Journal of Mathematics Education at Teachers College

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A Century of Leadership in Mathematics and its Teaching

TABLE OF CONTENTS

Preface

Articles

TABLE OF CONTENTS

LEADERSHIP NOTES FROM THE FIELD

Mathematics department faculty have prior experience and outside interests that enliven and enrich the instruction they deliver in the classroom. They often take leadership roles, and the scholarly environment at Teachers College is uniquely supportive of their reflection on the character and meaning of leadership.

In the following section, *Leadership Notes from the Field*, authors present the stories of projects of special importance to them. Three articles discuss the building of schools. Stuyvesant has arguably the strongest mathematics program of any public high school in New York City. Stuart Weinberg and Maryann Ferrara chronicle the development of that mathematics department, which they chaired in turn over many years. The HELP Primary school in Uganda and the Nambale Magnet School in Kenya are at the opposite end of the economic spectrum, but they too teach mathematics to youngsters. Peter Garrity and Nicole Fletcher discuss their assistance to the development of the school in Masese, Uganda. Similarly, Phil and Loretta Smith participated with the Nambale school's founding, and they write of the complex project of funding and building a new school in a developing country.

Among the common threads to these articles—the power of mathematics education to lift the less fortunate, the personal rewards of serving others, the time and effort it takes to build a school—the most pertinent to our leadership theme is *collaboration*. At Stuyvesant leadership is spread across the faculty and the levels of the organization, "shared leadership." For the Nambale school a charismatic priest sparked the work and contributions of many individuals and groups, "distributed leadership." The Mathematics department at Teachers College is itself a highly collaborative environment. It is fitting that we close the Journal's leadership issue with personal observations by department faculty regarding the collaborative nature of leadership.

House of Representative. While on this path less travelled, one student, Tom, wrote, "I never thought that the literature I've read about the 'American Identity' would have such a strong correlation to a math subject." Deciding on a method of apportionment involves more than examining the mathematics but relates to "what America values." Analyzing a method of apportionment for adherence to rules and for the possible existence of paradoxes in the context of fairness says that "we value a just process." The students found the topic "intriguing" because of "how alive it is, a topic as important now as it was in revolutionary times." Jenna wrote, "I love history . . . and I think it is very interesting that our Founding Fathers' debate can be related to the mathematics of apportionment." Sam wrote that the topic "gave me a new lens from which to view history." The topic appealed especially to those who considered themselves to be "humanities types" and provided an opportunity for both mathematical and literary expression.

How do we fit this topic in an existing curriculum short of starting a new course? Steal time! How? Go back to the previous paragraph that begins with "avoid more of the same and unnecessary repetition and review." And continue to look for new pathways for introducing your students to the mathematics they need to know.

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Mathematics Teaching and Learning: A Reflection on Teacher Training in Rural Uganda

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Building an elementary school, developing mathematics curriculum, and training teachers in Rural Uganda is a task filled with many challenges due to the lack of resources and high levels of poverty in the area. Embedded in these challenges are opportunities for creativity and leadership as teachers begin to shift from an education framework based on rote memorization and learner passivity to one that includes collaboration, active learning, and teaching for understanding.

Keywords: Uganda, mathematics teacher training, professional development, African elementary school

When asked the question, "What do you need?" an unemployed teacher and resident of Masese, Uganda replied, "Some paper, pencils, and $30 per month."

HELP International, a medical relief non-profit organization, opened the first free school in Masese in May 2009 with one teacher and 40 students in an open shed. The multigenerational cycle of illiteracy started to break on that day. Today, the HELP Primary School educates 400 children pre-kindergarten through fifth grade with nine teachers in a newly constructed school building.

HELP Primary School, located in a small village outside of Jinja, was created to offer free education to those students who could not afford the fees typically required to attend school in Uganda. Masese has many generations of uneducated people due to extreme poverty. Dr. Peter Garrity, Adjunct Professor of Mathematics Education at Teachers College, and Nicole Fletcher, PhD student at Teachers College, have joined forces with HELP International to assist in the development of the HELP Primary School. Here is their story.

In 2010, medical volunteers from HELP International expressed their desire to start a school and their need for educational expertise in doing so. That same year, I[1]

[1] First person singular references here refer to the first author.

volunteered to travel to Uganda to help organize the school, analyze the curriculum, and provide training in mathematics instruction. When I arrived, I found many children who were eager to learn. I also found a large, open shed serving as classroom space for four classes, no classroom teaching materials, no library, black painted wooden boards used for blackboards, a few donated chairs and benches, some old textbooks donated from the United States, and no set curriculum.

