.com
Handbook Revision	Julie Kolb, jkolb@wcpss.net
Historian	Kathryn Hill, kvgh@hotmail.com
Management Services	Rebecca Hoover, rebecca@hoovercpa.com
Math Celebrations	Emily Elrod, asumathteacher@gmail.com, and Tracie Salinas, salinastm@appstate.edu
Math Contest	James Beuerle, jbeuerle@elon.edu, and Philip Rash, rash@ncssm.edu
Math Counts	Harold Reiter, hbreiter@uncc.edu
Math Fair	Debbie Crocker, crockerda@appstate.edu
Minigrants	Sandra Childrey, schildrey@wcpss.net
NCDPI Representative	Kitty Rutherford, krutherford@dpi.state.nc.us
NCSSM Representative	Ryan Pietropaolo, rpietropaolo@moc.edu
NCTM Representative	Debbie Crocker, crockerda@appstate.edu
Nominations	Wendy Rich, wrich@asheboro.k12.nc.us
Parliamentarian	Julie Kolb, jkolb@wcpss.net
President NC MATYC	Nancy Rivers, njrivers@waketech.edu
Rankin Award	Lee Stiff, lee_stiff@ncsu.edu
Special Awards	Bampia Banguria, babangur@ncat.edu
Student Affiliates	Lisa Carnell, lcarnell@highpoint.edu
Trust Fund	Robert Joyner, rjoyner3@suddenlink.net

Becoming a Member

Follow the "Membership Information" link on the ncctm.org website,
or go directly to: http://www.ncctm.org/members/register.cfm



North Carolina Council of
Teachers of Mathematics
PO Box 4604
Cary, NC 27519

Non-Profit Org.
U.S. Postage
PAID
Raleigh NC
Permit No. 292