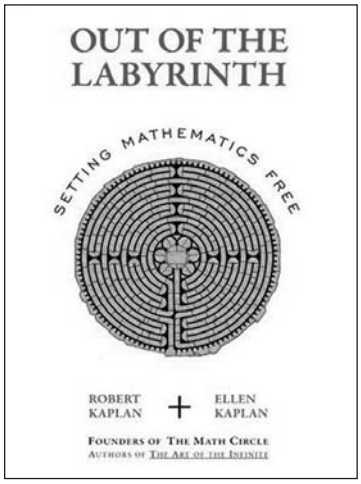

Out of the Labyrinth

Reviewed by Jesse Johnson

Out of the Labyrinth: Setting Mathematics Free
Robert Kaplan and *Ellen Kaplan*
Oxford University Press, USA, 2008
US$15.95, 256 pages
ISBN-13: 978-0195368529

Imagine that you are one of my students. You are 14, maybe 15, and you have never been asked to memorize your multiplication tables. It's unlikely that you have ever been asked to do homework. The word "fraction" and the sight of more than a sentence of words make you groan. You have lived in New York City your whole life. It's unlikely that you have a family member who has gone to college, but you definitely want to go. You have liked math at some point in the past, but your math teachers have never had more than two years of teaching experience, and your classmates are so distracting that you have long since decided that the best thing about math class is text messaging with your friends down the hall. Whether you think you are good or bad at math, learning it in class is difficult, as though you're walking in flip flops through snow up to your belly. When you do engage with mathematics, inevitably frustration, fear, insecurity, anger, disappointment, boredom, discouragement, or self-loathing get the better of you, and you check out.

Now, imagine that this fall, you walk into a different sort of classroom. There are only a few other kids, maybe five or ten, and you all have made the choice to be there. The teacher is more of a guide than a leader, and she's asking really interesting questions. You immediately have some ideas about the answer, and you know without any convincing that these questions matter. You feel excited, interested, engaged, thoughtful. You don't care that you could be playing video games now instead of being here in this classroom. You are working together with these other kids, none of whom is smarter or stupider than you. You are part of a group mind, like an athletic team, except that the other team is really on your side. No one cares who is talking, so long as you are collectively making headway in figuring out this problem. The answer starts to gel. You are happy, exhilarated—but only for a minute, because you're already moving on to the next question, asking how to extend this now completely obvious truth, to discover something else. It's absolutely riveting. This is the Math Circle.

Teaching mathematics is considered an exceptionally difficult task because so many kids come to math without enjoying it or believing they are good at it. Students and their families are comfortable dismissing fluency in mathematics as a worthwhile or necessary pursuit save as a means to get into college or graduate from high school. As a teacher, I have tried to join the ranks of amazing curriculum writers and educators who use modeling, discovery, application, and investigation to shine a light on the beauty, joy, and usefulness of mathematics. But it is a difficult, bewildering task.

In Robert and Ellen Kaplan's Math Circle, however, this task seems to be not only the central purpose but also the Circle's great success. They have written an excellent book about how math circles work, the context in which the circles have been successful, and why they are distinct from typical classroom structures.

The Math Circle is the Kaplans's contribution to improving the way kids experience mathematics. *Out of the Labyrinth* is the Kaplans' contribution

Jesse Johnson is a teacher of mathematics at New Design High School on the Lower East Side of Manhattan. Her email address is johnson.jesse@gmail.com.

to transforming the way educators and mathematicians alike think about math education. It has inspired my approach to teaching high school math in New York City, and I recommend it highly to mathematics educators as well as mathematicians who want to share their love of mathematics with others.

The Rise of Math Circles in the U.S.

