The Centroid

The Journal of the North Carolina Council of Teachers of Mathematics

In this issue:

- ☆ *Literate Mathematics Educator's Quiz: Updated for a New Century*
- ☆ *Math Teachers Circles: A Catalyst for Growth*
- ☆ *Math Contest Papers Accepted at the State Archives*
- ☆ *Logo Contest Winners*
- ☆ *Math Fair Winners*

Volume 43, Issue 1 • Fall 2017

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 college levels. *The Centroid* is published each year with issues in Fall and Spring.

Subscribe by joining NCCTM. For more information go to http://www.ncctm.org.

Submission of News and Announcements
We invite the submission of news and announcements of interest to school mathematics teachers or mathematics teacher educators. For inclusion in the Fall issue, submit by August 1. For inclusion in the Spring issue, submit by January 1.

Submission of Manuscripts
We invite submission of 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. Articles may be submitted at any time; date of publication will depend on the length of time needed for peer review.

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*.

Guidelines for Authors
Articles that have not been published before and are not under review elsewhere may be submitted at any time to Dr. Debbie Crocker, CrockerDA@appstate.edu. Persons who do not have access to email for submission should contact Dr. Crocker for further instructions at the Department of Mathematics at Appalachian State, 828-262-3050.

Submit one electronic copy via e-mail attachment 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.

Formatting Requirements

- Manuscripts should be double-spaced with one-inch margins and should not exceed 10 pages.
- Tables, figures and other pictures should be included in the document in line with the text (not as floating objects).
- Photos are acceptable and should be minimum 300 dpi tiff, png, or jpg 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*.
- All sources should be cited and references should be listed in alphabetical order in a section entitled "References" at the end of the article following APA style. Examples:

  Books and reports:

  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.

  Journal articles:

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

  Chapters or sections of books:

  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.

  Websites:

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

The Centroid

The Journal of the North Carolina Council of Teachers of Mathematics

Volume 43, Issue 1 • Fall 2017

About the Cover
The image on the cover depicts the centroid of a triangle.

Contact Information
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.

TABLE OF CONTENTS

NCCTM's Annual State Math Conference

November 2 and 3, 2017

NCCTM Leadership Seminar

November 1, 2017

Koury Convention Center in Greensboro, NC

Developing a Positive Mathematical Identity

Conference Keynote Speakers

Jennifer Bay-WIlliams, Karen Economopoulos, Valerie Faulkner, Joleigh Honey, William McCallum, Margaret (Peg) Smith, Lee Stiff, Jennifer Wilson

Leadership Seminar Presenters

Jennifer Bay-WIlliams, Margaret (Peg) Smith, Representatives from NC Department of Public Instruction

Preregistration Information

Conference: $65 for NCCTM members; $105 for non-members
Leadership Seminar: $65 for NCCTM members; $75 for non-members

Hotel Information

Rooms can be booked at the Sheraton Greensboro – Conference Hotel at a discounted rate using the online form.

Visit www.ncctm.org to preregister and for more information!

President's Message

State President Julie Kolb
Meredith College, Raleigh, NC
kolbjuli@meredith.edu

I hope that you had a relaxing and productive summer and are eager to start a new school year. I have enjoyed a little vacation time and have also had the opportunity to participate in some very interesting and worthwhile professional development activities. It's always nice to meet with other professionals to gain new ideas and activities for the classroom! In addition, it is rewarding to chat with colleagues and reflect on our practice; to think about what we have accomplished and what we hope to accomplish in the future; and discuss what we, as veteran teachers, can do to support and sustain the growth of our colleagues.

As members of NCCTM, we are fortunate to have many opportunities for professional interaction and development. Please enjoy the ideas presented in this issue of the Centroid and make plans now to attend the NCCTM Fall Leadership Seminar and Conference. I am very excited about the upcoming fall conference. The theme for this year's conference "Developing a Positive Mathematical Identity" relates to the research and writings of our featured speakers who endeavor to support all educators in the creation of a positive mathematical environment for all students. Being the nerd that I am, I enjoy the play on words in this theme! There are, of course, many mathematical identities that we use in the teaching and learning of mathematics, but that is not our focus. While thinking about a potential theme for the conference and exploring the work of our key note speakers, we found the following quote from Jenny Bay-Williams: "I believe that every child has the capacity to be mathematically proficient and we must design our schools and classrooms in ways that ensure that each student develops a strong mathematical identity." As educators involved in the implementation of NC Standards and creating classroom environments that are inviting to all students, this idea is especially relevant. It is our hope that the sessions at the conference will inspire and assist you as you encourage and enable all students to achieve a positive mathematical identity.

While the fall conference is the culminating activity of NCCTM, please be aware that there are many other activities and opportunities available to members of the organization. Please explore the website to learn more about Mini-Grants and the NCCTM Scholarships. Please encourage your students, and the students of your colleagues, to enter the Logo Contest, participate in regional Math Fairs, and compete in Math Contests. Start early in the school year to create excitement around these events.

I want to encourage each of you to become more involved in our great organization. Using the words of our Past-President, Ron Preston, if you are reading this and are not a member, consider joining. If you are a member, but participate in only one or two NCCTM activities, please consider participating in additional events. Perhaps this will be the year that you write a Centroid article, present at a spring regional conference, serve on a committee, or volunteer to serve as an officer. Invite a fellow mathematics educator to join you at the conference, to get his/her students involved in the Math Fair, and to read The Centroid. Share your ideas with the president, the Board of Directors, and the committee chairs. We have no limit on the number of members, the amount of talent, or the quantity of energy we can receive into our council!

I am very happy to have the opportunity to serve as president of the North Carolina Council of Teachers of Mathematics (NCCTM). I am just one of the many individuals who volunteer to serve this organization, and it is indeed a privilege to work with such a dedicated group of people. Let me know if you are interested in joining this great group of mathematics educators in serving the teachers and students of North Carolina! I hope that you will help me in sustaining the strength of our organization by continuing to be active participants and by providing me and the rest of the board with suggestions for activities that will meet your professional needs. We have a wonderful group of officers throughout the state and we are very excited about all that we hope to accomplish.

Please contact me with any suggestions that you have for improving our organization or ideas for professional growth activities and conference programs (perhaps you would like to make a presentation). Make it a great school year!

Literate Mathematics Educator's Quiz: Updated for a New Century

Maureen Grady, Rose Sinicrope, Ronald V. Preston, Charity Cayton, Catherine Schwartz, Kwaku Adu-Gyamfi, Catharina Middleton, and D. Brooke Hill
East Carolina University, Greenville, NC

The authors present a quiz designed to spark a few laughs and some lively discussion about what constitutes cultural literacy among mathematics educators.

