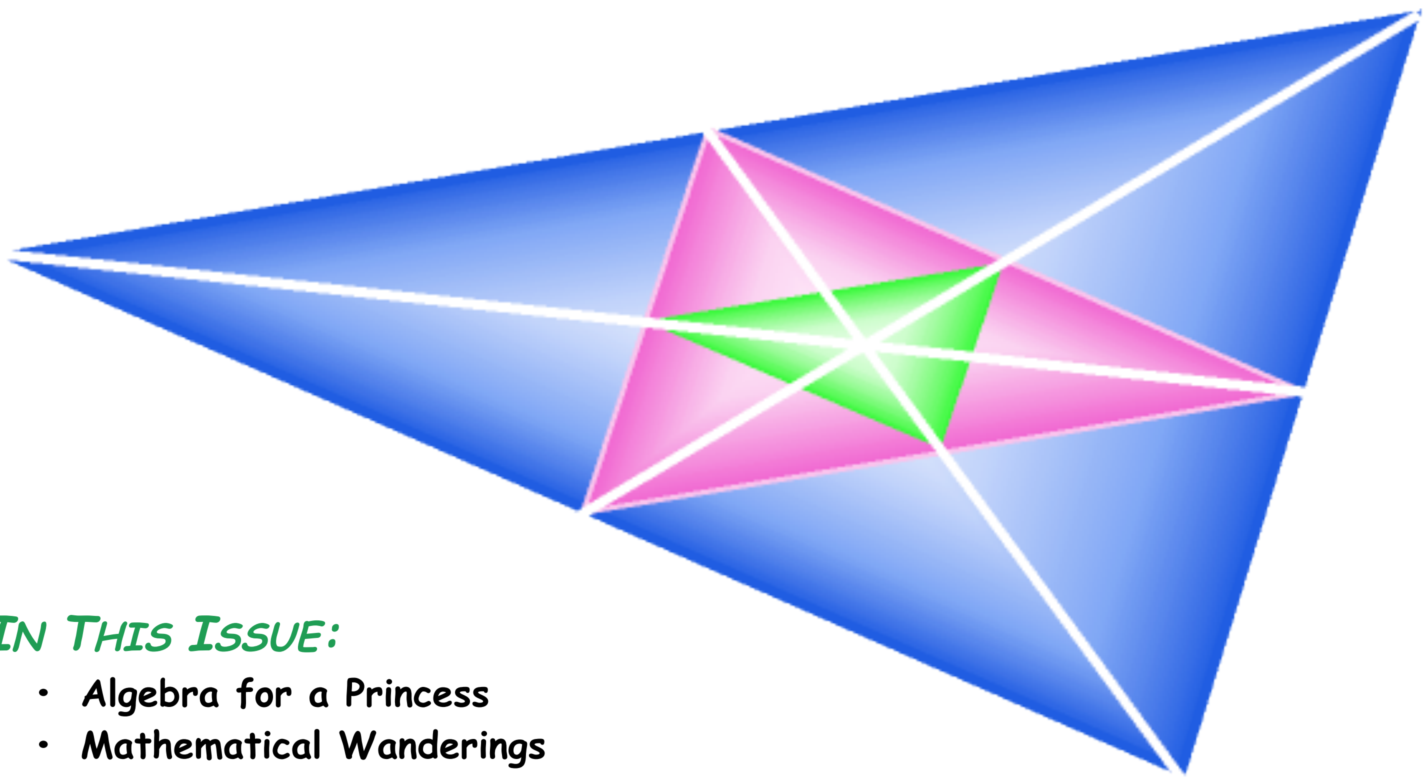
The Centroid



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- 2006 Rankin Award Winners

Official Journal of the North Carolina Council of Teachers of Mathematics
Volume 33 • Number 1 • Spring 2007

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

Submission of Manuscripts

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

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

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

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

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

North Carolina Department of Public Instruction. (1999). *North Carolina standard course of study: Mathematics, Grade 3* [On-line]. Available: http://www.ncpublicschools.org/curriculum/mathematics/grade_3.html

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

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

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

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

About the Cover

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

Copyright

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The Centroid

OFFICIAL JOURNAL OF THE NORTH CAROLINA COUNCIL OF TEACHERS OF MATHEMATICS
VOLUME 33 • NUMBER 1 • SPRING 2007

Articles

News & Information

From the Editor

The Centroid Goes On Line

Holly Hirst
Appalachian State University
Boone, North Carolina

News flash! The NCCTM website is becoming your place for "one stop shopping" for news, notes, and fun. Starting with the Fall 2007 issue of the Centroid, you will be able to access full text on line. In fact, you can help us save costs by reading the Centroid on line and dispensing with the paper copy. We also know that many of you prefer to read on paper or get the word out about NCCTM by sharing the Journal with your colleagues. Those of you who wish to continue to receive the Centroid on paper in the mail can request this service by returning the form below.

We hope you enjoy this issue. We have included articles about a 12th century Indian math text and planning a constructivist lesson, and we are introducing a new column by Wendy Rich, mathematics curriculum specialist for the Asheboro City Schools, entitled Mathematical Wanderings, which will appear in *The Centroid* each Spring. Wendy's inaugural column details an interview with NCTM President Cathy Sealey on the new curriculum focal points.

As always, we encourage you to consider assisting with *The Centroid* by:

- **submitting a manuscript** – general articles are welcome, as are the following special categories of articles: *A Teacher's Story*, *History Corner*, *Teaching with Technology, It's Elementary!*, *Math in the Middle*, and *Algebra for Everyone*.
- **becoming a reviewer** – please send e-mail to me if you are interested in helping in this way.

Contact information. Feel free to contact us at any time with submissions, news items, questions, or concerns.

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Continue to Receive the Centroid (Paper)

I wish to continue to receive a paper copy of the Centroid in the US Mail. Requests received by May 1 will be honored for Fall 2007.

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Presidents' Messages

State President
Jeane Joyner

joynerj@meredith.edu

Each new year seems more challenging than the previous one for educators involved in mathematics teaching and learning, and 2007 promises to be no exception!

In addition to the on-going responsibilities of our regular jobs, NCCTM members will be involved in NCCTM Board member elections, math contests, math fairs, spring and fall conferences, committee work for the organization, a revision to the North Carolina Mathematics Curriculum, and the start-up of the textbook adoption process for mathematics. Mini-grant winners are at work on their projects; the current regional and state NCCTM officers are at work on plans for four conferences. If you have not already registered for one of the three spring conferences, please do so right away.

NCCTM is moving toward more and more on-line features (be sure to read about plans for the Centroid); we are continually seeking ways to provide significant services to all of our members. Look for links to the State Math Contests, forms for Math Fair entries and the logo contest, and speaker proposal forms for the fall annual conference.

Since up-grading our website to serve you more effectively is one of the goals for 2007, we are interested in your feedback. Send comments to me or to the NCCTM email address <info@ncctm.org>. The member login at our website allows you to change your personal information at any time. By keeping your email current, you will receive updates from the organization when there are new postings on the website. If you do not have an email account, you will still be able to enjoy all of the features of the website, including the "members only" link that will become active later this year, by logging on from any computer. Knowing your NCCTM member number is a key. It can be found on the mailing label used to send this journal to you.

An important opportunity in which NCCTM members need to be involved is the revision of the Standard Course of Study for Mathematics. During 2007 the Mathematics Consultants at the Department of Public Instruction will be working with educators from across North Carolina to improve our state mathematics curriculum. While the time is short – the plan calls for recommendations to go to the State Board before the end of the year – the timing is excellent. We are positioned to have new goals and objectives in place as the call goes out to textbook companies for our next mathematics adoption. What makes this such a critical curriculum revision is that the textbooks we adopt are to be the ones we use in our classrooms through 2014. Now is the time for you to become involved.

In May new state and regional presidents take over the leadership of NCCTM. Randy Harter from Buncombe County will become the new state president. Debbie Crocker becomes president of the western region; Becky Caison becomes president of the central region; Rose Sinecrope becomes eastern regional president. Each of these leaders will bring to NCCTM new ideas and fresh enthusiasm for our work as educators. Thus, I say to you "thanks." Thanks for giving me an opportunity to serve as NCCTM President for the past two years; thanks for your professional involvement along with me; and most of all, thanks for the work you continue to do for the students in North Carolina

Eastern Region President
Julie Kolb

jkolb@wcpss.net

Greetings to and from the members of the Eastern Region. Isn't it amazing how quickly the school year goes by? I hope that you are enjoying your students and that you continue to feel rewarded in your choice of profession. I'm certain that we'll all do our best to make 2007 another great year!

I appreciate the opportunity that I have had to serve as Eastern Region president for the past two years, and I look forward to working with Rose Sinecrope in her role as president. These two years have been filled with many changes for our organization under the fantastic leadership of our president Jeane Joyner. It has been a pleasure to work with Jeane and the other members of the board; I know that you join me in thanking her (and the rest of the board) for her dedication to our organization and for her positive leadership.

The Fall Conference in Greensboro was a great success! The sessions and workshops presented many opportunities to add new activities to our classroom instruction. While the pace was hectic, it was fun to see former colleagues, to be inspired by new ideas, and to visit with the people who motivated and encouraged us to become teachers.

