

## Math Circles Flourish throughout the Front Range

Math Circles began in Eastern Europe in the 1800s, with the goal of sharing the beauty of mathematics. These extracurricular clubs, led by mathematicians and math teachers, began to appear in the United States about thirty years ago and now can be found throughout the country. In Colorado, the Colorado Math Circle, Pikes Peak Math Teachers' Circle, Rocky Mountain Math Teachers' Circle, and Northern Colorado Math Teachers' Circle are four examples. One attracts student participants and the other three attract teacher participants. All strive to reveal the joy of mathematics through inquiry-based learning.

### Colorado Math Circle

Now in its seventh year, the Colorado Math Circle brings high school and middle school students to the University of Colorado Boulder campus for math talks and collaborative problem solving. Sponsored by the CU-Boulder Outreach Committee and Department of Applied Mathematics, the CMC is intended for high school and middle school students looking for math enrichment beyond the standard classroom curriculum. Student participants are given an opportunity to learn advanced math topics and meet like-minded students who share their enthusiasm for math. In 2010-2011 the CMC attracted 170 students from 71 different schools and 30 hometowns across Colorado.

Twice a month the CMC offers talks by mathematicians and math teachers, on topics ranging from number theory to geometry to dynamical systems to computational linguistics. Past speakers have included faculty from CU-Boulder, UCCS, University of Northern Colorado, Colorado State University, Colorado College, and Fort Lewis College. In addition to hosting talks, the CMC offers problem-solving sessions to challenge students with difficult math problems and encourage them to work together to find solutions. This past month participants explored Ramsey Theory, Penrose tilings, and the Seven Bridges of Königsberg problem, all in a group setting.

A highlight of the year is the national ARML competition, the largest on-site math competition in the U.S. Each year the CMC selects and trains thirty of Colorado's top high school students to compete against

the country's strongest math students in a challenging team contest. The Colorado ARML Team has been remarkably successful these past six years: twice the team has won national honors, and three times a Colorado student has ranked among the top ten individuals.

During the summer the CMC leads free weeklong workshops at CU-Boulder. Using puzzles, games, multimedia presentations, and hands-on activities, these sessions show young students how fascinating and fun math can be. The CMC also offers the Sophie Math all-female summer workshops which help talented girls to develop confidence in their problem solving skills, and to encourage them to consider careers in math, science and engineering.

Each year Colorado Math Circle students win numerous state and national honors in mathematics. CMC alumni, now college students, are attending undergraduate research programs, publishing undergraduate research papers, and giving talks at math conferences. They have won national honors, including the NSF Graduate Research Fellowship, Barry M. Goldwater Scholarship, William Lowell Putnam Mathematical Competition honor roll, and Frank and Brennie Morgan Prize for outstanding undergraduate research in math. CMC alumni have returned to give talks and advice to younger students.

Middle school and high school students are welcome to attend any meeting free of charge. For more information, visit the Colorado Math Circle website at <http://www.coloradomath.org/>, or contact Silva Chang at [mathcircle@coloradomath.org](mailto:mathcircle@coloradomath.org).

### Pikes Peak Math Teachers' Circle

The Pikes Peak Math Teachers' Circle was formed in June 2008 as part of the Partnership for Innovative Preparation of Educators and Students project at University of Colorado Colorado Springs. The goal of PIPES is to increase the PIPEline of students who are interested in STEM topics, in order to increase the number of high school students who are both interested in, and prepared for, majors and careers in STEM disciplines. PIPES is a research project (funded by the Air Force Office of Scientific Research); the philosophy of the research program is that hands-on, inquiry-based methods in STEM education can be an effective way of increasing the STEM pipeline. This philosophy meshes perfectly with the Math Circle approach of inquiry-based

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discovery in mathematics.

The PPMTC is currently working with its third cohort of teachers. Each summer since 2009 a group of middle school math teachers from throughout the Pikes Peak region has participated in an intensive three day (25 contact hour) Teacher Circle Academy in Breckenridge. Dr. Brian Hopkins (St. Peter's College, New Jersey) has been the leader of the each of the three Academies. Participants experience the concept of a Math Circle. Teachers work in groups to try to solve math problems that are both open-ended and challenging.