Prompted by the wide adoption of the *Common Core State Standards* (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010), as well as the release of the *Mathematical Education of Teachers II* (Conference Board of the Mathematical Sciences, 2012), we are engaged in critical review and revision of our mathematics teacher preparation programs. A vital component under review is literacy in the content area. Communication about the role of literacy in mathematics teacher preparation has been challenging partly because of a lack of shared meaning of the term. "Literacy" has many different definitions (Shanahan & Shanahan, 2012) and those definitions often vary across subjects and grade bands (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010).

Engaged in this discussion of literacy in teacher preparation as mathematics teacher educators, we were reminded of *The Literate Mathematics Educator's Quiz* (Rudisill & Sinicrope, 1988). In the late 1980s the quiz was created in response to a flurry of discussion and concern about the cultural literacy needed to be a contributing citizen of the United States. We thought it was time for a diversion from the seriousness of our task of preparing effective teachers of mathematics to revise *The Literate Mathematics Educator's Quiz* and to generate discussion about what constitutes cultural literacy among mathematics educators.

We formed a panel of nine participants. Eight of the participants are experts in mathematics teacher education. Each of the eight holds a doctorate in mathematics education and has two to 30 years of university teacher education experience. The ninth member of the panel was a graduate student in mathematics education.

The panel reviewed the items of the original quiz (Rudisill & Sinicrope, 1988). Items unfamiliar to one or more panel members were evaluated to determine their current prominence in the field of mathematics education. We deleted some dated references such as those to older reform curricula (e.g., *SMSG*), policy documents, and software. Then each expert suggested additional items that are of current importance. These included questions about van Hiele levels and formative assessment. We also added more recently coined terms such as "Mathematical Knowledge for Teaching" and "edTPA." Additional revisions were made after reviewing the responses to the quiz from our graduating seniors.

We hope that you will enjoy the quiz as much as we enjoyed revising it. Although we primarily see this as humorous, we hope that it will raise questions about what it means to be literate in mathematics education. We also attempted to capture the type of conversation that occurs among mathematics educators. If you find it helpful as an assessment or just for fun, please use it with our permission.

So, sharpen your pencils, dust off your wits, and select the best answers to the multiple-choice questions. Our answers are provided at the end. You are, of course, free to disagree with any of them. If we spark a few laughs and some lively discussion about what is happening in our field, we will have fulfilled our goal.

References

Conference Board of the Mathematical Sciences. (2012). *The mathematical education of teachers II*. Providence, RI and Washington DC: American Mathematical Society and Mathematical Association of America.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common core state standards*. Washington, DC: Authors.

Rudisill, E. M., & Sinicrope, R. (1988). The literate mathematics educator's quiz. *Virginia Mathematics Teacher*, *14* (2), 16-19.

Shanahan, T., & Shanahan, C. (2012). What is disciplinary literacy and why does it matter? *Topics in Language Disorders*, *32*(1), 7–18. doi:10.1097/TLD.0b013e318244557a

Literate Mathematics Educator's Quiz

(1) Richard Skemp
- A) Relational and instrumental understanding
- B) Creator of RSVP
- C) Advocate for back-to-basics instruction
- D) All of the above

(2) Euclid's Fifth
- A) Euclid's unfinished symphony
- B) Postulate concerning parallel lines
- C) A Greek bourbon
- D) Plea used at Euclid's heresy trial

(3) Jean Piaget
- A) Foreign car
- B) Development stages of logical reasoning
- C) Miss Piggy's new baby
- D) Piaget's Little Theorem

(4) Blaise Pascal
- A) Invented an adding machine
- B) Projective geometry
- C) Triangular array of numbers
- D) All of the above

(5) Van Hiele Levels
- A) Seven-passenger vehicle for soccer moms
- B) Equipment for step aerobics
- C) Progression of geometric thinking
- D) Hands-on method for calculating mean

(6) STEM
- A) Some Time Engaged in Metamorphosis
- B) Student Teachers Employing Mathematics
- C) Squash Tomato and Eggplant Medley
- D) Science Technology Engineering Mathematics

(7) Mathematical Knowledge for Teaching
- A) Deborah Ball & Hyman Bass
- B) Quantum Integrable Systems
- C) Something funny about eggs
- D) Doing math without a calculator

(8) Hands-on
- A) Counting on fingers
- B) New brand of hand soap
- C) Mathematics with manipulatives
- D) Massage therapy technique

(9) Wait time
- A) Time it takes to download a new app
- B) Time spent waiting for students to answer questions
- C) Maximum amount of time before being greeted by wait staff after being seated
- D) A discrete math measure in queuing theory

(10) Paper folding
- A) Method of demonstrating fraction multiplication
- B) Method of creating really cool shapes to decorate your dorm room
- C) Method of demonstrating symmetry
- D) All of the above

(11) Euler Diagrams
- A) Similar to Venn diagrams
- B) The football diagrams used in Houston
- C) Allow for visualization of complex hierarchies
- D) Used to organize unrelated facts

(12) GSP
- A) Geometric Sums Postulate
- B) Great Semicircle of Pythagoras
- C) Global System Positioning for your vehicle
- D) Geometer's Sketchpad

(13) George Polya
- A) Predecessor to Gallup
- B) Napoleon's best friend
- C) Problem solving theorist
- D) All of the above

(14) PISA
- A) A multiple of pi
- B) Leaning tower
- C) Italian pie
- D) International assessment

(15) B. F. Skinner
- A) Graphic organizers
- B) Programmed instruction
- C) Weight loss specialist
- D) Developed first graphing calculator

(16) Tower of Hanoi
- A) Vietnam's version of the Leaning Tower of Pisa
- B) Biblical tower
- C) A strategy puzzle with discrete math connections
- D) Classic graph theory problem

(17) Tangrams
- A) Sunbathing grandmothers
- B) Seven polygons created by decomposing a square
- C) Metric measurement
- D) Messages converted from binary code to English

(18) Carl Friedrich Gauss
- A) Proved the Fundamental Theorem of Algebra
- B) One of the von Trapp children
- C) Map making and geodesy
- D) Developed famous problem solving method – Gauss and check

(19) Tessellations
- A) Parallel lines cut by transversals
- B) Things that make Tess really happy
- C) Tilings
- D) Mathematical puns