The Spring Conference is moving to Wesleyan College in Rocky Mount this year; we are hopeful that this change in location will make the conference more accessible to our membership “down east.” An exciting program is planned around the theme “Mathematical Tapestry: Weaving the Strands.” Jeane Joyner will deliver the keynote address at 9:00 AM on Saturday, February 17, 2007; sessions will last until 1:00 PM. Thanks to Ray Jernigan, Eleanor Pusey, and Gail Stafford for all of their hard work in making the conference a success. Information about all the conferences can be found on our website <www.ncctm.org>.

In addition to conference information, you will find other helpful and interesting information on our website – including future issues of the Centroid. I hope that you will take advantage of all that our organization has to offer in the areas of professional growth and networking. Remember that we are an organization of volunteers who are deeply committed to our profession and there are many ways that you could assist us. Perhaps you would like to volunteer to serve as an officer or present at or work at a conference; please feel free to contact any officer to express an interest in working with us. Enjoy the rest of your school year!

Central Region President
Emogene Kernodle

nekernodle@yahoo.com

It has been a fast two years. We have encountered many changes in mathematics education and NCCTM during this time. We’ve implemented a new state mathematics curriculum and with that new EOG and EOC tests. NCCTM has a new management services team and has taken great strides with online conference registrations, online renewal of membership, and online voting.

The Central Region decided to “think outside of the box” for our Spring Conference. With the Fall State Conference in our own backyard, we decided to look around the region for resources that may be a little different from traditional spring conferences. This spring, our conference will be at The Natural Science Center in Greensboro on February 24. After the conference, members may visit the Central Region Math Fair that will be at Greensboro College on the same day.

I would like to thank Sylvia Davis, Karen Ellis, Angela Flowers, Vincent Snipes, and Elaine Tucker for their dedicated service and support during this biennium. Your regional officers selected mini-grant winners, math logo contest finalists and winners, obtained speakers for conferences, and transported materials from one management team to the other. Our region will be in good hands as Becky Caison begins her term as Central Region President.

In closing, serving as your Central Region President has been an honor and privilege. I appreciate all of your help and dedication to mathematics education.

Western Region President
Carmen Wilson

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Happy New Year from the Western Region! In this time of “rigor, relevance, and relationship,” it is certainly an exciting time to be a mathematics educator. I hope that many of you are planning to come to the 2007 Western Region Mathematics Conference on the campus of Jacobs Fork Middle School in Catawba County on February 24^{th}. Once again we will be hosting a “conference within a conference.” Pre-service teachers will attend sessions for grade bands K-2, 3-5, or 6-8 led by outstanding educators in our field. Our in-service conference will feature sessions for teachers in K-2, 3-5, 6-8, and 9-12 grade spans. Session leaders include some of our state’s best classroom teachers as well as the math folks from the Department of Public Instruction. Check-in will be at 8:00 AM. Sessions will begin at 9:00 AM and will end at 1:00 PM. There will be a morning snack break. You may register online <www.ncctm.org>. If you need more information you may contact me by email or phone <336-246-2400>.

The 2007 Western Region Math Fair will be held on Saturday, March 31^{st}, at Appalachian State University. Students attending school in North Carolina are eligible to enter the Math Fair. Projects may be entered in the following categories: Grades K-2 (individual or class projects), Grades 3-5 (individual or class projects), Grades 6-8 (individual projects), or Grades 9-12 (individual projects). Projects must be pre-registered to be accepted for competition, and there is a limit of 9 projects per category per school. On the day of the Math Fair, each project must be represented by one or two students whose names appear on the project, and the projects must be checked in at the registration desk between 9:00 and 9:30 AM. For more information and a registration form, contact Dr. Betty B. Long <longbb@appstate.edu; 828-262-2372>.

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History Corner

Algebra for a Princess

Dr. Alfinio Flores[1]
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Tempe, Arizona

Seldom in the history of mathematics do we have a book of arithmetic and algebra named after a beautiful young girl. Bháskara the Learned (also known as Bhaskaracharya), named his book *Lilavati* after his daughter. Her name means beautiful. Bháskara was a mathematician and astronomer who lived in India between the years 1114 and 1185 AD. Several of the problems in the book are explicitly addressed to his daughter.

> ***16.*** *Beautiful and dear Lilavati, whose eyes are like a fawn's! Tell me what are the numbers resulting from 135 [multiplied by] 12? .... Tell me, auspicious woman, what is the quotient of the product divided by the same multiplier?* (Bháscara, 1971, p. 6)

Other problems let us know more about this charming girl. She is described as "pretty girl with tremulous eyes" (example 49), and as a lovely woman, intelligent, and a skillful calculator (see examples 13, 37, 58, 68 at the end of the article). One cannot help but wonder, who was this pretty girl? Why does she have tremulous eyes? Why is she asked to solve problems like these?

We also learn a little about the life around Lilavati. Examples are often set in rich, splendorous, and romantic settings:

> ***100***. *Four jewelers, possessing respectively eight rubies, ten sapphires, a hundred pearls, and five diamonds, present, each from his own stock, one apiece to the rest in token of regard and gratification at meeting: and they thus become owners of stock of precisely equal value. Tell me, severally, friend, what were the prices of their gems respectively?* (Bháscara, 1971, p. 45)

> ***114.*** *In a pleasant, spacious and elegant edifice, with eight doors, constructed by a skilful architect, as a palace for the lord of the land, tell me the permutations of apertures taken one, two, three, &c.* (Bháscara, 1971, p. 50)

The following example is from one of the commentaries.

> *The third part of a necklace of pearls, broken in an amorous struggle, fell to the ground: its fifth part rested on the couch; the sixth part was saved by the [young woman]; and the tenth part was taken up by her lover: six pearls remained strung. Say, of how many pearls the necklace was composed*. (Bháscara, 1971, p. 25, footnote 5)

There are also reminders that in those days life could be very harsh for some people, like the slaves. The inverted rule of three terms is used to figure out the value of living beings, when their value is regulated by the years of service they may provide in the future. So, the older a person, the less her value, as in the following example, where a slave aged 20 is worth less than a slave aged 16.

> ***76.*** *If a female slave sixteen years of age, brings 32 [nishcas], what will one aged twenty cost?* (Bháscara, 1971, p. 34)

About the mathematics in *Lilavati*

One is also intrigued by the mathematics itself. Let us look at a multi-step problem.

> ***49.*** *Pretty girl with tremulous eyes, if thou know the correct method of inversion, tell me, what is the number, which multiplied by three, and added to three quarters of*

[1] *Professor Flores teaches at Arizona State University and uses hands-on materials, technology, and stories to make mathematics more tangible for teachers and students.*

the [product], and divided by seven, and reduced by subtraction of a third part of the quotient, and then multiplied into itself, and having fifty-two subtracted from the product, and the square root of the remainder extracted, and eight added, and the sum divided by ten, yields two? (Bháscara, 1971, p. 21-22)

How can one solve such a problem? What exactly is one asked to do in each step? How can we relate the methods used in India in the 12th century to our own modern symbolic methods? The method used by Bháskara to solve this problem is by inverting the operations involved. He gives the rule of inversion as follows. The first part of the explanation is pretty straightforward.

To investigate a quantity, one being given, make the divisor a multiplicator: and the multiplier, a divisor; the square, a root; and the root, a square; turn the negative into positive; and the positive into negative. (Bháscara, 1971, p. 21)

Lilavati was a book that had a great influence in Indian mathematics. Several commentators added notes and explanations, because the original was not always clear for everybody. Here is part of the explanation of the rule of inversion, which may not be as clear for modern students.

If a quantity was to be increased or diminished by its own proportionate part, let the denominator, being increased or diminished by its numerator, become the denominator, and the numerator remain unchanged; and then proceed with the other operations of inversion, as before directed. (Bháscara, 1971, p. 21)

Here are some clarifications that may help understand the instructions for the inversion method. We will describe them also using modern mathematical notation. For example, a number added to three quarters of the number is the same as the number times seven quarters,

$$p + \frac{3}{4}p = \frac{7}{4}p .$$

We can see that the denominator of the second fraction is the same as the denominator of the first. And 7, the numerator of the second fraction is obtained by adding the numerator and denominator of the first fraction. A number reduced by a third part of the number is the same as multiplying the number by two thirds,

$$r - \frac{1}{3}r = \frac{2}{3}r .$$

Here again, the denominators of the two fractions are the same, and the numerator of the second fraction is obtained by subtracting the numerator of the first fraction from its denominator. We can tabulate the operations of the multistep problem using letters for the unknown numbers at different steps of the process.

initial number	n
multiplied by 3	$3n = p$
added to three quarters of the product	$p + \frac{3}{4}p = \frac{7}{4}p = q$
divided by seven	$q / 7 = r$
reduced by subtraction of third part of the quotient	$r - \frac{1}{3}r = \frac{2}{3}r = s$
multiplied into itself	$s \times s = t$
having 52 subtracted from the product	$t - 52 = u$
square root of the remainder extracted	$\sqrt{u} = v$
eight added	$v + 8 = w$
the sum divided by ten yields two	$w / 10 = 2$

To solve the problem we need to use the inverse operation for each step. The chain of inverted operations is as follows:

$$2 \xrightarrow{\times 10} 20 \xrightarrow{-8} 12 \xrightarrow{\text{square}} 144 \xrightarrow{+52} 196 \xrightarrow{\text{sq root}} 14 \xrightarrow{\times 3/2} 21 \xrightarrow{\times 7} 147 \xrightarrow{\div 7/4} 84 \xrightarrow{\div 3} 28$$

The method described by Bháskara to solve this problem is very close to the process known as backtracking. "Backtracking is a process of finding an unknown number, *n*, by working backwards from the result, using students' natural problem solving skills. It breaks complex algebraic equations down into stages." (Lovitt and Clarke, 1988).