The tradition of math circles originated in Eastern Europe and Russia during the twentieth century. These informal meetings of students were led by mathematicians and focused on providing substantive, creative engagement with mathematical ideas outside of the usual topics taught in schools. By stimulating bright young minds, these circles inculcated life-long love of mathematics and the sciences and provided a breeding ground for many of the great scientists from that part of the world. The Kaplans's Math Circle, begun in Cambridge, Massachusetts, in 1994, was the first to be established in the United States; another one was launched in Berkeley in 1998. The success of these two circles inspired others in the San Francisco Bay Area and across the country to start up circles of their own. (Robert Kaplan wrote an article, "The Math Circle", which appeared in the September 1995 issue of the *Notices*; see also "Math Circles and Olympiads. MSRI Asks: Is the U.S. Coming of Age?", by James Tanton, in the February 2006 *Notices*.)

According to the Mathematical Sciences Research Institute (MSRI) in Berkeley, which has carried out several programs to foster math circles, there are over forty active circles in the United States in such locations as San Diego, CA; Mobile, AL; Flint, MI; Salt Lake City, UT; St. Louis, MO; and Albany, NY. As the MSRI website explains, math circles vary greatly in style. Some are very informal, with the learning proceeding through games and stories; others are more traditional enrichment classes. Some prepare students for Olympiad competitions, while others eschew competition. No matter what the style, all math circles share the goal of getting students to enjoy learning mathematics and provide a social context in which that learning happens.

MSRI is developing a website (`http://www.mathcircles.org/`) for math circles, with the aim of eventually developing a National Association of Math Circles. In April 2009 MSRI held a workshop called "Great Circles", which attracted over eighty participants. In addition, the Mathematical Association of America now has a SIGMAA (Special Interest Group) on Circles, for those working in or interested in starting math circles.

—Allyn Jackson

What Is the Math Circle?

The Math Circle is a small extracurricular mathematics workshop in which students discuss deep mathematical content in a lively context, the result of which is to "waken in everyone first an awareness of, then a love for, and finally the power to do mathematics" (page 159). Every participant in a math circle has chosen to be there. Most of the classes are made up of five to fifteen students of approximately the same age, with the occasional parent or janitor. The Math Circle has students who range in age from five to seventeen and study mathematical topics atypical for their ages: set theory for elementary schoolers, taxicab geometry for middle schoolers, and combinatorial geometry for high schoolers are just a few examples. They meet for an hour each week for ten weeks to discuss and investigate a particular problem, during which time they explore the problem from an intuitive and later a more formal and rigorous perspective.

Math Circle courses evolve and adjust to the specific needs and interests of the students present. There is no homework assigned because Circle facilitators know that the problem will percolate of its own accord in students' minds. There is no shame in the Math Circle, both because the leaders don't make space for it to grow, and because the students are so engaged they forget whatever shame they might have come in with. They abandon ego, the myth of talent, and the idea that the goal is to be the best in the class or even best as a group in some competition. The facilitator asks questions that are open-ended and interesting, accessible and significant. The questions invite problem solving while always building up a deeper and larger sense of the whole mathematical context. The students and facilitator work together on one problem over the course of the ten weeks, deepening their understanding, developing their arguments, and generalizing their own procedures—in short, learning mathematics through doing. For the students, the facilitator is just one of many footholds along their way. The Kaplans charge, "You learn math by inventing or discovering it yourself" (page 204).

Out of the Labyrinth

Before getting into the nitty-gritty of the Math Circle, the Kaplans spend a lot of time analyzing what makes mathematicians who love math different from the rest of the world. What is it that we enjoy? Why is this joy such a rarity in our communities? The Kaplans believe that it isn't anything particularly special about us. They argue that all people are capable and pretty much ready at any moment, whatever their histories, of

having great experiences doing math. They reason that our definitely human architectural instinct, which drives mathematical thought, is as natural and necessary to our existence as breathing. "The passion for order, the delight in symmetrical balance and asymmetrical tension, the sense that the whole, which is greater than all its parts is the whole *of* those parts—all these are expressions of this instinct" (page 76).