I worked with members of the U.S. team to begin addressing the administrative needs, and after a few days of observing classes, I began to plan professional development for a staff of teachers with little classroom experience or knowledge of effective mathematics teaching strategies. I realized that I was facing a major problem: How do you transition a pedagogy employing repetition, the British method of instruction employed by the Ugandan teachers, to one encouraging student interaction and problem solving? To lead them into this process, I had to establish trust with the teachers. I did this by getting to know the teachers and their students outside the classroom and by observing, teaching, and spending time each day in their classroom. I wanted to show them that I understood their situation, and I also wanted to show them the possibility of engaging mathematics teaching and learning in what seemed like a limiting situation. Once trust was established, I used a simple strategy from my professional development workshops in New York: meet with the teachers to tell them what strategies they will see, let them see the strategies in action with students in their classrooms, and then meet to reflect on the observed strategies.

We collected donations of mathematics manipulatives to bring to Masese, including base ten blocks, geoboards, and fraction strips, all with the goal of introducing the principles of constructivist pedagogy to the teachers. After just two weeks of conducting model lessons, observations, and professional development meetings, the Masese teachers were trying the strategies and using the manipulatives in their classes.

The teachers began to look for ways to use manipulatives, but when you have limited resources, where do you find manipulatives to accommodate a class of 50 to 90 students? The teachers have proven to be very creative. In my first session with third grade (known as Primary 3 or P3), when I asked students to add 16 and 18, they gave me 214 as the answer. To address this error and to build an understanding of place value, I introduced base ten blocks. I told a story: A farmer had 16 goats in a field and brought 18 more goats into the field, how many goats did he now have in the field? The story was used to provide context for the students in order to reflect on appropriateness of an answer. The base ten blocks were used to provide a concrete representation of place value. These two strategies, providing meaning and concrete representation, enhanced student retention. Once a few of the students understood the regrouping concept, they made up addition problems and demonstrated their understanding using the base ten blocks in front of the class. Although American teachers are employing this strategy as a way to better align with the shifts of the Common Core Standards, it represented a considerable challenge in Uganda because of their culture and the large numbers of students in a class. We demonstrated the value of stories and student presentation in classes as well as in the professional development sessions, they are strategies that will take time for them to incorporate into practice.

The potential for change is there, and it is evident in the teachers' reflection session, but after the base ten block lesson. During the discussion on place value, the teachers observed it would be very difficult to use base ten blocks with so few sets and so many students. As an alternative strategy, I described the use of the chip abacus as another way to understand operations with place value. In this strategy, three columns representing hundreds, tens, and ones are drawn on a piece of paper or on the ground. A number is then defined by the number of chips placed in each column. Simon Peter, the P3 teacher, saw this as a manageable solution to the group's observation. The next day he led the class outside to find small pebbles to use as chips and then showed the students regrouping in addition with their stones. With very little, the teachers use their ingenuity to find creative ways to address a concept to help the children understand.

Later with P3 we began to develop the concept of multiplication. Geoboards were used to demonstrate the area model of multiplication. Students used rubber bands on the geoboard to create a rectangular array from which they had to count the number of squares formed by the rectangle. From the geoboard we introduced array sheets where students were given multiplication sentences and asked to draw the array, color the interior, and tell us the product. I also demonstrated an alternative approach for introducing arrays by using the children themselves. The children became the array. For the product of ten we had four groups of students, the first group formed a 1 by 10 array, the second, a 2 by 5 array, the third, a 5 by 2 array, and the last group, a 10 by 1 array. I guess sometimes a large class has its benefits.

After the 2012 school year began, I faced new problems in my work with HELP Primary school: a dramatic increase in enrollment, two new grade levels, and requests from teachers from a nearby school to participate in the mathematics professional development program. With the number of teachers attending the workshops doubling and the addition of two new grades, I realized it would be best to conduct the workshops for two levels, lower elementary (K–3) and upper elementary (4–6), thereby allowing greater focus on the strategies most appropriate for those grade levels. My style of teacher training is very interactive, with teachers working in groups, exploring materials, and experimenting with strategies. Splitting the teachers into two groups helped

P3 students working with base ten blocks

Dr. Garrity co-teaching a lesson on multiplication using geoboards

to reduce the number of teachers in the sessions and increased teachers' opportunities for engagement in the workshop activities.

Word began to spread throughout the Jinja School District about the training sessions being taught by a professor from Teachers College Columbia University. Soon teachers from other schools in surrounding towns asked if they could also attend the free mathematics teaching workshops, a rare professional development opportunity in this area. A "good" problem was emerging. In response to the growing number of teachers requesting to attend the workshops and support from the Education Department in Jinja, I designed multi-day courses in mathematics teaching and learning at three levels: kindergarten, P1, and P2; P3 and P4; and P5, P6, and P7. I invited my former student, Nicole Fletcher, to join the professional training team because of her strong background in both early childhood education and mathematics. We analyzed the government-mandated mathematics curriculum for P1 (the first grade for which official curriculum is available) through P7 and developed a series of hands-on workshops in which we taught the Ugandan teachers mathematical concepts and specific strategies for implementation in their classrooms.