In the example above, instead of using several different letters we can also describe the process with one letter to represent the unknown number,

$$\frac{\sqrt{\left(\left(\frac{2}{3} \times \frac{\frac{7}{4} \times 3n}{7}\right)^2 - 52\right)} + 8}{10} = 2 .$$

A closely related and very effective way for beginners to deal with such complex equations is to use the cover up method (Whitman 1982; Kieran and Chalouh 1999). If in the above equation we cover the numerator of the left side expression with a box, it becomes a less intimidating equation,

$$\frac{\Box}{10} = 2 .$$

What is inside the box is thus equal to 20. Thus

$$\sqrt{\left(\left(\frac{2}{3} \times \frac{\frac{7}{4} \times 3n}{7}\right)^2 - 52\right)} + 8 = 20 .$$

Covering the square root, the equation becomes $\Box + 8 = 20$. By continuing using the covering method we can reverse the steps one by one until we obtain $3n = 84$, and finally, $n = 28$.

As can be seen from the sample problems given, *Lilavati* has a wealth of different kinds of arithmetic and algebraic problems that could be used in our classrooms. Teachers can use the problems to challenge students. Students can represent the relationship between the quantities in the problems using modern mathematical notation. Example 68 (below) can be represented by

$$n - \sqrt{\frac{n}{2}} - \frac{8}{9}n = 2 .$$

Bháskara was also a poet. *Lilavati* was written in verse. He was obviously proud of his daughter and also of his book. In the dedication of the book, the author describes his process of computation, or arithmetic, as "delightful by its elegance, perspicuous with words concise, soft and correct, and pleasing to the learned" (p. 1). He ends the book with this remark.

> *Joy and happiness is indeed ever increasing in this world for those who have Lilavati clasped to their throats, decorated as the members are with neat reduction of fractions, multiplication and involution, pure and perfect as are the solutions, and tasteful as is the speech which is exemplified.* (Bháscara, 1971, p. 277)

It is nice to see an author who deals with this topic in such a pleasurable way.

Bháskara and Lilavati are not only historic figures, but also legendary. In those times astronomers used to be also astrologers. Here is the story according to Joseph (1992) about the origin of the book's name. Slightly different versions of the legend exist. From casting Lilavati's horoscope, Bháskara

> *discovered that the auspicious time for her wedding would be a particular hour on a certain day. He placed a cup with a small hole at the bottom in a vessel filled with water, arranged so that the cup would sink at the beginning of the propitious hour. When everything was ready and the cup was placed in the vessel, Lilavati suddenly out of curiosity bent over the vessel and a pearl from her dress fell into the cup and blocked the hole in it. The lucky hour passed without the cup sinking. Bhaskaracharya believed that the way to console his dejected daughter, who now would never get married, was to write her a manual of mathematics!* (Joseph 1992, p. 269)

Additional Examples

13. Dear intelligent Lilavati, if thou be skilled in addition and subtraction, tell me the sum of 2, 5, 32, 193, 18, 10, and 100 added together; and the remainder when their sum is subtracted from 10000.

37. Tell me, dear woman, quickly, how much a fifth, a quarter, a third, a half, and a sixth, make when added together. Say instantly what is the residue of three, subtracting those fractions?

58. Tell me quickly, skilful calculator, what number are they, of which the difference is 8, and the difference of squares 400.

68. The square root of half the number of a swarm of bees is gone to a shrub of jasmine, and so are eight-ninths of the whole swarm; a female is buzzing to one remaining male that is humming within a lotus, in which he is confined, haven been allured to it by its fragrance at night. Say lovely woman, the number of bees.

The examples given in this article follow mainly the wording and numeration of Colebrookes' translation. Additional examples are available on-line with slightly different wording (History of Mathematics at Brown).

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Bháscara (pp. 1-127). Ann Arbor, MI: University Microfilms.
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NCCTM Trust Fund: Donating to Help Teachers Pursue a Graduate Education

In March and October, the NCCTM Trust Fund Committee accepts applications from NCCTM members who are elementary, middle, or secondary teachers of mathematics and who are enrolled in a graduate program taking courses in mathematics and/or mathematics education. Since its inception in 2000, the NCCTM Trust Fund has provided $38,500 in scholarships. The application can be found on page 27 in this issue or on the NCCTM website <www.ncctm.org>.

Memorial Donations

During the past year, the NCCTM Scholarship Trust has received $600 in memorials from six donors honoring the memory of five members of NCCTM. A letter explaining the purpose of the Trust Fund is sent to the family of the person memorialized. The name and address of the donor is provided unless the donor requests anonymity. The donor also receives a letter expressing the gratitude of NCCTM and the Trust Fund Committee.

In Memory of	Donor
Gwen V. Clay, Professor Meredith College	Maggie Holder Jan Wessell
John Daniels, Professor Emeritus, East Carolina University	John Cramer
William F. Palmer, Professor Emeritus Catawba College	Ron Hahn
Katye O. Sowell, Professor Emeritus East Carolina University	John Cramer Jan Wessell
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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

Please provide the name of the person being honored/memorialized through the donation and the name and address of the person that NCCTM should notify of your gift.

John Kolb, NCCTM Trust Fund Chair

Mathematical Wanderings

with Wendy Rich
Asheboro City Schools
Asheboro, North Carolina

I had the pleasure of hearing Cathy Seeley's presentation at the NCCTM Leadership Seminar on October 4th, 2006. Her session, "Preparing Students for a Global Future," left me wishing more teachers had the opportunity to benefit from participating in this discussion. So I jumped at the occasion to do an interview with Cathy and share some of the information she gave regarding documents available through NCTM and her viewpoints in general concerning the direction of mathematics instruction.

Cathy Seeley

Initially, I was captivated when Cathy related Lowe's and Home Depot's advertisement slogans as great mathematics philosophies. "Let's Build Something Together" and "You can do it! – We can help!" fit perfectly in her discussion of preparing students for jobs that we can not even begin to imagine today. She stated there were three things educators need to do in mathematics; students must be able to make sense of the mathematics they are learning, they must be able to attain the skills necessary to do the mathematics, and they must be able to apply the mathematics in problem solving situations.

Cathy discussed the Linking Research and Practice Initiative NCTM is currently developing to help link instructional practices in mathematics to research. Then she discussed the Curriculum Focal Points and how important it is for us to understand NCTM's position since the press had grossly misrepresented the Curriculum Focal Points. Knowing this is news that needed to be shared with our readers and that Cathy needed a ride to Steak and Shake, I decided to begin a column for the Centroid to get this news out to our readers – hey! I will do anything for mathematics… and fries!

On the drive over we chatted about her children and how she can not pass up a Steak and Shake whenever she can find one. Over our meal, the conversation turned to the Curriculum Focal Points and how the press has misrepresented this new document by claiming that NCTM is returning back to the basics. In actuality, the document is offered as a starting point in a dialogue on what is important at particular grade levels and as an initial step toward a more coherent, focused curriculum in this country. I asked Cathy to give our readers the bottom line on the curriculum focal points document since the recent press had been full of inaccuracies:

> *It's really unfortunate the real story of the focal points wasn't enough of a story so the focus had to be something else that was inflammatory and incorrect. The bottom line is the Principles and Standards are the foundation of the council's work and the focal points need to be used in light of PSSM and all of the other support materials from NCTM including the position statements. We hope the focal points can inform the next generation of state standards and tests and the next round of materials development.*

Cathy was really excited to share about the upcoming research briefs through NCTM's Linking Research and Practice Initiative.

> *The council is going to come out with research ABC's in the near future. They will be composed of Analyses, Briefs, and Clips that deal with questions that are important to people in schools. The Research Analyses will be the in-depth 10-15 page compilation of what we know about that question. The Research Briefs will be the 2-3 page summary of the analysis. The Research Clips will be a 2-3*

sentence sound bite that gets at the essence of what we know. I see these being particularly helpful to leaders of mathematics for assisting in making decisions about procedures and programs and to also stimulate discussion among professional communities.

As the conversation was winding down, I asked Cathy what she would most like to see in mathematics instruction throughout classrooms across the nation.

I think the most important thing is to shift some of the responsibility to students by engaging them in mathematics, rather than watching their teacher do the mathematics. Many teachers do this already, but not nearly enough. What you really want to see is teachers putting pieces together, not just presenting isolated bits of information. We want to see our students connect what they know to other ideas in mathematics. Most of all they need think and solve problems, even if it means taking longer than a few seconds to get into a problem; so many of our students have learned to give up if they don't get it right away. So, in the global village that our students are entering they need to have lasting skills that help them think, create, and solve problems for jobs that we can't even imagine today.

As I now reflect back on my discussion with Cathy and her session that morning, I continue to see NCCTM members leading the way to building a mathematics community where our students understand the mathematics, know how to do it, and use it to solve problems. Our students can do it, because we will help!