Lacking models in both school and home that respond to momentary failure in mathematics with resiliency and persistence, most people have no reason to believe they can be successful at math if they have instead experienced failing and then giving up. Our society subscribes to a cultural belief in natural talent that, combined with teachers who are afraid of math, negative stereotypes about what it means to be a mathematician, and the utter inaccessibility of mathematical language and symbols, makes it almost impossible for many people even to conceive of the idea of loving math.

The first 140 pages of the book are devoted to the Kaplans's analysis of the joys, struggles, and demands of doing mathematics. They consider people who have had discouraging experiences with mathematics, as well as those who have had great experiences. The premise of the book, in large part, is to understand the gap between these two ends of the spectrum and suggest what might connect them. Reading this book is a bridge for those of us who love math to understand the experience of those who don't. The Kaplans offer the Math Circle as a bridge in the other direction.

So what is necessary to do mathematics? I'd love to read your lists. Robert and Ellen say: be stubborn, risk becoming enthralled, learn to step back. Much of what they suggest amounts to something that sounds a lot like meditation. On page 74, there's a quotation of C. J. Keyser about Sophus Lie, whose answer was: "Imagination, Energy, Self-Trust, Self-Doubt." The authors add to this list fearlessness and risk-taking. "It is like falling in love" (page 34). I wonder how many people have felt this about anything, much less mathematics? Is it possible my students could be blissful in math class?

Out of the Labyrinth offers an illuminating description of the qualities we develop when we do mathematics: stubbornness, a high threshold of frustration, attention without tension, precision, an ability to break things apart, playfulness, experimental fervor, architectural instinct. The Kaplans describe the many cultural, educational, language, and social barriers to developing these qualities that explain why we don't all love math. They summarize the long global history of mathematics education, critiquing the "cookbook math" that has been found in most math classrooms since ancient Egypt.

Finding the Math Circle in the Classroom

This book helped me to understand what it is I do when I do math and why I like it so much, and this understanding clarified how important it is for my students to enjoy doing math. It is a challenge to share the wealth not just of my knowledge but also of my joy and the meditative, transcendent experience of doing math. How I can offer more enjoyment to my students is still a problem, addressed only in part by the Kaplans in this volume.

"It would be ideal were today's hurdles removed and understanding math made the goal, rather than passing tests on the names of things and the application of rules" (page 185). The Math Circle approach is a critique of and a response to contemporary and historical models of mathematics education. I do wish that the Kaplans would bring their brilliance into the classroom. I wish they would bring their immense eloquence and experience to writing a book that is much more rigorous in describing teaching techniques, rich problems, and subtleties of facilitating group collaboration and discussion. The Math Circle may not be a perfect model for classroom teaching, and the students' self-selection distinguishes Math Circles from a typical classroom. Nevertheless all of the ideological elements of the Math Circle structure are adaptable for classroom teaching. As a result of reading this book, I have introduced more problem solving, open-ended exploration, and discussion into my classes. I am more attuned to the experience of my students, whether they meet me loving math or not, and I put a high priority on cultivating the excitement the Kaplans identify as necessary for feeding interest and enjoyment of mathematics. This year most of my students do enjoy math class and feel comfortable asking deep questions and probing for the answers themselves. To ice the cake, I have two freshman girls who asked for my help in pursuing degrees in mathematics.

I believe that if it is indeed possible for anyone in a Math Circle to enjoy learning mathematics, then it must also be possible to teach math educators how to provide opportunities for students to enjoy learning mathematics. I want to know how to come up with those meaningful questions within the state curriculum and create a classroom where my students feel capable and engaged. However difficult it may be to teach these things, I hope the Kaplans choose to take this on in more detail in their next book.

The Math Circle gives kids the experience of discovery and allows them to develop confidence in their own abilities to question and understand the world. If the capacity to enjoy mathematics is within reach of all people, what is getting in the way? I believe this is arguably the most important question we mathematicians can be thinking about, and I tip my hat to the Kaplans for their help in both answering the question and closing the gap.