

## The Art of Teaching Mathematics

By Garikai Campbell, Jon Jacobsen, Aimee Johnson, and Michael Orrison

On June 10–12, 2007, Harvey Mudd College hosted *A Conference on the Art of Teaching Mathematics*. The conference brought together approximately thirty mathematicians from the Claremont Colleges, Denison, DePauw, Furman, Middlebury, Penn State, Swarthmore, and Vassar to explore the topic of teaching as an art. Assuming there is an element of artistic creativity in teaching mathematics, in what ways does it surface and what should we be doing to develop this creativity?

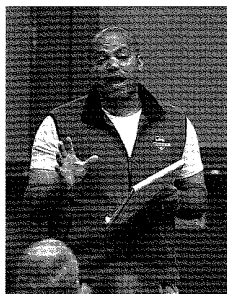
The first day of the conference focused on the art of teaching and the second day

ics among the students. It was, she said, an experience that not only significantly broadened her understanding of both teaching and learning mathematics and improved her own teaching, but also one that confirmed her sense that teaching mathematics is an incredibly artistic endeavor.

After Maria set the tone for the conference, George Andrews (Penn State) framed the discussion by challenging the notion of teaching as a science and arguing why we must consider teaching as an art. Although there are many lessons we can learn from scientific studies of teach-

in which one learns to accommodate for all these variations. This parallels the subtle variations we see in our students, classrooms, and college environments. To this end, George argues we should be developing our teaching through the relationship of master and apprentice.

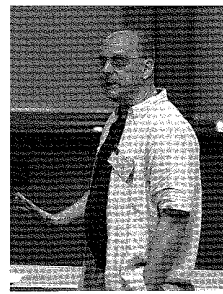
With this in mind, the conference turned to theater to discuss ideas from that realm that carry over to the classroom. Ann Woodworth, a theater professor from Northwestern University introduced these ideas in “The Classroom as a Stage,” a workshop in which we both talked about and were required to perform the physical



Garikai Campbell



Ann Woodworth



Tom Garrity

focused on building community within this craft. The conference was organized by Jon Jacobsen and Michael Orrison at Harvey Mudd College with assistance from John Harris and Mark Woodard (Furman), Ben Lotto (Vassar), and Lew Ludwig (Denison). It was funded by a grant from the Andrew W. Mellon Foundation.

Maria Klawe (Harvey Mudd) opened the conference with “Lessons Learned from a Third Grade Classroom.” Maria recounted her four years collaborating with a third grade teacher to explore the effectiveness of mathematical computer games and other activities in enhancing the motivation and learning of mathemat-

ing, George maintained that because of the personal nature of teaching, there will always be aspects of these studies which fail to be repeatable or transferable.

The classroom environment is filled with empathy, self-awareness, subtle adjustments, and other tacit knowledge that is communicated but not stated. Alluding to the work of the philosopher Michael Polanyi, George said, “We know more than we can tell.” George prompted us to consider, for example, creating a violin. One needs to work with wood, cat gut and a number of other materials with high degrees of variations. Teaching one to create a violin from these raw materials requires a hands-on sort of training

act of teaching.

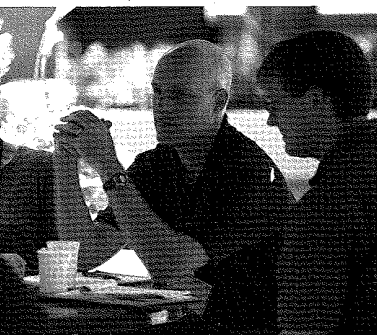
Ann pointed out that according to some, much of what we communicate is non-verbal and of the remainder, up to half is tone. So, in the end, a very small percentage of what we actually communicate is content. Ann demonstrated this, for example, by saying the same simple phrase in three different tones with three distinct sets of body language. The mathematicians in the audience recognized, perhaps surprisingly, the multitude of similarities and connections between acting in theater and teaching in the classroom and the value of paying attention to one’s physical presence and voice. This is not to suggest that we don’t do this already,

but there are tricks one can employ to do even better.

From there, the conference shifted focus and on the second day, concentrated on building community. Garikai Campbell (Swarthmore) reflected on community building through the Professional Development Program (PDP) Summer Math Institute at Berkeley. The program was developed by Leon Henkin and Uri Treisman to, in part, encourage underrepresented minorities to consider pursuing a PhD in mathematics. Garikai talked about his sense of the key communal components of the program that made the year he spent there as a student, one of the most rewarding, exciting, and invigorating mathematical experiences he has ever had.

In particular, he recalled that the intellectual engagement instigated by the organizers, encouraged by the faculty and actualized by the students extended well beyond the courses being taken — students talked about mathematics as a whole; mathematical ideas that were related to things touched on in other students’ classes; and even meta-mathematical and philosophical ideas.

Students talked walking back from classes, over meals, on the way to concerts, and out at the weekend picnics. Moreover, the program seemed to be built around a triumvirate of high intensity, high expectations and high accountability and on the principle that a truly successful community should provide students the opportunity to transform how they see themselves so that ‘student of mathemat-



Participants at a breakout session.



Group photo.

ics’ has the potential to be one’s primary identity.

Finally, Tom Garrity (Williams) talked on “Using Mathematical Maturity to Shape Our Departments.” Other disciplines don’t seem to have a corresponding notion of mathematical maturity, he argued, so what is this thing we seem to have so uniquely in mathematics? One can trace through the time a student is in elementary school through undergraduate years, through graduate school to beginning professor to full professor to emeritus and outline the specific skills and reasoning ability one should have minimally attained at each level. Once one does this,

a good question one could ask is: what are the ways a department can facilitate the continued development of this mathematical maturity? Tom shared examples from Williams such as Faculty Jam Sessions, in which a few people give talks, in one sitting, around a single topic, and Faculty Dadaism, where over lunch, the department picks three areas out of a hat and tries to make connections.

An interesting theme that appeared throughout the conference was the importance of tacit knowledge in learning — whether it be from the teacher, the classroom environment, the social environment on campus, or the college environment. There was a common thread throughout the conference that suggests we need to do more thinking about what is happening outside our classes. Focusing only on the lectures and homework is a limiting factor.

In our mathematical culture teaching is generally not viewed as an art or craft and master teachers are somewhat reluctant to take on the title and/or to articulate what makes them a master. However programs based on this concept such as Project NExT clearly demonstrate the progress that can be made by embracing this model.

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