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Cycles of Learning: A Constructivist Approach to Planning for Inquiry-Based Differentiated Instruction

Chris Moore[1]
Lakeside High School
Wilmington, North Carolina

Although effective planning for instruction is universally recognized as an essential part of effective teaching, planning student-centered inquiry is somewhat of a contradiction in terms. As pointed out in the National Science Education Standards (NSES), inquiry teaching requires responsiveness to students, which in turn mandates that activities and strategies be continuously adapted and refined, rather than executed according to a plan (National Research Council, 1966). Inquiry-oriented teachers must constantly adapt their plans in ways that both stimulates inquiry and channels that inquiry towards meeting planned goals and objectives. The need for flexibility is far from the only special challenge in planning for inquiry-based instruction. As pointed out in the NSES, inquiry-oriented teachers must struggle in their planning with the tensions created by a number of competing tugs and pulls:

- the tension between guiding students toward a set of predetermined goals and allowing students to set and meet their own goals,
- the tension between taking the time to allow for in-depth learning and moving on to cover the whole curriculum, and
- the tension of the demands of making sure students acquire the mandated understandings and abilities and the demands of providing developmentally appropriate student-centered instruction.

Thus, as compared to more traditional teaching methods, inquiry-based instruction requires especially extensive and creative planning (National Research Council, 1996; National Council of Teachers of Mathematics, 2000; Lederman and Niess, 2000).

Tomlinson (1999) presents a similar argument for a need to improve practices in planning for differentiated instruction. Tomlinson argues that weaknesses in planning result in teaching that, while it may appear differentiated, fails to help students form meaningful connections among important ideas. Tomlinson argues that the clear visualization of goals is the first step towards differentiated instruction, and that, in the absence of such a vision, attempts at differentiated instruction are doomed to disintegrate into "varied avenues to 'mush.'" (p.14).

Planning Based Upon Student Thinking

Although effective planning is vital to inquiry-based differentiated instruction, many of the traditional approaches to planning are ill-suited to these methods of instruction. First, traditional unit plans and lesson plans focus on *behavioral objectives* while best practices in inquiry-based and differentiated instruction are rooted in *constructivist* principles. For constructivist teachers, measures of student behavior are not enough—it is the thinking that underlies the behavior that is important. These teachers need tools for planning that focus on the concepts to be mastered and deeply understood by students, rather than the activities the students will perform. Planning based upon activities promotes lessons in which all students are doing the same thing or similar things. Planning based upon thinking allows for much more flexibility in what students do, while retaining consistency of and control over what they are learning about. Planning based on thinking opens doors to methods in which students share a common learning experience while simultaneously learning through varied methods.

Another weakness of traditional planning methods is that traditional planning strategies break the curriculum into sequential units with relatively sharp starting and ending points. This approach to organizing the curriculum is at odds

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with the constructivist model of learning as a process that occurs slowly over time. As described in the NSES (National Research Council, 1966), time and varied learning experiences are necessary if students are to construct information-rich, highly connected knowledge structures. The approach of chunking the curriculum into discrete topical units is especially problematic in mathematics for two reasons. First, even more than other disciplines, mathematics content lends itself to introducing "new" content as a natural progression of what has already been learned. Secondly, mathematics instruction includes a large measure of teaching skills, and the need for teachers to plan for the distribution of skills learning over extended periods of time has been recognized as essential to effective skills instruction (Marzano et al., 2001). Thus, constructivist mathematics teachers must plan not merely for how students will spend a few weeks studying a topic, but for how numerous topics, concepts, and skills practice will be kept in play for months—often for the entire school year.

The Cycles of Learning Model

One model for lesson planning that supports these ideals of constructivist thought is the "cycles of learning" model. Although the terminology and details of the model vary in the literature, the model is generally described as an iterative approach made up of the following components:

- **Engage:** In this stage the teacher motivates students by creating interest and stimulating curiosity in the topic of study. As with any constructivist pedagogy, the primary goals of the engagement stage include challenging students' existing misconceptions and raising productive questions—questions that can be answered through student explorations (Tracy, 2003; Lorsbach; 2002, Author, 2001; Leim, 1987; Elstgeest, 1985).
- **Explore:** During the Explore stage students work in cooperative groups, often collecting data and experimenting. These explorations may challenge pre-existing misconceptions, creating disequilibrium. Students should be puzzled.
- **Explain:** After completing some explorations, students need to reflect upon what they have done and learned and to explain the concepts explored in their own words. Students learn to use evidence to defend and clarify their views. The quality of student data collection and record keeping that occurred during the explore stage becomes relevant during this stage. In addition to learning from each other, students learn from explanations provided by the teacher at this stage, with those explanations being rooted in the students' experiences.
- **Extend:** Explorations of the key concepts are extended to provide students with additional opportunities to confirm and expand their developing conceptual frameworks.
- **Evaluate:** Evaluation is integrated into all stages of the process.

As the term "cycles" suggests, an iterative approach to content delivery and assessment is central to the model. This iterative approach ensures that students are provided time and varied opportunities to learn concepts, including opportunities for misconceptions to be dispelled (Drayton and Falk, 2002). Also, because the curriculum is defined in terms of key concepts (big ideas) rather than fact-centered topics (details), any given exploration may provide opportunities for students to engage, explore, and communicate about numerous curriculum concepts. Thus, the cycles of learning model provides a natural tool for integrating curriculum around big ideas, giving students repeated and varied explorations to help them grasp concepts they may find counterintuitive (Tracy, 2003).

Because instruction often must be directed towards promoting behaviorally worded learning objectives such as those in the North Carolina Standard Course of Study, an important first step in implementing the model is to restate the objectives as concept statements. Ideally these statements should be in "kid language" and represent approximations of what the teacher would want to hear a student articulate during the "explain stage" of the process, at that point where the student first really grasps the key concept being taught. Table 1 shows an example of how some of the seventh grade North Carolina Mathematics Curriculum learning objectives can be translated into concept statements. When applied to the 2003 seventh grade math and science curriculums, this process reduced the number of math objectives from 34 objectives to 12 concept statements and the science curriculum from four strands and 20 objectives to 10 concept statements.

State Objectives	Corresponding Concept Statements
The learner will. . . . • Develop and use ratios, proportions, and percents to solve problems • Draw objects to scale using scale drawings to solve problems • Identify, define, and describe similar and congruent polygons with respect to angle • Use scaling and proportional reasoning to solve problems related to similar and congruent polygons.	Ratios, Proportions, Scaling, and Similar Figures are closely related mathematical concepts involving quantitative comparisons among related measurements. • A ratio has two numbers which represent either a part-to-part or a part-to-whole comparison. Ratios can be expressed in a variety of ways including as fractions, decimals, and percents. • A proportion is a comparison of two ratios, and therefore contains four numbers. If three numbers in a proportion are known, the fourth can be found using algebra. • Scales apply ratios and proportions to distances or sizes. • The math of proportions can be used to find unknown measures of "similar figures," which are sets of figures that are different in size but identical in shape

Table 1: Examples of NC SCOS learning objectives and concept statements derived from those objectives.

The second step in applying the model involves writing long-range plans centered on concept-oriented learning objectives. The format for these plans calls for placing the concept statement in the middle of the page. The planned activities written above the concept statement describe the planned learning events that will lead up to students grasping the concept. The events written on the bottom half of the page, below the concept statement, emphasize what students will do as they extend and apply their understandings of the concept. The page is formatted in an hour glass shape to emphasize how, initially, students are focusing in on the conceptual objective and then, later, broadening out from that objective to extend their learning. Two different types of information are recorded for each planned learning event, what the students will be doing (the activities) and the thinking those activities is intended to illicit (Rogers, 2002).

This structure for planning supports the teacher in maintaining a focus on both student activities and student cognition as students construct rich knowledge structures. By tracking the desired type of thinking associated with each learning event or activity, the teacher can chart a variety of different paths through the process for different students while ensuring that all students are engaged in all essential thought experiences within the learning process.

A simplified example of one such plan, which shows only some of the activities that would be included over the course of a year of instruction, is shown in Table 2 at the end of this article. Note that the inclusion of dates in the plans allows for the cycles of learning long-range plans to serve as pacing guides as well.

The cycles of learning model incorporates informal and formal assessment throughout the learning process. During a student's movement through the initial cycle of learning for a given concept this assessment is mostly formative. As students progress, the assessment becomes increasingly summative.

Hour-glass shaped concept-centered long-range planning documents can be effective tools for organizing a constructivist curriculum. This planning model allows the teacher to focus on big ideas and how they are being taught through iterative approaches in which students have many and varied opportunities to learn. The teacher can maintain this focus while also ensuring that established objectives are mastered by all students. The cycles of learning model provides the "first step towards differentiated instruction" outlined by Tomlinson, creating a framework that ensures that instruction is directed towards appropriate end goals (providing consistency of *what* is taught) while promoting opportunities for great flexibility in *how* that content is taught.