(20) Singapore Math
- A) Instructional approach developed by Liping Ma
- B) A mathematics instructional program
- C) A literature-music approach to math instruction
- D) An algorithm for solving quartic equations

(21) NAEP
- A) National Advancement of Educational Pedagogy
- B) New Aftermath of Ever-ending Problems
- C) New Approach to Evaluating Pi
- D) National Assessment of Educational Progress

(22) Flatland
- A) A two-dimensional world
- B) Fictional world
- C) Euclidean world
- D) All of the above

(23) Cuisenaire rods
- A) Attachments to a food processor
- B) Tool for changing tires
- C) Manipulative tool for whole numbers and fractions
- D) A unit of measure equal to one fortieth of a furlong

(24) Isaac Newton
- A) Developed the first fig bar
- B) Public television science reporter
- C) Discovered calculus
- D) Co-founder of Apple Computers

(25) Math Wars
- A) Armageddon
- B) Card game to review basic facts
- C) Early application of game theory
- D) Debate about modern mathematics education

(26) Geoboard
- A) Square or circular arrangement of pins
- B) Astrological chart
- C) Writers of the Common Core geometry standards
- D) Disinterested in geometry

(27) Sieve of Eratosthenes
- A) Greek tragedy
- B) Method of determining prime numbers
- C) A yuppie's sand toy
- D) Categorization procedure for geometries

(28) CCSSM
- A) Chuckie Cheese Special Sites Map
- B) Common Core State Standards for Mathematics
- C) Constantly Changing State Statistics Methodology
- D) Common Core Science Studies and Mathematics

(29) Chaos
- A) Friday afternoon pep rally
- B) A popular classroom management strategy
- C) Iterations of deterministic inputs
- D) Formless matter

(30) edTPA
- A) Educational Trial of Patience Assessment
- B) Educators' Tea Party Association
- C) Edge Transformation Postulate of Asymmetry
- D) Teacher Performance Assessment

(31) Function
- A) A graph
- B) A job description
- C) A univalent relation
- D) Under form

(32) High-leverage practices
- A) Methods to lift objects onto high shelves
- B) Teaching moves to maximize learning
- C) Math used to predict the highest yields on investments
- D) Practice that makes perfect

(33) Formative Assessment
- A) A special type of test or series of tests
- B) An intentional learning process teachers engage in with their students
- C) A program teachers adopt and add to what they already do

D) Gathering information about student learning to inform instruction

(34) Mathematics Discourse
A) A means to engage students in exchanging ideas about mathematics
B) A class taken to bash mathematics
C) A place to play golf with math professors
D) A famous debate between Einstein and Fermat

(35) Smarter Balanced
A) Diet focused on all food groups
B) Assessments for *Common Core*
C) High-tech scale
D) Better tool to balance equations

(36) Mobius strip
A) Slow, erotic dance
B) Strip on back of credit card
C) One-sided surface
D) Cartoon about a whale

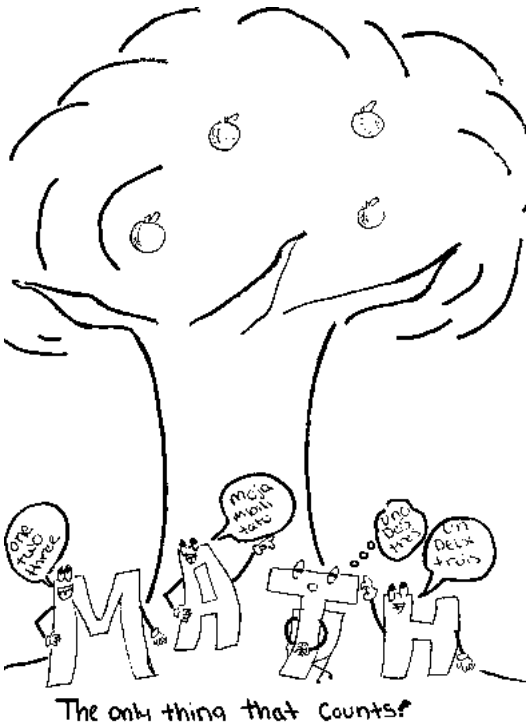
SOLUTIONS:
1 A; 2 B; 3 B; 4 D; 5 C; 6 D; 7 A; 8 C; 9 B; 10 D; 11 A; 12 D; 13 C; 14 D; 15 B; 16 C; 17 B; 18 A; 19 C; 20 A; 21 A; 22 D; 23 C; 24 C; 25 D; 26 A; 27 B; 28 B; 29 D; 30 D; 31 C; 32 B; 33 D; 34 A; 35 B; 36 C

2017 NCCTM Logo Contest Winners

Reported by Anthony Finlen, Asheboro, NC

The Mathematics Logo Contest is held each spring. The NCCTM Board selects the winning logo at its Spring meeting. The 2017 winning logo, pictured, will be available on shirts at the NCCTM State meeting in October.

State Winner: Eastern Region 9th Grader Kiersten Heels
Johnston County Early College Academy
Teacher: Sarah Holmes



Other Finalists:

Eastern Region
10th Grader Emma Boone, Ridgecroft School
Teacher: Jenks Johnson
10th Grader Flor Gaspar-Perez, NECP School
Teacher: Susan Cloer

Central Region
1st Grader Noah Martin, Seagrove Elementary School
Teacher: Rebecca Parks
5th Grader Victor Sanchez, Seagrove Elementary School
Teacher: Kim Gillispie
6th Grader Emma Key, Resurrection Lutheran School
Teacher: Lisa von Sprecken

Western Region
4th Grader Brinley Neal, North Brook Elementary School
Teacher: Denise Smith
8th Grader Allie Stafford, Harris Middle School
Teacher: Jennifer Revels
12th Grader Ashton House, Concord High School
Teacher: Kathrin Morrison

Math Teachers' Circles: A Catalyst for Professional Growth

Nathan Borchelt, Axelle Faugn, Kathy Jaqua, and Sloan Despeaux
Western Carolina University, Cullawhee, NC

The authors present the idea of Math Teachers' Circles, including some ideas for how to structure an MTC and some research supporting their use for professional development.

