

The Math Circle Summer Institute at Notre Dame

Bob and Ellen Kaplan

At the beginning of Plato's *Republic*, Socrates describes a procession he had seen the day before, where riders carrying torches handed them on to one another. This image exemplifies the conversation he and his friends then have. It also describes our own Math Circle discussions. Our method, however, isn't Socratic: we aren't trying to elicit specific answers to coyly posed questions. Ours isn't even a method, since we're not imposing a fixed template on different topics and different people. What happens grows organically toward broad and deep mathematical insights and their proofs, from the qualities of whoever happens to be present.

People can learn this approach, as our Math Circle Summer Teacher Training Institute last July at Notre Dame showed. We will hold the Institute again this summer. Last year 24 people came from across the country, as well as from Mexico, Singapore, and Argentina. They ranged from elementary school teachers to university professors, and the mix was wonderful. After playing the role of students

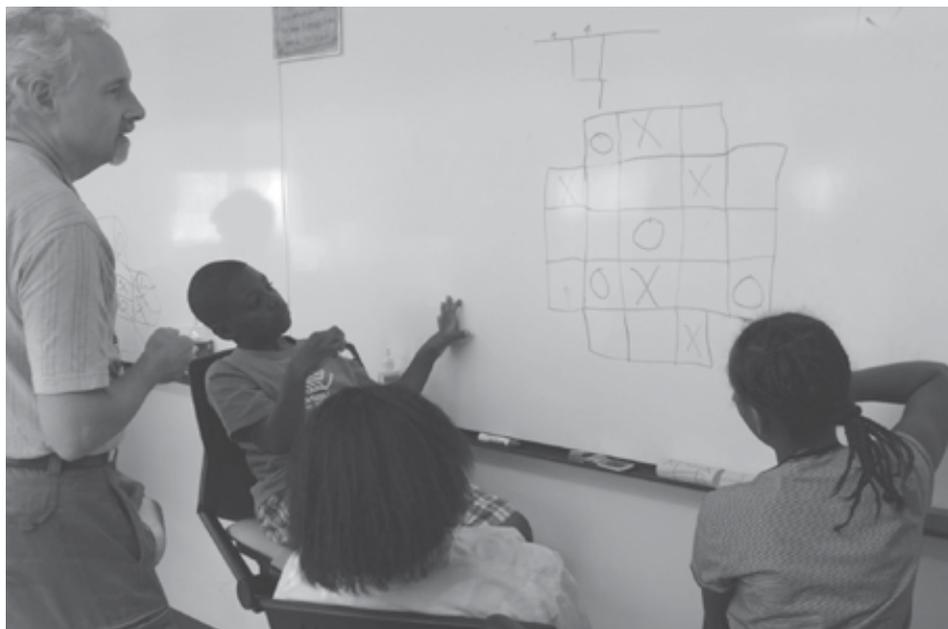


The participants in last year's Institute.

in classes led by the four of us, they then led classes of their own with the students (ranging in age from five to sixteen) we had gathered. These sessions alternated with discussions of the theory and practice of our approach, and congenial evenings of working on math together.

The key idea is to pose an accessible mystery: Can you tile a rectangle with squares, no two of which are congruent? What is the mathematics of origami? Which polygons can be constructed with straight-edge and compass? Why does $e^{i\pi} = -1$? Then let people loose on it. Rather than saying "No, it goes like this..." or "Here, let me explain..." the leader nudges the conversation as unobtrusively as possible toward fruitful lines of thought. People come away from these classes with a real sense of what it means to do math, and of how mutual struggle can be suddenly rewarded by the fireworks of an insight. Their delight in their colleagues, and a new assessment of themselves, galvanized their confidence along with their competence.

Participants at the Institute have described it as a transforming experience. "I was able to learn more about math than in all my years of high



Trying to figure out Tic-Tac-Toe on a torus.

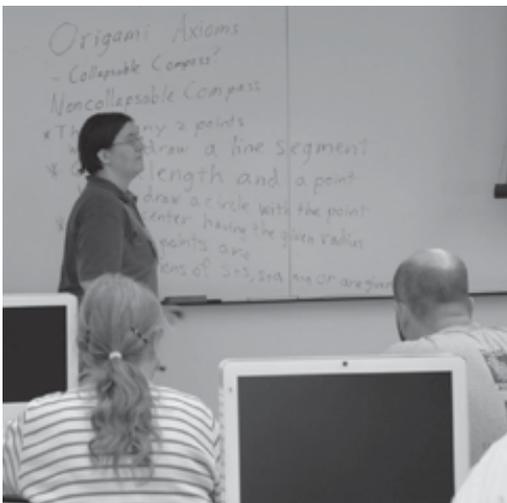
school when I literally sat terrified in my seat,” one of them said. Another said that the Institute had “affected my perception of myself and of my relationship with mathematics. As a result it will improve the way I teach and I will be starting a Math Circle in our Kids’ Club when school resumes. Math is freedom!”

Part of the magic is in the collaborative, rather than competitive, atmosphere. “It was great because people were working together, getting really involved in the math. I myself was more intensely involved in doing math problems than I’ve been for a long time.” One person said that “I didn’t pursue a PhD because I knew I wouldn’t enjoy working alone so many hours a day. Here, we talked math and did math most of our waking hours, and it was glorious! Flexible schedule, no stress, meant I had lots of energy to keep thinking hard all day.”

Several participants felt that this approach could have real impact on mathematics teaching in the United States. “How do we get Americans to be less intimidated and more able in math & sciences? The answer is the Math Circle teaching technique... I don’t think I can explain why this approach works while our traditional one fails other than to say that it helps students to learn to think and to deal with hard problems.”

Last year’s institute attracted a group that was not only multinational, but also multi-professional. One participant pointed out that “The presence of non-teachers at what could be considered a professional development opportunity for teachers speaks well for the idea, and provides a unique source of inspiration for teachers. During the week,

a vibrant and diverse cohort has formed simply for the love of math. There has also been an intrinsic motivation for the cohort to establish a way to persist.” There was talk of starting a Wiki to allow continued collaboration.



Working out the axioms for origami.



Bob Kaplan teaches how to count.

“This institute has been the best math teacher training I have had since starting to teach in 1982. The passion for math is contagious! I have learned so much and am inspired to share it with my colleagues. The best part of this experience was to be around and talk to other teachers who are excited about and care deeply about teaching. An atmosphere was created where the participants felt relaxed and their passion spread to everyone. I left the sessions wanting more.”

Many of those who attended have since opened Math Circles of their own all over the country. We hope more will come and spread the message.

To apply, and for more information on the upcoming Math Circle Institute at Notre Dame, July 5th to 11th, please contact Bob & Ellen Kaplan at kaplan@math.harvard.edu or Amanda Sereney at viajera6@gmail.com. See also the Math Circle home page at <http://www.themathcircle.org/>.

Bob and Ellen Kaplan have run the Boston Math Circle for many years. They are the authors of several books, including Out of the Labyrinth, which describes their approach to communicating mathematics. In his MAA Review, Dennis Lomas said that the book “offers a lucid, firsthand account of unfolding mathematical insight and growth of mathematical knowledge. Many are likely to find this book useful and insightful, including students, teachers, philosophers, psychologists, and those who might wish to follow in the Kaplans’ footsteps.”