Activities: What Students are doing	Concept Formation: Thinking the activities promote
• **Ratios in current events data** • **Number line scaling #1 (social science context)**: Use scaling with a "multiple number line" (dates from 1500 to 2000, years from 0 to 500, percents of distance with 0%, 25%, 50%, 75%, 100% as benchmarks, corresponding fraction ratios, corresponding cm benchmarks. **(Sept.)** • **Number line scaling #2: World's largest nose (life science context)**: Students use number line scaling techniques and ratio calculations to compare proportional sizes of stuffed animals' noses. **(Oct.)**	• Direct comparisons of numbers can be misleading—fractions or percents can provide more honest picture • A given distance can be subdivided into proportional segments using various units (measured distances, counting numbers, fractional/decimal/percentage parts, etc. Ratios can be used to compute from one set of units to another to allow for accurate scaling and proportional comparisons. • Proportional comparisons can be reasonably estimated using benchmarks, such as 0, ¼, ½, ¾, 1. • Certain comparisons are worth memorizing (e.g., ¼ = 0.25, = 25%) • Living things have varying proportions as means of adapting to environment. • Multiple number line and ratio/scaling math are broadly applicable
• Additional application of ratio and scaling in social studies context by comparing demographics of different African populations. **(Dec.)** • Additional application of ratio and scaling using maps and math "Week-by-Week" problems (**Sept. – May)**	• Proportion, ratios and percents allow meaningful comparisons of quantitative data among groups having different total sizes—e.g., in comparison of "amount of AIDS in populations" a smaller actual number may correspond to a larger percent (fraction, decimal part, proportion). Ratios/proportions are sometimes ESSENTIAL in making meaningful (not misleading) comparisons.
Major Concept and closely related sub-concepts RATIOS, PROPORTIONS, SCALING and SIMILAR FIGURES are closely related mathematical concepts involving <u>quantitative comparisons</u> among related measurements. . . (see table 1 for complete concept statement). ***NC SCS Grade 7 Math objectives: 1.01, 2.01, 3.02, 3.03***.	
• Comparing ratios of surface area to volume for various geometric shapes (includes "new boxes from old" in which students make a cube-shaped box with identical volume of original non-cube box out of pattern for original box). (see 3D models plan) **(Dec.)** • Comparing ratios of perimeter and area for 2D shapes when perimeter changes **(Jan.)** • Math textbook activities on choosing strategies for setting up ratio problems and using scaling with geometry models **(Dec.)** • Indirect measurement activities using shadow ratios and similar triangles. (**Jan)** • Measuring height of inaccessibly tall objects with student-built astrolabes using scale drawings of triangles (Pythagorean theorem) **(Jan)**	• Broaden understanding of applicability of concept and gain skills in using math applications • Apply to geometry • Explore relationships of perimeter/area surface area/volume • Increase facility in working with various nets and patterns for representing 3D prisms in 2D space • Gain skill in measuring angles and working with relationships among angles in triangles. Strengthen ratio-geometry connections.
• Apply ratios to more Middle East social studies problems similar to those used above with Africa Data but requiring more extensive computation **(Feb)** • Apply ratios to probability problem in which catch-mark-release-re-catch sampling is used to estimate the population of fish in a lake. **(March)** • Explore and use ratios as one way of expressing probability statements. **(April)**	• The tools of ratio, percent, proportion have been mastered to degree that students can take on and solve realistic real world problems. • Students begin linking what they have recently learned to next major unit of math, "probability and statistics." • Probability is expressed as ratio of number of ways expected outcome can occur compares to number of all possible outcomes

Table 2: Example of an hour-glass shaped concept-centered long-range planning document.

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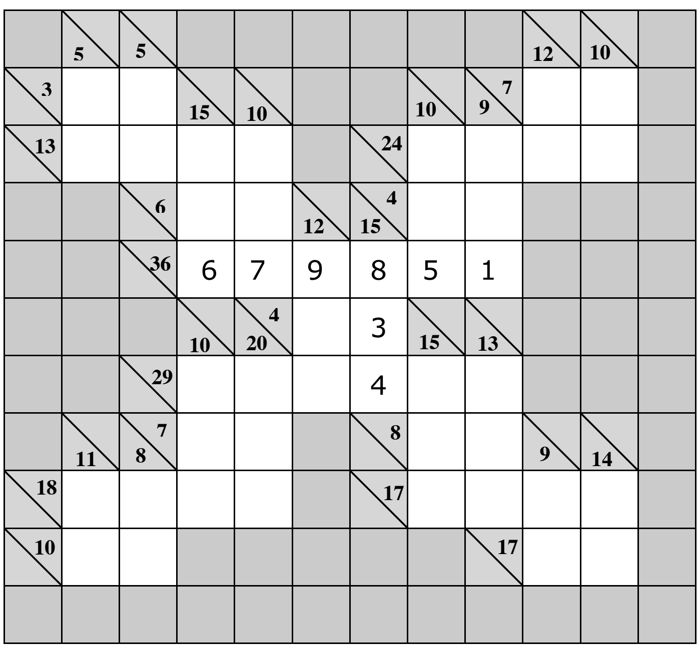
Have You Sudoku-ed and Kakuro-ed?

I admit it; I am hooked. I have always loved magic squares and arithmetic games. Now, thanks to their popularity in the last year, I have books and books of these puzzles. For those who have not tried these new fads, here are the rules:

Sudoku: The goal is to arrange the digits 1 through 9 in each of nine 3x3 blocks, without repeating the digit in the block or in the row or column formed by all the blocks.



Kakuro

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

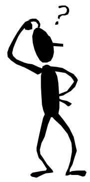
Sudoku

Kakuro: The goal is to arrange the digits 1 through 9, one in each non-shaded block, without repeating the digit in the row or column, so that the row or column adds to the number in the shaded block at the top or left. (The answer to this puzzle is not unique; can you find them all?)

Here are two for you to try – my first attempts at designing puzzles. Enjoy!

-Holly Hirst, Centroid Editor

Problems to Ponder



Spring 2007 Problems

Gregory S. Rhoads
Appalachian State University
Boone, North Carolina

Grades K–2	Leo and Leona start at the number 4 and count together, Leo counts by **twos** and Leona counts by **fours.** When Leo gets to the number 20, what number will Leona be on?
Grades 3–5	Carlie's bill from the auto mechanic was \$186.95. If the mechanic charged \$61.95 for parts and \$50.00 for **each hour** of labor, then for how many hours of labor did they charge Carlie?
Grades 6–8	Irvin was driving from Boone to Wilmington to go to the beach, a distance of 320 miles one way. He has the choice of 2 cars, a Bummer which looks cool but only gets 13.2 miles per gallon, and a Flugo which gets 38.4 miles per gallon. If gas currently costs \$2.35 per gallon, how much will Irvin save **for the entire trip (both ways)** if he chooses to drive the Flugo instead of the Bummer?
Grades 9–12	What is the largest integer value of n such that 2007! is divisible by 34^n?

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 publish creative or well-written solutions from those submitted. If you would rather not have your solution published, please so indicate on your submission. Keep in mind that proper acknowledgement is contingent on legible information and solutions.

Send solutions by 31 March to:

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

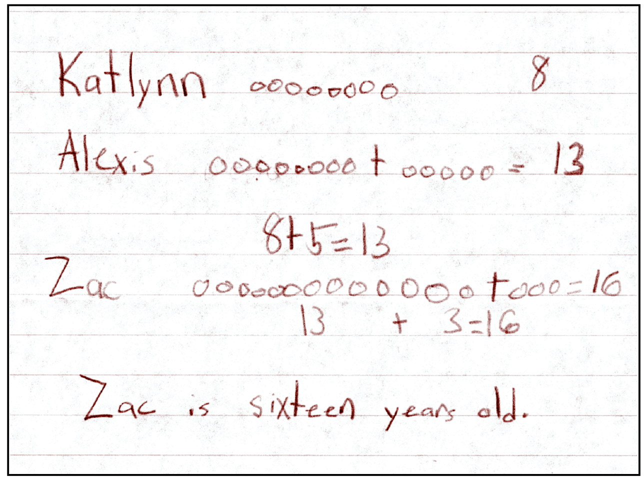
As these problems are intended to stimulate independent thinking, it is expected that a submitted solution indicates that the student completed a significant part of the work. Please try to have the students use complete sentences when they write up their solutions to promote effective communication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

Solutions for Problems from the Fall 2006 Issue

Grades K-2

Alexis is 5 years older than her sister Katlynn, and 3 years younger than her brother Zac. If Katlynn is 8 years old, how old is Zac?

Solution: By Jessica Sullivan, 2nd grade, **North Rowan Elementary** (Teacher: Ms. Hood)

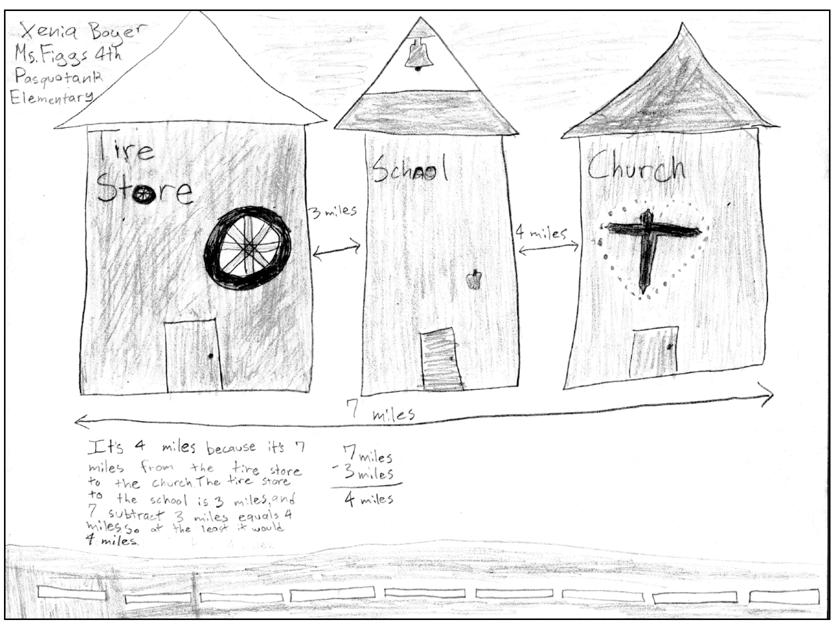


Correct solutions were received from: Millen Marie Sanqui of **Hardin Park Elementary,** Abby Williams of **Lawsonville Elementary**, Paris Joyner and Jathanna Rice of **Mariam Boyd Elementary,** and Jessica Sullivan of **North Rowan Elementary.**

Grades 3-5

A tire store, a school, and a church all lie along Route 421, a perfectly straight road. If the distance from the tire store to the church is 7 miles and the distance from the tire store to the school is 3 miles, what is the least possible distance between the church and the school? Draw a picture of your answer with all three buildings.