A dozen or so teachers and a few mathematicians from a local university gather in a small downstairs room at a local café on a rather chilly afternoon. They enjoy fresh baked cookies and their favorite coffee drink as they sit down at small rectangular tables to discover several stacks of various-sized pancakes sitting on plates in front of them. Their challenge this time was "The Pancake Problem," first posed by "Harry Dweighter" (read this out loud to get the pun) in 1975:

> *The chef in our place is sloppy, and when he prepares a stack of pancakes they come out all different sizes. Therefore, when I deliver them to a customer, on the way to the table I rearrange them (so that the smallest winds up on top, and so on, down to the largest at the bottom) by grabbing several from the top and flipping them over, repeating this (varying the number I flip) as many times as necessary. If there are n pancakes, what is the maximum number of flips (as a function of n) that I will ever have to use to rearrange them? (Dweighter, 1975)*

The tables decided to start with small cases and quickly finished off the 1- and 2-pancake stacks (finding that $f(1) = 0$ and $f(2) = 1$). They then started introducing notation for numbering their pancakes and symbolically representing the number of flips at each step. After finding that the 3-pancake stack would yield what they called a *pancake number* of 3 (i.e., $f(3) = 3$), one teacher conjectured that since they had pancake numbers of 1 then 3, the remaining pancake numbers would be 5, 7, 9, etc. Another teacher replied "it's not going to be that way." From the open-ended and challenging nature of the problem, she had captured that simple questions in mathematics often have complicated answers. It was just another evening in the Smoky Mountain Math Teachers' Circle.

Math Teachers' Circles

A Math Teachers' Circle (MTC) is a model for professional development (PD) that empowers teachers through an encouraging, collaborative, and non-competitive community of mathematics educators. Circle members include mathematics teachers and postsecondary educators who meet regularly to work together on rich mathematical tasks. They engage in shared experiences in order to deepen mathematical knowledge as well as strengthen pedagogical content knowledge. The goals of a MTC are (1) to engage school mathematics teachers in mathematical problem solving; (2) to involve them in an ongoing dialogue about mathematics with students, colleagues, and professional mathematicians; and (3) to provide guidance, materials, and resources to middle school mathematics teachers that will

enable them to promote open-ended problem solving as a way of learning, thinking about, and practicing mathematics in their classrooms (mathteacherscircle.org). This paper will present specific information on the MTC model and discuss ongoing research studying the impact of an MTC on its members.

An MTC needs an effective leadership team comprised of one to two college mathematicians and two to three in-service teachers. This group is responsible for planning, coordinating, and publicizing MTC events and activities. Both the leadership team and regular Circle members share ownership of the MTC, which is important to the success of the collective. A typical MTC involves two important types of planned activities each year. Each summer a residential immersion program is planned to build the community and launch the program for the following year. In the following academic year, the group meets regularly for monthly meetings. This model for PD is specifically recommended by the Conference Board of the Mathematical Sciences in the Mathematical Education of Teachers II Report (2012), "A substantial benefit of [Math Teachers' Circles] is that they address the isolation of both teachers and practicing mathematicians: they establish communities of mathematical practice in which teachers and mathematicians can learn about each other's profession, culture, and work" (p, 68). The Smoky Mountain Math Teachers' Circle (SMMTC) was formed in 2014 and serves as a catalyst to foster significant personal and professional growth of middle school and secondary teachers from the Western region of North Carolina, while engaging in rich and fun mathematics experiences.

Literature Background

In the midst of national curricular changes, NCTM published *Principles to Action*: *Ensuring Mathematical Success for All* (2014) which included a set of guiding principles reflecting significant actions that promote eight Mathematics Teaching Practices recognized as essential components of mathematics classrooms. The second of these Mathematics Teaching Practices encourages teachers to implement tasks that promote reasoning and problem solving. Effective teaching of mathematics engages students in tasks which allow multiple entry points and varied solution strategies. "Teaching Mathematics requires specialized expertise and professional knowledge that includes not only knowing mathematics, but knowing it in ways that make it useful for the work of teaching" (NCTM, 2014, p.11). NCTM's Guiding Principle for School Mathematics: Professionalism challenges educators to hold themselves and colleagues accountable for their personal and collective professional growth toward effective teaching and learning of mathematics (NCTM, 2014, p. 5), encouraging them to demand opportunities for PD and collaboration that strengthen mathematical content knowledge and implementation of Mathematical Teaching Practices (NCTM, 2014, p. 116).

A look at recent research on MTCs provides evidence that members of a MTC feel more pedagogically prepared and have increased self-efficacy as mathematics teachers. They use more inquiry-based teaching practices in their classrooms (Marle, Decker, & Khaliqi, 2012). Another study identified four principal categories as areas of growth through participation in a MTC: Mathematical Content Knowledge, Attitudes about Mathematics, Instructional Practices, and Professional Activities (White & Donaldson, 2011). Circle members indicated that they were more pedagogically prepared and have increased self-efficacy as mathematics teachers and mathematicians. Another study (Silverstein, 2014) determined that 97% of respondents said they had grown mathematically as a result of participation in MTCs, and 84% of the respondents reportedly had changed something about the way they teach mathematics.

If change is to happen in the American mathematics classroom, and in order to limit early attrition of the mathematics teacher workforce, supportive professional development (PD) opportunities that target content must be available to teachers. Such PD may take the form of teacher networks, in other words "a collection of teachers who: interact voluntarily and have opportunities to take leadership roles; have a shared sense of reform purpose related primarily to school improvement and self-reflective pedagogical inquiry; and seek both learning and collegiality through collaboration" (Morrison, 2011, pp. 2-3). Morrison identifies several key components of successful teachers' networks, such as fostering relationships first, maximizing collegiality through both online and in-person contacts, targeting the emphasis of knowledge type to the demographics of the network, building pedagogical expertise into teacher learning, building supportive teacher-driven structures, and organizing resources in an online archive.

Math Teachers' Circle members construct a shared identity and through social interaction evolve into a group with shared interests who exhibit the desire to grow mathematically and professionally through collective learning

experiences. Beyond the building of a network and the commitment to meaningful PD, it is the doing of mathematics and engagement with fellow educators that has the potential for a MTC to be a powerful force generating teachers' growth.

Themes and Focus Questions

At the heart of the MTC model are the strong, collaborative working relationships that are centered on specific content within a community of mathematics educators. Our work focuses on three types of relationships—a) social to combat the sense of isolation, which can particularly be felt by teachers in small schools, b) intellectual through the actual doing of mathematics independent of teaching content expectations, c) professional from embedded conversations that make connections to content from school coursework and new contacts for sharing teaching ideas/activities. We discuss the types of working relationships teachers build within the MTC model of PD by examining three components of these relationships.