In the workshop for P5, P6, and P7, I emphasized problem solving as the key to true understanding of mathematical concepts. I demonstrated how to develop a concept using problems created by the teachers. I utilized concrete and visual models to introduce fractions, percents, and algebraic concepts and then showed the natural transition to algorithms. For the first time, the teachers truly understood both the mathematics they taught to their students and strategies that would lead their students to understanding.

In the workshop for kindergarten, P1, and P2, the focus was numeracy, place value, problem solving, and operations. The workshop also introduced strategies that help make abstract concepts concrete for young children. Some of the strategies focused on the classroom environment or daily routines and others dealt with instruction and activities during mathematics lessons.

One difficulty that arose during the workshops was lack of materials and resources for teachers to implement the strategies into their classrooms. Our team brought donated mathematics manipulatives for the HELP Primary School, but we were now delivering professional development to a wider audience of teachers from all over the Jinja School District. This forced the workshop group to be creative and come up with alternative ways to incorporate these new strategies into under-resourced classrooms. Some of the ideas discussed included creating fraction "tiles" using a template glued to card stock; making a set of base ten blocks by cutting old cardboard into "units," "rods," and "flats;" and making handwritten number lines, hundreds charts, and other visual resources for the classroom. Whenever possible, we

Nicole coaching teachers on how to use the chip abacus

also introduced activities that required use of an abundant resource in every class—children. An example of this was the human graph, where the class is polled on a particular question, such as favorite color, and then the children line up according to their answer. This was used to introduce the concept of comparing quantities and related vocabulary such as more, less, same, and difference. This was also used to introduce fractions with older children.

The Ugandan school system requires students to demonstrate sufficient mastery of grade-level material in order to move ahead. Children take nationally-administered exams every year starting in P1 and cannot move to the next grade level until they have passed the examination. A consequence of this requirement is large enrollments in P1 and P2 due to low passing rates. A challenge of the workshops was trying to help teachers implement the new strategies when some had upwards of 90 students of varying ages in a class. Though the idea of dividing such a large number of students into groups was daunting and a break from their traditional teaching methods, the teachers realized that implementing group work could immediately increase the level of engagement in their classrooms. During the workshop, teachers were able to see that by implementing group work, all students were now able to actively participate in discussion around collectively solved problems and present their work to the class, creating opportunities for peer-to-peer learning and again increasing engagement in the classroom.

We went to Uganda as a humanitarian venture to teach, inspire leadership in teachers, and improve the quality of mathematics teaching in the school. We understood very quickly that students cannot be attentive and learn if they are hungry. Since the establishment of the school, we now provide lunch and breakfast each school day as well as lunch during the school breaks for all students and staff. Prior to the establishment of the school food program, children generally ate every third day, as that was all the parents could manage.

So we return to the initial question, "What do you need?" Today, the answer from the teachers of Masese is: another school building to accommodate students through the secondary level, more well-qualified teachers, more professional development, textbooks, furniture for the school, decent sanitation facilities, and a security fence. The list of needs has grown, along with the ambition of these dedicated teachers to provide a higher quality of education to their burgeoning student body. Our goal is to clothe, heal, feed, and educate *every* child in Masese. We have indeed begun steps to achieve that goal.

Faculty Attitudes Toward the Cultivation of Student Leaders

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This paper discusses how the faculty at an urban public middle/high school prioritized the identification and cultivation of student leaders in order to improve equity, classroom management, and student learning. Faculty identified student leaders, piloted steps to develop them, and shared a rubric to assess leadership performance. The paper illustrates a promising case of faculty collaboration, but also the limitations of a relatively inexperienced group in a challenging demographic and institutional setting. A focus on student leaders may help teachers advance the mathematical practices prioritized by the Common Core mathematics standards.

Keywords: student leadership, Common Core State Standards, student-centered classroom, mathematical practices, faculty attitudes

Introduction

During the first six months of the 2012–2013 school year student leadership emerged as a topic of faculty and administration discussion at the school where I teach. Initially our interest was a reaction to the observation that most faculty efforts were spent on misbehaving students or those with weak academic performance. It seemed unfair; it also seemed unwise. A consensus formed that influencing a relatively small number of leading students might be an efficient way to improve the overall classroom learning environment as well as promote higher-level academic behavior. In particular we wanted students to be more self-reliant, to work hard at problems, and to articulate their reasoning in discussion with other students. The faculty spent several meetings identifying student leaders and developing ideas to cultivate the leadership behaviors we desired. The project is ongoing.

I suggest that the spontaneous local action taken by the faculty at this school should be viewed from the perspective of three research contexts. First, the high-level academic behaviors the faculty targeted are the *mathematical practices* the mathematics education establishment has required in the *Common Core State Standards for Mathematics* (CCSSM) (National Governors Association Center for Best Practices & Council of Chief State School Officers [NGA & CCSSO],