Solution: By Xenia Boyer, 4th grade, **Pasquotank Elementary** (Teacher: Ms. Figgs)



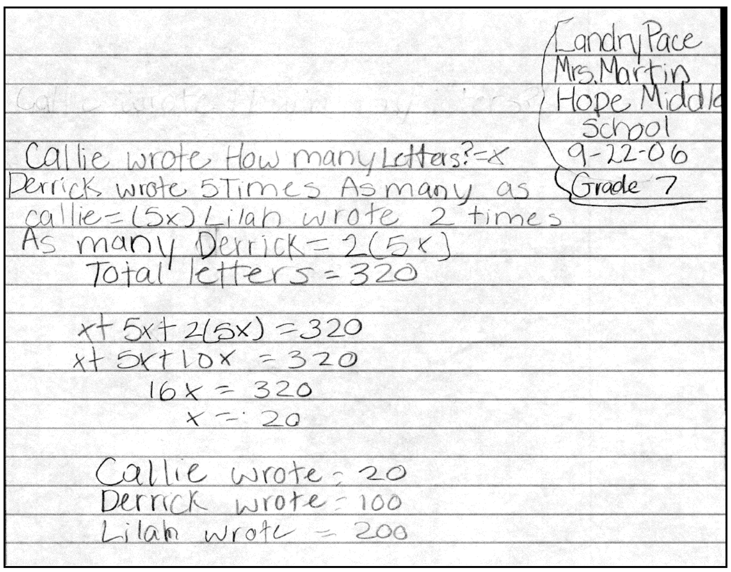
Editor's Note: Nice picture and use of subtraction.

Correct solutions were received from: Jason Latta, Emmy McGuirt, and Chance Roedel of **David Cox Road Elementary**, Noah Bacon, Lauren Bennett, Elijah Berlin, Jennifer Garrard, Jake Macmillan, Joseph O'Keeffe, Dante Otero, Steven Vogel, and Ryan Woods of **Easley Elementary**, Mari Joe Sanqui of **Hardin Park Elementary**, David Ballard, Joy Cockerham, Hogan Coe, Laura Dobbins, Josh Hudson, Charity Love, Tyler Martin, Jared O'Neal, Christian Shores, Madison Snow, Braden Sprinkle, and Hannah Wilmoth of

Mountain Park Elementary, Nikki Brodeur, Brooke Conley, Ashley Davis, Sean Gerres, Lori Ann Kesten, Tia Lloyd, Crystal Mandel, Cora Nash, and Kelly Wilson of **Moyock Elementary**, Veronica Sanchez, Brendan Smith, and Carter Thomason of **North Rowan Elementary**, Kaylee Aldridge, Courtney Bacon, Jackson Bely, Laura Bexell, Ashleigh Bosarge, Justin Burgin, Paula Evans, Celine Ganiere, Cole Jordan, Ashley Lomelino, Nathan McConnell, McNair Moore, Evans Morgan, Emily Northrop, Rachel Owens, Alanna Pinilla, Kate Reeves, Mandy Shoults, Bear Stevenson, David Thacker, and Matt Widener of **Parkwood Elementary**, Abigail Beasley, Britnee Bogue, Xenia Boyer, Blair Gregory, James Harrell, Samuel Lindsay, Christian Morris, and Hayden Wood of **Pasquotank Elementary**, Erakana Burnett, Jacara Carr, Erica Rascoe, Robbie Sampson, and Toni Swain of **Pines Elementary.**

Grades 6-8

Callie, Derrick, and Lilah are writing letters to the students at the local middle school. Derrick will write 5 times as many letters as Callie, and Lilah will write 2 times as many letters as Derrick. If they plan on writing 320 letters in all, how many will each person write?



Landry Pace
Mrs. Martin
Hope Middle School
9-22-06
Grade 7

Callie wrote How many Letters? $= x$
Derrick wrote 5 Times As many as callie $= (5x)$ Lilah wrote 2 times As many Derrick $= 2(5x)$
Total letters $= 320$

$x + 5x + 2(5x) = 320$
$x + 5x + 10x = 320$
$16x = 320$
$x = 20$

Callie wrote $= 20$
Derrick wrote $= 100$
Lilah wrote $= 200$

Solution: By Landry Pace, 7th grade, **Hope Middle School** (Teacher: Mrs. Martin)

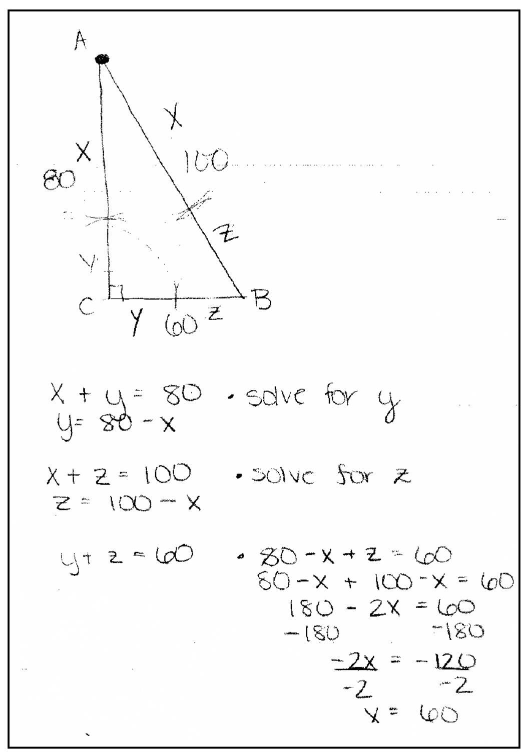
Editor's Note: Many students used the guess-and-check method. This solution does a great job of showing the steps for solving the problems using algebra. He uses a variable for the unknown, sets up and solves an equation, and explicitly gives the complete solution.

Correct solutions were received from: Meredith Andrews, Stacey Andrews, Drew Barchard, Aaron Beck, Benjamin Bell, Jonathan Bell, Anna Bishop, Morgan Carraway, Jenna Chamblee, Kate Chambree, Zach Colby, Sam Collins, Sarah Davis, Taylor Dunn, Brooke Eller, Katherine Fisher, Marie Gentry, Grant Gillespie, Elisa Goebel, Clay Gooding, Angele Gray, Ethan Greer, Will Grieves, Emma Hadley, Chelsea Haithcox, Parker Hayes, Phillip Hedrick Jr., Alex Hill, Stephanie Kim, Amy King, Sam Kuyath, Sally Lipe, Rachel Loggins, Amy Lyon, Will Lyon, Quincy Malesovas, Allie Mancuso, Nico Mancuso, Staci Mayo, Kelly McIntosh, Adelison Miller, David Nail, Jenna Neely, Jacob North, Joanna Norton, Bekah Page, Rachel Patton, Spencer Peterman, Graham Ragan, Joel Ragan, Emily Rangel, Susan Rich, Kyle Roberts, Katelyn Robertson, Ashlynd Rose, Kristin Rose, Kaitlyn Shaw, Olivia Shields, Rajan Singh, Laura Smith, Bethany Spivey, Jeffy Summers, Alexander Thomas, Lizzy Thomas, Hannah Thompson, Morgan Thurmond, Alex Towery, and Alex Watson of **Caldwell Academy**, Hunter Young, Ashley Brown, Trace Buck, Rebecca Hobbs, Alec Perkins, Isaac Riddick, Joseph Stallings, Tabitha Thierjung, Alexandra Toti, Dene Vann, and Jackie Wiggins of **Central Middle School**, Li An, Carly Bloomfield, Jeffrey Brasher, Zak Brown, Jamie Coyle, Zack Elliott, Anna Erickson, Amanda Frankel, Jack Freedman, Brandon Gilbert, Alex Hilleary, Tyler Hinshaw, Abby Jameson, Sharon Jiang, Nabil Lachgar, Alex Little, Katy Llewellyn, Mitch Loflin, Margaret Macon, Jordan Marsh, Irene Martin, Justin Morris, Anne O'Brien, Aaron Riddle, Rioghnach Robinson, Kasey Skinner, Andrew Stafford, Will Stamp, Maddy Thomas, Vipul Vachnarajani, Clay Wash, Avery Wells, Meredith Welty, Rachel Whitt, Hannah Wooten, Hannah Young, and Jesse Zhu of **Hanes Middle School**, Rebecca Baker, Charlotte Laun, Bianca Oyander, Layne Abernathy, Lindsi Ahearn, Kate Ball, Hannah Bauer, Nicole Beaulieu, Ashlee Bogenn, Brett Bowman, Claire Foster, Aakash Gandhi, Davis Hardee, Courtney Hardy, Caitlyn Hudson, Luke Jones, Anna Lawrence, Rebecca Leis, Avery McClenney, Sanddy Medina, Chandler Mullis, Peter Opiela, Landry Pace, Kimberly Reid, Hannah Rockingham, Camille Snyder, Amir Taha, Alexandra Theus, Amanda Tucker, Bree W., Brandon