1. What are the roles and actions taken by various members of the collective while engaged in mathematical exploration?
2. How does participation in a MTC affect the growth of Circle members as individuals and across groups?
3. How has participation in a MTC affected members' actions as mathematics educators?

Data Collection, Results, and Discussion

Data were collected from sources such as self-reported qualitative pre-/post- confidence and classroom transfer surveys in order to gauge the effect of MTC interventions on mathematics teachers' personal views of their own mathematical skills and their ability to translate newly acquired knowledge into their classroom. We also collected data on expectations, current implementation of problem solving in the classroom, and changes attributed to participation in this PD initiative. The videotaping of MTC interventions and teacher interactions provided qualitative feedback on roles assumed by members during the meetings. Finally, case study interviews allowed us to more specifically target those teachers who exhibit classroom transfers and serve as a feedback loop for the resources used back into the group for more extensive sharing of classroom implementation. University mathematics faculty were also interviewed regarding their initial motivation for joining MTC meetings, as well as possible implications of their participation on their teaching and professional growth.

These data show that Circle members approached each new meeting and new problem with curiosity and enthusiasm. Much of the positive reaction can be traced to the first interpretation of the roles within MTC, social interaction, and the resulting comfort with collectively attempting nontraditional problems. The nature of the problems made it possible for teachers at all levels to work together on solving them. Just because someone routinely worked with college-level mathematics, it did not mean that person would be able to solve the problems quickly. On the post survey of the summer institute, one member noted that it was "the easy interactions that kept the levels (elementary, middle school, secondary, college) from mattering. No one cared who knew more or less because the problems were generally not the standard ones." It is interesting to note that differences are recognizable in preferred solution techniques across the levels. College professors tend to jump to the paper/pencil abstraction quicker (which can be seen in videos of members working on problems), while elementary/middle grades teachers often insist on checking every step with the manipulatives (as in the pancake activity). These differences, however, did not inhibit interactions. In fact, one teacher noted, "The sharing of college instructors was wonderful; it made me really excited about next year and using everything with my students (even though school just finished); I want to keep searching this summer!"

Throughout the first year, teachers across levels also began to take on more leadership roles. Externally, Circle members made conference presentations about MTCs and their experiences participating in a MTC. Another group initiated a second MTC in a nearby city, taking on primary responsibility for advertising, developing, and leading MTC meetings. Internally, teachers began to take ownership of activities and to direct small group discussions. Ultimately, the roles and actions of MTC members allowed for professional and personal growth. Members, both teachers and professors, comment on increased mathematical awareness including access to new knowledge. Teachers indicated an increased desire to further investigate mathematics and to look for ways to make use of some of the concepts with their students. Following the summer immersion, one teacher expressed pleasure at being exposed to new ideas and a rekindling of the joy of learning/exploring mathematics. Another teacher stated

"I feel very excited about math these last few days. I know my excitement will carry over into the classroom." This ownership of mathematical knowledge and desire to use or implement it in their own classrooms is indicative of the common repertoire of the collective. Professors also reap benefits of active MTC participation, as the meetings broaden their appreciation and acceptance of various levels of thinking about mathematics. The increased collaboration with teachers is also seen as beneficial. One member stated that a "primary motivation for participation is to know teachers in the region, understand their struggle, and support departmental efforts towards community engagement."

Beyond the obvious networking bonuses that gathering a group of motivated mathematics teachers brings to their social and intellectual potential, the access to alternative pedagogies and available resources was also praised by summer participants. To the question "In what ways do you anticipate participation in a MTC may affect your classroom practice?" Several answered they would use games and activities in their classrooms in order to promote student engagement and to encourage "kids to struggle more" in a fun way, either by modifying existing activities, by taking the time to search more on their own, or by using activities shared during the workshop. Engaging in MTC investigative, open-ended tasks allowed teachers to better understand what they could expect from their students as problem solvers. They were reminded what it was like to struggle with mathematics as opposed to standing as the expert in the classroom. One teacher reported that "After a few activities I was always looking for a pattern, shortcut or prediction on the rest of the activities. If this has the same effect on my 7th graders, that would be amazing!"

Circle members comment extensively on the power of collaboration to help clarify problematic situations by examining different thought processes, as well as allowing various contributions to merge into a quicker path to finding a solution. In the fall semester, teachers had a chance to implement these changes in their classroom and reflect on them. Case study interviews allowed us to explore the successes and challenges the teachers faced in their classrooms. Interviewed teachers reported that they took steps towards letting students spend more time on problems and allowing them to struggle more as a result of being challenged themselves, which is often lacking in PD interventions. Teachers have a rekindled interest in searching educational websites for more interactive tasks, and also perhaps a better understanding of what makes a good task (hands-on and open-ended), which makes task selection easier. A growing interest in History of Mathematics shared with their students is also apparent: One teacher sent a student to an undergraduate History of Mathematics research conference. University professors did not report major changes in their classroom practices attributed to participation in MTC meetings. However, they do admit to better understanding where their students come from and to becoming more receptive to the idea of open-ended, hands-on work in their classroom. Both university faculty and school teachers mention time constraints as a major challenge for making these instructional modifications in their teaching.

The PD that the teachers created for themselves through the MTC was praised in member survey responses. One member highlighted the "fellowship with other math professionals and the "take aways" (both tangible games, as well as knowledge and depth of mathematics), and total immersion in a math community." By fostering confidence to tackle open-ended mathematics problems, teachers become better equipped to initiate more student-centered, inquiry-based pedagogies in their classrooms.

Future Directions

While in-service middle school teachers formed the initial focus of our MTC, we are gradually expanding this focus in several directions. The inclusion of high school mathematics teachers has proven to be a very natural extension. Middle and high school teachers have worked together seamlessly in sessions, and it is only the size limitations on a Circle, which become somewhat unwieldy above 20 members, that have induced us to separate the two groups of teachers into separate Circles. We also anticipate adding an elementary school MTC to what we expect to be a complementary chain of Circles that will meet altogether at least once a year. Additionally, a few senior pre-service teachers from our local university have gradually been infiltrating the Circle. This was not something that was originally intended, but the benefits of getting to collaborate and network with in-service teachers has proven to be an invaluable experience for them as they engage in their student teaching experiences.