During the subsequent academic year, each cohort of teachers attends six 2.5 hour Seminars on the UCCS campus, held roughly once per month. During the first hour of these Seminars a mathematician will give a presentation in the Math Circle style: an open, challenging, inquiry-based question will be raised, and the teachers will work in groups to try to understand the various patterns or ideas which underlie the mathematics involved. After a quick break for sandwiches, the second hour is taken up with presentations by the teachers themselves, with reports on activities they have used in their own classrooms. The discussion surrounding these activities is always quite lively.

The PPTMC has received quite positive feedback from participants. Most teachers not only like the activities that they learn in the Circle which they can incorporate in their own classrooms, they also seem to very much like being challenged to learn new material and new ideas. Many say it's nice to feel like a student again!

Applications for the fourth PPMTC cohort (June 2012 and the subsequent AY 2012-2013) are now being accepted from middle school math teachers from the Pikes Peak region. (This is, broadly defined, as Castle Rock to the north, Divide to the west, and the New Mexico and Nebraska borders to the south and east.) Information is available at <http://www.uccs.edu/~pipes/ppmtc2.html>. For general questions about the PPMTC, contact Gene Abrams at [abrams@math.uccs.edu](mailto:abrams@math.uccs.edu). For information about the PPMTC Academy and Seminars, contact Kathleen Fitzpatrick at [kfitzpat@uccs.edu](mailto:kfitzpat@uccs.edu).

## Rocky Mountain Math Teachers' Circle

Imagine fun, engaging, open-ended, challenging mathematical problem solving with enthusiastic colleagues and math faculty members-during the summer and on

Saturday mornings! That's what the Rocky Mountain Math Teachers' Circle is all about.

The journey began in 2009 as a partnership between the Department of Mathematical and Statistical Sciences and the University of Colorado Denver and the St. Vrain Valley School District. It has since expanded to include teachers from across the entire state. Each summer, there is a weeklong immersion workshop for middle-level (grades 4-9) math teachers. During the academic year, Saturday morning sessions run once per month, nine in all, and interested teachers are invited to attend as their schedule permits.

Part of the summer workshop and a small portion of each session are dedicated to discussing classroom connections and implementation of problem solving in the classroom. But first and foremost, the goal is to re-excite and re-energize math teachers by engaging them in mathematics with their colleagues.

The Rocky Mountain Math Teachers' Circle is part of a national network of Math Teachers' Circles, loosely organized by the American Institute of Mathematics, with 34 active chapters and 11 in their initial planning year. Thus far, approximately 80 teachers from 20 different school districts across Colorado have participated, and that number grows with each additional session.

Thanks to generous foundational and grant support, most recently from the Mikkelson Foundation and the National Science Foundation, thus far there has been no cost to participants. Teachers from across the state are invited to participate.

Dates for the Summer 2012 weeklong immersion workshop, to be held in Downtown Denver at the University of Colorado Denver, will be finalized by the end of the fall semester, and applications will be accepted soon after. Interested districts or teachers are invited to contact the program director about tailoring some sessions or coming to your district to help with the professional development needs of your math teachers.

For details or additional information, visit the website, <http://rmmtc.ucdenver.edu>, or contact the program director, Diana White, at [Diana.white@ucdenver.edu](mailto:Diana.white@ucdenver.edu).

## Northern Colorado Math Teachers' Circle

The Northern Colorado Math Teachers' Circle is the most recent Math Teachers' Circle in Colorado. Serving Greeley and Northern Colorado, and formed in spring 2011, this

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circle is currently pursuing funding opportunities and planning their inaugural summer immersion workshop to be held in Estes Park from June 25-29, 2012. During this free five-day residential mathematics immersion workshop, middle school math teachers from Greeley and surrounding communities will work on problem-solving activities and have opportunities to connect the problems to their own classroom curriculum. Each day will consist of approximately 7.5 hours of highly interactive mathematical problem-solving sessions. During the 2012-2013 academic year the Northern Colorado Math Teachers' Circle will hold six free monthly dinner seminars (3 contact hours) at the University of Northern Colorado where teachers will engage in problem-solving activities. More information can be found at <http://www.unco.edu/NHS/mathsci/teachercircle.html>. For general questions, contact Cathleen Craviotto at [Cathleen.craviotto@unco](mailto:Cathleen.craviotto@unco).

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