Wainwright, and Alex Watkeys of **Hope Middle School**, Cara Allison, Antuanette Anglon, Zach Barnes, Whitney Brodie, Danica Cabral, Roshan Chacko, Alex Currin, John Hodge, Will Huffaker, Matt Knott, Rebecca Lee, Yesenia Obando, Shareka Roberts, Dylan Sanner, Shea Stepusin, Jenna Talloy, Lucas Tanthoney, Kyle Watkins, and Patrick Whitt of **North Granville Middle School**, Michaela Bullins, Phillip Coleman, Megan Fulk, Kayla Greeson, Morgan Lawson, Daisy Mincey, Bobbie Mobley, Alexa Moorefield, Andrea Oakley, Josh O'Dell, Travis Sexton, Amanda Van Zant, and Dallas Walsh of **Pine Grove Middle School**, Stephanie Rieger of **Rugby Middle School**, Raven Breitenfeld, Brittany Futch, Annasa Harris, Kayla Hurst, Sharisse Jimenez, Taylor Long, Donovan Parry, Leah White, and Troy Williams of **Seventy-First Middle School**, Dimetris Anderson, Maggie Belangia, Cameron Bell, Loquita Benfield, Brook Bowen, Riketta Darfleet, Lyndsae Deele, Travis Demery, Courtney Early, Darius Faison, Salaat Faulkner, Shirone Ford, Kemonti Francis, Branden Gordon, Quadeisha Green, Holley Harrison, Savannah Harvey, Kiara Heckstall, Lester Heckstall, Terren Hill, Stephen Hoggard, Melissa Jernigan, Tameakia Lee, Raquel McArthur, Rosean McArthur, Tyia Mills, Kevin Purvis, Loella Quroa, Quamaine Rascoe, Keisha Richardson, Darrell Roberts, Kierra Smallwood, Triwan Smallwood, Jaleesa Stocks, Zachia Sweet-Newkirk, Jamesha Thompson, Dyleezia Warren, Cody White, Martynez White, Dennis Williams, Desiree Williams, Haley Williams, Isaac Williams, and Tia Woolard of **Southwestern Middle School**, Christopher Alberti, Amy Arzola, Zach Beck, Julianne Blackburn, Tess Boyle, Sydney Brooks, Harry Cohen, Rosheny Edathil, Ociris Garcia, Sara Gurley, Will Inabnit, Jacob Ingle, Andrew Johnson, Rebecca Johnson, Mary Kirkman, Michael Louros, JoAnna Michael, Kaley Moser, Christina Stone, William Stutts, Steven Thomas, Sophie Thompson, Sam Trevathan, Nick Trummel, Allie Vaughn, Hannah Whited, and Mario Wiley of **Turrentine Middle School**, Matthew Beck, Tiffany Beck, Daniela Benitez, Matthew Berrier, Lori Caudle, Andrea Link, Alicia Middleton, Cole Middleton, Michael Quintana, Ashley Robbins, Taylor Ross, Katie Shoaf, Rachel Tam, and David Thurston of **Tyro Middle School.**

Grades 9-12

An acute triangle has sides of length 60, 80 and 100 feet. A circle is centered at each vertex such that each circle is tangent (touches at one point) to the other two circles. What is the radius of the circle centered at the vertex opposite the side of length 60?



Solution: By Callie Gaertner, 12th grade, **Hickory Grove Baptist Christian School** (Teacher: Mrs. Brown).

Editor's Note: This solution made each radius a variable and set up 3 equations using them. Some observant readers noted that the triangle must be a right triangle since the side lengths satisfy the Pythagorean Theorem.

Correct solutions were received by: Karen Collins, Jessica Creacy, Daniel Cui, Zach Davis, Liz Gorham, Michael Guama, Cameron Handyside, Kathleen Harris, Janey Kugath, Rebecca Loggins, Sarah Moon, Drew Payton, Anna Powers, Katelin Robbins, Lauren Shelmardine, Jonathan Storch, and Mitchell Watson of **Caldwell Academy**, Corey McClintock, Joey Murphy, Carra Saunders, and Carolin Utecht of **Charles D. Owen High**, Haley Cusano, Callie Gaertner, Caitlin Goforth, Anthony Jain, Wesley Klontz, Natalie Nieman, Joshua Rierson, Carrie Leigh Sutton, Joel Vandekrede, and Kaitlyn Whitlock of **Hickory Grove Baptist Christian**, Amber Edwards of **Jones Senior High.**

Awards

Mini-Grants from NCCTM

Reported by Sandra W. Childrey
Dillard Drive Middle School
Cary, North Carolina

Through the Mini-Grant program NCCTM provides incentive funding for teachers as they develop activities to enhance math education. This program provides funds for special projects and research to enhance the teaching, learning, and enjoyment of mathematics. Available to current members of NCCTM, the mini-grants are awarded by the three regional organizations to members *within their geographic boundaries*—If you incorrectly identify with the wrong region, your proposal will be ineligible for funding. A total of $15,000 is available each year for mini-grants, with each region awarding approximately $5000 in grants to its members. In recent years, over 30 proposals have been funded, for an average grant of just less than $800. The following members received minigrants for use in 2006-2007.

Central Region:
- Kathleen Nester
- Lisa Williamson
- Sylvia Davis
- Pamela Moses-Snipes

Eastern Region:
- Rebecca S. Willis
- Pat Peoples
- Celina C. Turnage
- Christie Wuebbles
- Dorothy R. Gillis
- Judith Grimsley-Toler

Western Region:
- Laura Gardiner
- Karen A. Morrison
- Donna Brackett and Dena Wolfe
- Terri Ferguson
- Andy Blevins

Grant proposals must be postmarked or emailed by September 15, and proposals selected for funding will receive funds as soon as possible after the state conference. If you do not receive a confirmation of your submission within one week, contact the Mini-grant Coordinator to be sure the document was received.

Guidelines

For your project proposal to receive favorable consideration, the guidelines below should be followed. Use section one (I) as an outline for your proposal, incorporating the points in section two (II). The proposal should be typed or printed clearly in black ink to facilitate reproduction for judging.

I. Projects will be evaluated on the following criteria:
a. Purpose/objectives
b. Justification (why project is important)
c. Implementation/plans
d. Impact - # of students, reusable materials, etc.
e. Economic feasibility (can it be done with funds requested)

II. Project description should include the following:
a. What the project is expected to accomplish
b. Specific/details of the project
c. Number of students to be served
d. Detailed budget
e. How you will share the outcomes of your project (i.e., submit an article to the Centroid, present at the state conference, participate in a poster session, etc.)

III. Possible projects for consideration include: Math clubs, field days, contests, math activities and laboratories, research projects/topics, family math, and parent workshops, etc. This list is not meant to limit you to these ideas. Creativity is encouraged.

IV. Proposals must be submitted for consideration in the *correct* NCCTM Region. Be sure to verify your region before submitting.

Mini-Grant Proposal Cover Sheet

Grant Applicant(s)____

Position:____

School/Institution:____

Home Address:____

Home Telephone:_______________________ County:_______________________

School Address:____

School Telephone:_______________________ County:_______________________

Email (required):____

NCCTM Membership #____________________**NCCTM Region**____________________

- In order to ensure blind screening of your proposal, please do not mention your name or the name of your school or institution in your proposal. This cover sheet will be removed after a code number has been assigned to your proposal.
- All proposals must be postmarked by September 15 or received on the 15th of September if emailed.
- All applicants must be members of NCCTM by September 1 for the school year in which their proposals are funded.
- Only one application per member, per year, will be accepted.
- Receipt of grant proposals will be acknowledge by email within one week of receipt.
- Grant recipients will be notified as soon as possible following the NCCTM State Conference.

Title of Project:____

Amount Requested:____

Please have the principal of your school/supervisor of your institution sign below to indicate his/her support and approval of your proposal.

____

Signature Position Date

Return this application form and direct all questions to:

Sandra W. Childrey, Coordinator
NCCTM Mini-grant Committee
111 Durington Place
Cary, NC 27518
Phone 919-816-9042

Applications may be emailed as an attachment to: schildrey@wcpss.net

Awards

2006 Outstanding Mathematics Education Award Winners
Christa Lynne Conner
Michelle Culbertson
Davina Davis

Reported by Bampia A. Bangura
North Carolina Agricultural and Technical State University
Greensboro, North Carolina

Each fall, NCCTM sponsors the selection of three Outstanding Mathematics Education Students. The Special Awards Committee identifies the most outstanding mathematics education student from each of the three regions in North Carolina. Nominations are requested from all Colleges and Universities with teacher preparation programs. The recipients for the 2006 Awards are: Christa Lynne Conner from Western Carolina University in the Western Region; Michelle Culbertson from East Carolina University in the Eastern Region; and Davina Davis from North Carolina A&T State University in the Central Region.

Michelle Culbertson

Michelle Culbertson is a senior and NC Teaching Fellow at East Carolina University, double majoring in mathematics and mathematics education. Her professors describe her as a strong mathematics student. In the 16 year history of the ECU student chapter of NCCTM, Michelle has been the most active member. She held the office of secretary for two years and as president she obtained funding to support student lodging for the 2005 NCCTM state conference. At ECU she continues to nurture younger students in assuming leadership roles in the NCCTM student organization. Michelle has a special concern for Hispanic communities of Eastern Carolina and as such she took a minor in Spanish to reach those students. She volunteered in a range of community activities in her efforts to reach out and experience different cultures. She spent a summer in Argentina in 2005.