Although it was not in our initial plan, the widened membership focus of our MTC will allow for the discussion of mathematics content across grade levels, often referred to as vertical alignment. The last piece of this vertical alignment puzzle comes from community college mathematics instructors currently recruited for Circle leadership

positions. Besides fostering a vertically-aligned PD experience for our local mathematics educators, we also want to replicate the MTC model all over the state. We have held "mock Circles" at professional meetings. We bring leadership teams from nascent circles to our summer immersion experiences and send our local team leaders to new Circles to act as mentors and facilitators. The ultimate goal is establishment of a North Carolina Network of Math Teachers' Circles. An anticipated outcome of this network is that it will provide support not only to establish, but also to maintain existing MTCs, while serving as a catalyst for professional growth for Circle members.

References

Conference Board of the Mathematical Sciences. (2012). *The Mathematical Education of Teachers II, American Mathematical Society*, Providence, RI; and Mathematical Association of America, Washington DC.

Dweighter, H. (1975). Elementary problem E2569. *American Mathematical Monthly*, *8*(10), 296.

Marle, P., Decker, L., & Khaliqi, D. (2012). *An Inquiry into math teachers' circle: Findings from two year-long cohorts.* School Science and Mathematics Association Annual Convention, Birmingham, AL.

Morrison, C. (2011). *Advice from the field of teacher networks: Informing a potential AP teacher network in Colorado. A study prepared for the Colorado Legacy Foundation.* Unpublished Master's Thesis, University of Colorado Denver.

National Council of Teachers of Mathematics. (2014). *Principles to action: Ensuring mathematical success for all*. Reston VA: Author.

National Governors Association Center for Best Practices and Council of Chief State School Officers. (2010). *Common core state standards for mathematics.* Washington, DC: Authors.

Silverstein, H. (2014). The state of the circles: National survey shows scope of MTC impact. *MTC Circular Summer*, Autumn, 4.

White, D., & Donaldson, B. (2011, January). *How do math teachers' circles affect teachers? Themes from teacher surveys*. Paper presented at the MAA Session on Fostering, Supporting, and Propagating Math Circles for Students and Teachers, Joint Mathematics Meetings, New Orleans, LA.

Innovator Award Nominations

The North Carolina Council of Teachers of Mathematics accepts nominations for the Innovator Award at any time. The Committee encourages the nomination of organizations as well as individuals. Any NCCTM member may submit nominations. The nomination form can be obtained from the "awards" area of the NCCTM Website, www.ncctm.org. More information can be obtained from: Dr Rose Sinicrope, sinicroper@ecu.edu.

Rankin Award Nominations

The Rankin Award is designed to recognize and honor individuals for their outstanding contributions to NCCTM and to mathematics education in North Carolina. 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.

The nomination form can be obtained from the "awards" area of the NCCTM Website, www.ncctm.org. More information can be obtained from Lee V. Stiff, lee_stiff@ncsu.edu.

Math Contest Papers Accepted at the State Archives

Reported by Heather South, Western Regional Archives, Asheville, NC
and Ralph Willis, Western Carolina University, Cullowhee, NC

The Western Regional Archives branch of the State Archives of North Carolina recently accepted two collections that, once we process and archive, will be available for research by the mathematics community and general public. These collections were donated by Ralph Willis, retired faculty of Western Carolina University. As the founder and coordinator of Western Carolina University's Annual High School Mathematics Contest from 1970 to 2010, Dr. Willis kept detailed and well organized records documenting the contest and its administration. It was during the first ten years that he assisted other campuses to initiate similar mathematics competitions which eventually served as a basis for NCCTM to establish the now statewide network of mathematics contests.

The WCU Mathematics Contest papers include copies of each of the four subject exams along with answer keys, press releases, and newspaper clippings for each contest year. There is also internal and external correspondence relating to organizational details, photographs of winners as well as the various categories of school winners, and details regarding the accompanying scholarship program. The State Mathematics Contest papers range from the first State Finals Competition 1978-1979 to Dr. Willis' final year with the program in 2009-2010. This collection contains all of the internal organizational correspondence, details regarding the scholarship program, teams that traveled to the ARML Competition, and all the exams administered in the second round of the State Finals Competitions in Algebra I, Algebra II, and Geometry.

The materials also include two sets of display panels that relate to NCCTM and its state-wide network of mathematics contests. The first of these include 30 panels assembled in conjunction with the NCCTM's 25th anniversary at the 1994 Annual Conference. They document the formation of the organization, its governance structure, activities, programs and awards, along with each years' regional and state conferences. The second group, fifteen panels, document the State Contest Committee celebrating its 25th anniversary. The display includes program brochures, exams, photographs of winners, listing of ARML teams, scholarship winners, and various other images.

The regional and state-wide mathematics materials are a wonderful addition to the archives. We want to add more collections with a STEM emphasis to our holdings and are looking for materials documenting both science and mathematics. For NCCTM, these might include Mathematics Fair history, NCCTM Governance materials, student affiliate information, regional councils, and the NCCTM's Publication, *The Centroid*. You'd be surprised at how often organizations overlook the historic research value of their own records, and we are grateful that Dr. Willis had the foresight to document and preserve his decades with the NCCTM State Math Contest and the WCU Mathematics Contest that started it all.

The Western Regional Archives are located at 176 Riceville Rd in Asheville. Our hours are 9am until 2pm Monday through Friday and by appointment at other times. To learn more about the WRA and these collections check out our website archives.ncdcr.gov/Public/Western-Regional-Archives, call 828-296-7230 ext. 240 or email Heather.south@ncdcr.gov.

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. In recent years, grants averaged just less than $800.

The application is available on the NCCTM website, www.ncctm.org. Proposals must be postmarked or emailed by September 15, and proposals selected for funding will receive funds in early November. 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. Email Sandra Childrey, schildrey@wcpss.net, with questions.

2017 State Math Fair Winners

Reported by Betty Long, Appalachian State University, Boone, NC

NCCTM sponsors three regional Math Fairs each spring, and the best projects presented at these regional Fairs qualify for the State Math Fair. This year's State Fair was held at the North Carolina School of Science and Mathematics on 28 April 2017. The following students were selected for top honors in each division.

Primary Division, Grades K-2

1st Place: "Relay Race Around the World"; Santana Wade; International School at Gregory, Wilmington
2nd Place: "Barbie Math"; Jovie Beecham; Coddle Creek Elementary School, Mooresville
3rd Place: "Which One is the Easiest? Addition, Subtraction, or Multiplication?; Alexander Song; A.B. Combs Elementary School, Raleigh
Honorable Mentions: "Road to Running"; Kaydence Moore; Poplar Springs Elementary School, King
"Bottle Flip 1.0"; Kade McLawhorn; Snow Hill Primary School, Snow Hill
"Sports Measuring"; Blake Burge; Poplar Springs Elementary School, King
"Count the Rainbow"; Andrew Blanton; Lake Norman Elementary School, Mooresville

Elementary Division, Grades 3-4

1st Place: "Getting My House Off the Grid: A Cost-Benefit Analysis"; Sarrah Kitchell; Valle Crucis Elementary School, Sugar Grove
2nd Place: "Home Field: Is it an Advantage?"; Steuart Reiss; Codington Elementary School, Wilmington
3rd Place: "How to Calculat and Plan a Healthy Meal for Your Body Type and Weight"; Deen Shehzad; Sandy Ridge Elementary School, Durham
Honorable Mentions: "Cupcake Math"; Anna Burnett; Coddle Creek Elementary School, Mooresville
"Spaghetti Dinner on a Budget"; Sophia Smith and Caleb Pun; Excelsior Classical Academy, Durham
"On Target!"; Sumner Basinger; Lakeshore Elementary School, Mooresville

Intermediate Division, Grades 5-6

1st Place: "Carolina Pick 3: Is it a Fair Game?"; Abigail Winslow; Excelsior Classical Academy, Durham, NC
2nd Place: "Our Waste Wastes Water"; Will Kelley and Jackson Greene; South Asheboro Middle School, Asheboro
3rd Place: "Cut and a Twist"; Colin Hanes; Carnage Magnet Middle School, Raleigh
Honorable Mentions: "Programming With Squares"; Michael Giurcanu; Hope Middle School, Winterville, NC
"Math for Problem Solving: Parking Lot Solution"; Nick Patnaik; Lake Normal Elementary School, Mooresville, NC
"It's Outta Here"; Chance Mastin; East Wilkes Middle School; Ronda

Middle School Division, Grades 7-8

1st Place: "What Does Sports Greatness Mean?"; Reif Snyder; Mt. Mourne IB Middle School, Mooresville
2nd Place: "Bridges"; Rolando Hernandez and Jeannette Graham; South and North Asheboro Middle Schools, Ashboro
3rd Place: "Can Trend Lines Predict the Future?"; Freddy Kelly; South Asheboro Middle School, Asheboro
Honorable Mentions: "The Math Behind Dance"; Grace Miller; Lakewood Montessori Middle School, Durham
"A Kicker's Payday"; Jackson Heubel and Sam Adams; Hope Middle School, Greenville
"Plug Into the Sun"; Fatima Abdul Aleem; Al-Iman School; Raleigh

High School Division, Grades 9-12

1st Place: "The Banach-Tarski Paradox"; Malachi Clark; Asheboro High School, Asheboro
2nd Place: "RSA Encryption"; Carlton Ellis and Jazmin Santillan-Castillo; J.D. Clement Early College High School, Durham
3rd Place: "Crossbar Calculating"; Sarah Sarp and Olivia Sessoms; Clinton High School, Clinton
Honorable Mention: "Time Dialation"; Davonya Cheek; J.D. Clement Early College High School, Durham
"The Great Clinometer"; Tyler

Trust Fund Scholarships: Now $1000

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 the 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.

The Trust Fund Committee is pleased to announce that the amount that can be requested to help with the cost of graduate coursework is now $1000.

Applications will be reviewed biannually, and the deadlines for applications are March 1 and October 1. The nomination form can be obtained from the grants and scholarships page on the NCCTM Website (www.ncctm.org). More information can be obtained from Janice Richardson, richards@elon.edu.

Donating to the NCCTM Trust Fund

Did you receive a Trust Fund Scholarship that helped you to complete your graduate coursework and you want to show appreciation? Do you wish to memorialize or honor someone important to you and your career as a math teacher?

Consider making a donation to the NCCTM Trust Fund, please send your donation, payable to Pershing LLC for the NCCTM Trust Fund, to:

Joette Midgett
North Carolina Council of Teachers of Mathematics
P. O. Box 33313
Raleigh, NC 27636

Problems to Ponder

Holly Hirst, Appalachian State University, Boone, NC

Fall 2017 Problems

Grades K–2: Henry wants to build three raised beds in his garden to plant vegetables. He wants to build two beds shaped like triangles and one shaped like a square. If he wants to make each side of the beds out of a board that is 10 inches long, how many boards does he need and how long are all the boards together?

Grades 3–5: According to wired magazine, when a squirrel hibernates in the winter, its heart only beats 10 times per minute, which is 5% of its normal heart rate. How many beats per minutes is the squirrel's normal heart rate?

Grades 6–8: Jody brags that his Dad's car can go 200 miles in 3 hours, and Steve says his Dad's is faster because it can go 300 miles in 4 ½ hours. Is Steve right?

Directions for submitting solutions:

1. Students: NEATLY print the following at the top of each solution page:
   - Your first name (we will not publish last names)
   - Your teacher's name
   - Your grade
   - Your school
2. Submit one problem per page. ***Students who submit correct solutions will be recognized by their first names only in the next issue of The Centroid.*** We will also publish one or two especially creative or well-written solutions from those submitted. If you would rather not have your name published, please so indicate on your submission.

Proper acknowledgement is contingent on legible information and solutions. Send solutions by 21 December 2017 to:

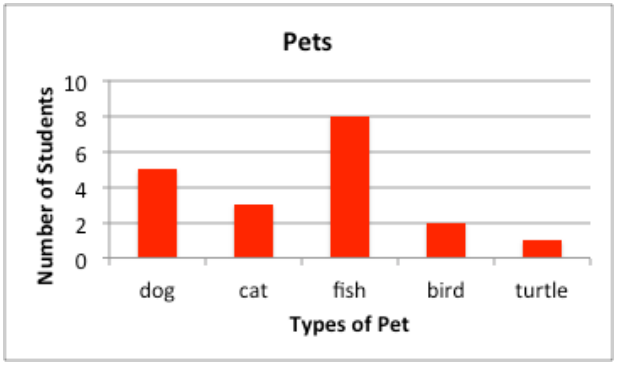
Problems to Ponder, c/o Dr. Holly Hirst
Mathematical Sciences
BOX 32069 Appalachian State University
Boone, NC 28608

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.