Christa Lynne Conner

Christa Lynne Conner is a junior at Western Carolina University who is pursuing a B.S. Ed with a concentration in mathematics. She has been involved in many aspects of the mathematics and mathematics education programs at WCU. Christa served in the Department of Mathematics and Computer Science as a student assistant in mathematics from 2004 to the present. She worked as an assistant in the Western Carolina math contest in 2005 and 2006. Currently, she is the president of the NCCTM student chapter at WCU. Before that, she served as secretary/treasurer for the organization. She has participated in three NCCTM annual fall conferences. Christa is also active as a mathematics tutor and presented at the Undergraduate Expos in 2005 and 2006. She has always shown strong leadership qualities. In this connection, she is serving as the department’s representative to the Dean’s Advisory Committee of the College of Arts and Sciences. Christa is mature, conscientious, and scholarly. She was the recipient of the Freshman Mathematics Award.

Davina Davis

Davina Davis is a senior at North Carolina A&T State University. She is pursuing a BS in mathematics education. Davina is active in the Mathematics Department and is currently the president of the NCCTM student chapter at NC A&T. She has served in this capacity for two years. In the summer of 2005, Davina was one of two NCA&T math students selected to participate in the MATH SPIRAL program held at the campus of the University of Maryland at College Park. She has participated in two Pre-service Teacher panels representing NC A&T. Davina understands the importance of learning communities. She speaks Spanish fluently and is involved in many campus activities. She is the student assistant for the Regional High School Mathematics Contest at NCA&T. Her professors describe her as inquisitive, enthusiastic, and dedicated to academic excellence.

Awards

2006 W. W. Rankin Award Winners
Emogene Kernodle
Phillip Johnson
William Waters

Reported by Brian Felkel
Appalachian State University
Boone, North Carolina

The W.W. Rankin award is named in memory of professor W.W. Rankin, an outstanding math teacher at Duke University whose work with teachers exemplified excellence and who was instrumental in organizing annual mathematics conferences and developing summer institutes for NC teachers. This year there were three recipients: Ms. Emogene Kernodle, Dr. Phillip Johnson, and Dr. William Waters.

Emogene Kernodle

Emogene Kernodle has been teaching mathematics at the high school and middle school levels for over 30 years. Her contributions to mathematics and mathematics education include: Mathematics department chair; Workshop presenter for high school and middle school math teachers; leader in NCCTM at both the regional and state levels. She has served NCCTM as the state conference chair, state program chair, and regional secondary vice president and state secondary vice president.

Her colleagues recognize her for her hard work and innovation. She taught the first discrete math course, first calculus course, and the first computer science course ever offered at her high school. She has participated in national and international conferences in technology. She also serves on the leadership team at her high school; coaches the quiz bowl team; is the varsity cheerleading coach; and is in charge of planning the senior graduation exercises.

Emogene is known for her caring and nurturing support of others. One colleague writes:

> *Emogene has taken me under her wing since I came and not only been a mentor to me as a math teacher and colleague but also been a great friend and supporter. She still finds time to cheer my own children on at their sporting events.*

Emogene Kernodle is currently the president of the Central Region of NCCTM.

Phillip Johnson

Phillip Johnson has been a mathematics educator for 46 years, first as a high school teacher, then as an instructor/professor in a wide variety of college and university settings both in the US and abroad.

Phillip has done much for mathematics education through teaching, writing, conference presentations, and helping to plan and organize mathematics courses and conferences. He is a two-time chair of the State Mathematics Conference and chair of various other NCCTM committees over the years.

Phillip has held distinguished mathematics and mathematics education positions, first at high schools in Fredericksburg and Fairfax County, Virginia, then at the University of Richmond, Vanderbilt University, NC State University, UNC-Charlotte, and Appalachian State University. Abroad, Phillip has held influential positions in mathematics education at Cambridge University in Cambridge, England, Cuttington University College in Liberia, West Africa, and Kingston University, Kingston, England.

With degrees earned chronologically from Appalachian State University, American University, and Vanderbilt University, Phillip prepared well for an outstanding career in the field of mathematics education. Over the many years he has generously given of time and talents to further the cause of mathematics education in North Carolina and continues to do so as Director of the Math/Science Education Center at Appalachian.

William Waters

William Waters has made numerous outstanding contributions to mathematics education and has been a member of NCCTM from its inception in 1970, contributing to NCCTM in a variety of roles.

He has served NCCTM as an officer, editor, committee chair, and a journal article author. He has twice been elected to the NCCTM Board of Directors, as Eastern Region Vice President for Colleges and as State Vice President for Colleges. He served on the editorial panel for *The Centroid* as associate editor for two years and one year as editor when the journal was housed at NC State University. He served as chair of the Program Committee for one of the last annual meeting held in Raleigh. Three of his journal articles have been published in *The Centroid*.

William has been most visible in the organization at the regional and annual meetings of NCCTM. He has attended every annual meeting of NCCTM since the first one at Salem College and has made countless presentations at NCCTM meetings. Because his sessions receive high evaluations and are so highly valued, program committees often ask him to be on their upcoming program. He can always be counted upon to do high school/college sessions that provide interesting and novel approaches to teaching familiar mathematics topics.

In his role as a faculty member he has established an impressive record of achievement and has become a role model for pre-service mathematics teachers. Teaching undergraduate and graduate courses in mathematics education and mathematics, he has influenced the professional development of hundreds of mathematics teachers. He has supervised the student teaching of an estimated 220 prospective student teachers, directed 10 master's theses, and has chaired or co-chaired the committees of PhD students. He was twice selected to receive a University Outstanding Teaching Award and named to the NC State Academy of Outstanding Teachers.

As a faculty member in the mathematics department, William has taught approximately fifteen different mathematics courses, but he is best known in that department as the instructor of the course on the history of mathematics. He never taught the same course twice. He would choose different material to keep the course and his teaching fresh. Curiosity and scholarly work in developing an ever broader reach in historical mathematical topics became the impetus for much of the material he refined for presentations at NCCTM and the 25 papers he published in a variety of regional and national journals. In this way he spread his influence in mathematics education beyond North Carolina.

NCTM 2007 National Meeting

Mathematics: Representing the Future
March 21-24, 2007 in Atlanta, Georgia

From the Conference Website: Representations of mathematical ideas are an essential component of learning and doing mathematics. Different representations—models, drawing, manipulative materials, mental images— help to illuminate different aspects of a concept or relationship. This focus will help teachers, school leaders, and teacher educators expand their expertise about how to use representation as an integral component of the teaching/learning process.

When you're not attending the conference sessions, gallery workshops, and research presentations, we invite you to experience Atlanta. Its fascinating attractions, fabulous restaurants, new aquarium, local culture and nightlife, offer many leisure activities for meeting participants. You may be surprised at how mathematical a city Atlanta is, as well as being a gateway to history, art, sports, dining, and shopping.

<http://www.nctm.org/>

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 now,
please submit as much of the following information as possible.
Nominations are accepted at any time.

Nominations should include the following information. Use as many typewritten pages as needed. If possible, attach a vita of the nominee.

Name of the nominee

Current position

Your relationship to the nominee (e.g. principal, co-worker, etc.)

The nominee's contributions to mathematics education, NCTM, NCCTM, etc. (Please include information on specific offices held and honors received by the nominee.)

Any information about contributions to the community, teaching, and education that would be of value to the Rankin Award Committee in its deliberations

Other relevant information

Letters of endorsement from other colleagues may be included.

Date of nomination

Nominator* Name

Current position

Business or educational institution

Preferred mailing address

Preferred telephone number

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

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

Innovator Award Nominations

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

Nomination Form

Name of Nominee____

Present Position____

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

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

Signature:____Date:_____________________

Name (print/type):____

Position:____

Business or Institution:____

Address:____

Phone: Business:___________________ Home: _____________Email:_____________________

Send to: John Parker; 316 Soundside Drive; Nags Head, NC 27954

NCCTM Trust Fund Scholarship

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

Applicants must be:

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

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

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

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

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

(Please print all information.)

PERSONAL INFORMATION:

Name:______________________________

Home address:______________________________

____

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:

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's Signature:______________________________Date:__________

Principal's Signature:______________________________Date:__________

Instructor's 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.

MEMBERSHIP – NORTH CAROLINA COUNCIL OF TEACHERS OF MATHEMATICS

Name: ______________________________ Home Telephone: (____) - ____________

Address: ______________________________ School Telephone: (____) - ____________

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

School System: ______________________________

MEMBERSHIP STATUS

❑ New ❑ Former/Renewing Member # _________

POSITION

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

LEVEL

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

MEMBERSHIP DUES

❑ 1 year:	$10.00	____________
❑ 3 years:	$25.00	____________
❑ 10 years:	$75.00	____________
❑ Full-time Student:	$5.00	____________
❑ Contribution to Trust Fund:		____________
Total Payment Enclosed:		____________

Payment by ❑ Check ❑ Visa ❑ MasterCard

Card # ______________________________

Exp. Date ______________________________

Signature ______________________________

Please make your check or money order payable to NCCTM. Send this form and your payment to
NCCTM
P.O.Box 4604
CARY, NC 27519
Payments by credit card may be mailed or faxed to
919-859-3342