Spring 2017 Problems

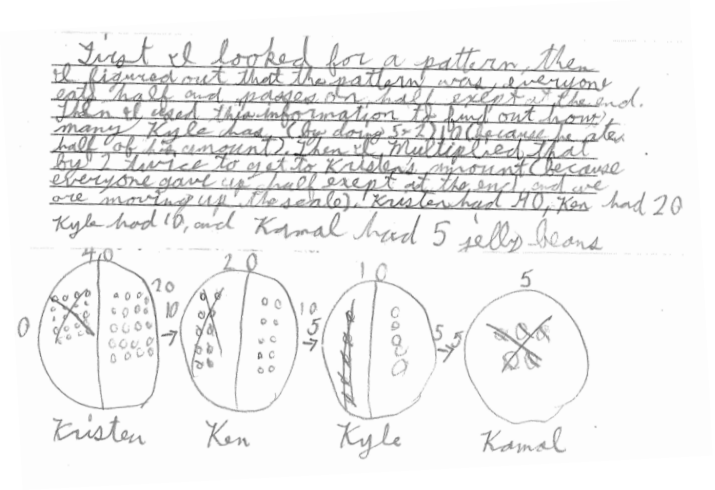
Grades K–2: Mrs. Burns' second grade class drew the chart to the right showing the pets belonging to the students in the class.

Joan has 2 dogs and Jayleen has 8 fish, but everyone else in the class has only one pet. How many pets are there total? How many students are in the class?



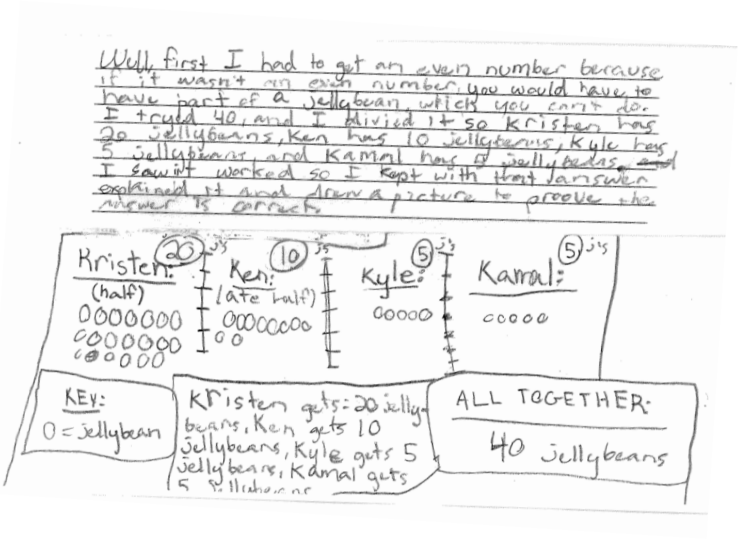
No correct solutions were received. Teachers: Send in responses if you want to use this problem during the 2017-18 school year!

Grades 3–5: Kristin gave half of her jelly beans to her brother Ken and ate the rest. Ken ate half of those jelly beans and gave the rest to brother Kyle. Kyle ate 5 of those and gave the last 5 jelly beans to brother Kamal to eat. How many jelly beans did each child eat?



Many correct responses were received from Mrs. Mark's 4th grade class and from Ms. Keane's 4th grade class at the Ravenscroft School. Submitted by Mrs. Byrne.

The top example is from student number 1 in Mrs. Mark's class, and the bottom image is from student number 19 in Ms. Keane's class.



Grades 6–8: Mr. Gibson is creating a tulip garden and wants to plant a large area with 300 bulbs with equal amounts of each of four colors. He already has 32 red bulbs, 26 orange, and 9 yellow, but no white ones. How many more of each color does he need? If the bulbs cost 25 cents and you get 10% off if you purchase 50 bulbs of the same color, how much will Mr. Gibson spend?

No correct solutions were received. Teachers: Send in responses if you want to use this problem during the 2017-18 school year!

Introducing Illuminations' newest app: **NCTM KenKen**

The app includes 241 FREE puzzles of the variety that America's puzzlemaster, Will Shortz, calls, "the most addictive puzzle since Sudoku!" Download the ad-free, classroom-friendly app today!

NCTM has created lesson plan ideas go to with the app! Check out: http://illuminations.nctm.org/KenKenLP

NCCTM Board

contact information can be found at ncctm.org

Officers

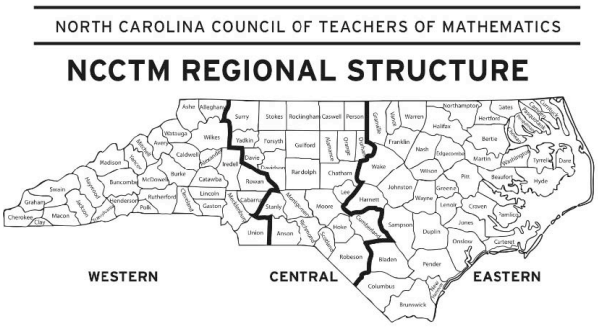
	State	Eastern Region	Central Region	Western Region
President	Julie Kolb	Tim Hendrix	Julie Riggins	Karen McPherson
Past President	Ron Preston	Lynnly Martin	Vincent Snipes	Marta Garcia
Elementary Vice President	Kitty Rutherford	Leah Southerland	Deanna Wiles	Brian Bettis
Middle Grades Vice President	Katie Martin	Kim McCuiston	Sara vaughn	Jessica Vernon
Secondary Vice President	Michelle Powell	Renea Baker	Allison Yokeley	Laura Baucom
College Vice President	Katie Mawhinney	Charity Cayton	Tracy Howell	Holly Pinter
Other State Officers	Secretary Christina Pennington	Parliamentarian Wendy Rich		

Committee Chairs

Centroid Editors, Holly Hirst and Debbie Crocker
Webpages, Holly Hirst
Conference and Exhibit Services, Kay Swofford
Convention Services, Marilyn Preddy
Financial Chair, Ray Jernigan
Handbook, Ray Jernigan
Historian, Kathryn Hill
Leadership Conference, Julie Kolb
Management Services, Joette Midgett
Math Celebrations, Anthony Finlen and Heather Thomas
Math Contest, James Beuerle and Phillip Rash
Math Counts, Harold Reiter
Math Fair, Betty Long
Minigrants, Sandra Childrey
NCDPI Representative, Kitty Rutherford
NCSSM Representative, Ryan Pietropaolo
NCTM Representative, Debbie Crocker
NCSM Representative, Debbie Crocker
NCMATYC Representative, Luke Walsh
Nominations, Ron Preston
Rankin Award, Lee Stiff
Special Awards, Rose Sinicrope
Student Affilliates, Lisa Carnell
Trust Fund, Janice Richardson

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 33313
RALEIGH, NC 27636