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# Training Elementary Teachers for the New Millennium

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The elementary teacher of the future will work with children who are surrounded by numerous technologies and confronted with an explosion of information. The teachers and the children will be unable to learn all the new technologies and all the information, because it will be impossible to keep abreast of all the new knowledge that will be created. These teachers of the future will need to be able to be lifelong learners and will need to help children become more independent learners.

With the support of the Exxon Education Foundation, we are working with small cohorts of elementary teachers and preservice teachers to change the students' world view of mathematics from a subject that is to be "taught" to one that is to be "uncovered." The basic idea of the PRIME (Partnership for Reform in Mathematics Education) Project is to allow the students to construct knowledge concerning new mathematics concepts and pedagogy. The students take college mathematics classes with this focus, and are mentored in elementary classrooms by teachers in the project.

In this article we will describe the classes taken by the project members and the student field experiences. We will share our successes along with lessons which will guide us as the project continues.

### A PERIOD OF DISCOVERY

The project started during the summer of 1997 with two classes for the mentoring elementary teachers, one based on applications of elementary mathematics and the other based on current trends in mathematics pedagogy. The pedagogy class included some training in mentoring of preservice students. We selected the teachers primarily from Title I schools, based on principals' recommendations. We asked the principals to choose teachers who felt comfortable with mathematics and whom they thought would be good mentors for our students.

At the end of the first summer institute, the project evaluator interviewed the teachers and read their journals. Two themes which emerged from the journals were how the teachers were exploring theories of learning and how they were thinking about how mathematics can be taught. All teachers stated that they were intrigued by the constructivist approach to teaching, where teachers create classrooms to assist students in understanding mathematics. They were concerned about how they would succeed, but expressed willingness to try the approach. The teachers began to question some of their own practices in light of the theory and research presented during the first week of the institute.

The teachers had to come to terms with their own mathematical proficiencies. They had to learn to recognize where weaknesses existed and to take action in these areas. These teachers recognized that there was a dimension of "knowing" mathematics that they had not acquired. They needed to rethink their existing belief systems, question their own practices and knowledge of mathematics, and then work collegially to learn new skills.

The teachers commented favorably on the opportunity to read professional literature, to learn strategies for incorporating technology, and to find meaningful applications for children. The teachers considered their having time to read professional literature as a plus of the institute. Likewise, the participants enjoyed being able to work with calculators and software and to be able to see how they could use these technologies in their classrooms.

Finally, the teachers told how they enjoyed both a field trip to the Exxon refinery where they learned how the workers used mathematics in their jobs, and a discussion by a Montana teacher who spoke about using literature to teach mathematics.

The teachers benefited from becoming learners and working in group situations. One teacher commented:

> I need to build a classroom environment that allows children to feel safe. The students need

to feel confident with taking risks. They also need to learn, as I am, that we don't always have to go the same route to come to the answer.

Teachers identified that their confidence in mathematics improved due to the ability to feel comfortable in a group situation. The recognition that it was possible to learn from others in a group has transferred to their own classrooms.

The teachers appreciated being given the time to create meaningful instructional units. The project evaluator used her Instructional Evaluation Guide (1997) to analyze the units. She found that the teachers demonstrated the ability (1) to create contexts that foster problem-solving skills; (2) to encourage students to communicate mathematically; (3) to explore issues or topics that would be interesting to young people; and (4) to encourage the use of mathematical tools to pursue these investigations in greater detail. The teachers needed to develop greater understanding of the mathematics being studied and its applications and the improvement of student thinking.

We recruited the elementary preservice teachers from the required mathematics content classes. The two of us, together with one other instructor, teach these classes. We looked for students who had some talent in mathematics and in explaining the subject to other students. Students who were capable in mathematics but were lacking ability to communicate mathematics to others were discouraged from applying to join the project.

The first class for the elementary preservice teachers was taught in the fall of 1997. The 23 students were about evenly divided between sophomores, juniors and seniors. The focus of the course was applications of mathematics in the elementary and middle school, since elementary certification in our state includes grades K-8. Topics included geometry, measurement, business applications, social studies applications, probability, and number theory. All of these topics built upon those that the students had studied in the two required semesters of mathematics content. This course was planned and taught by us, although the students had minor input into what they would be learning. Pairs of students prepared units on the topics we had discussed in the class.

The project evaluator analyzed the units designed by the students. She found that a large percentage (87.5%) created units that would be interesting to young people. Additionally, they demonstrated the ability to design problem solving investigations that were relevant and encouraged students to communicate about mathematics. As with the elementary teachers, the students need to increase their understanding of core concepts and their ability to develop and extend the critical thinking skills of their students.

Eight of the students were placed with mentor teachers during the fall of 1997. The students all experienced growth in their ability to conduct elementary classroom activities. One of the teachers was so pleased with the work of her student, Jennifer, that she asked her to help with a presentation at the state teachers' meeting. When we contacted the teachers during the semester, some shared that they did not feel fully prepared to mentor preservice teachers. We agreed to provide additional training the following summer. We were able to visit about eight of the teachers' classrooms to observe lessons they were teaching. We noted that about half of them were using excellent pedagogy and had created communities of mathematics learners. The children were responsible for their learning, and the teachers did not give the children all the answers but had them evaluate their own thinking. The other teachers still maintained more formal classroom environments and offered their students little input into their learning. We planned to try to change these approaches with the next two classes for the teachers.

#### CREATION OF A COMMUNITY OF LEARNERS

In the spring of 1998 we taught a class to the mentor teachers which featured the Curriculum and Evaluation Standards (NCTM, 1989). In this class we coordinated the activities about 50 percent of the time and the teachers led the instruction the rest of the time. Each pair of teachers was responsible for designing activities illustrating one NCTM curriculum standard. The mentor teachers really enjoyed being able to share their ideas with their peers. In this way, we realized our goal of the teachers interacting as a community of mathematics learners. All of us involved in this learning situation demonstrated growth in becoming more constructivist.

In the summer of 1998 the class featured the Profes-

sional Teaching Standards (NCTM, 1991) along with more mentoring training. In this class we also allowed the teachers to have more input into their learning, and they were able to suggest some of the activities that would take place in the class. The teachers appreciated being able to read about and gain understanding of these standards. The mentoring training was more meaningful, since a number of the teachers had already worked with preservice students.

Four preservice teachers were placed with PRIME teachers during the Spring 1998 semester. These students worked in the classrooms two days a week. Most of the placements were productive for both students and teachers. Six students were placed with PRIME teachers during the fall of 1998; one student teacher did such an excellent job that the PRIME teacher wanted to use her as a long term substitute when she went on maternity leave.

That fall the students took a class on the Curriculum and Evaluation Standards (NCTM, 1989) modeled after the one that the teachers had taken. We were pleased with the growth that the students had made in mathematics knowledge and also in their ability to present mathematics to others. Five pairs of students were chosen by their peers to present the activities they had designed at a regional NCTM meeting.

During the fall 1998 class, the students also dealt briefly with the Professional Teaching Standards (NCTM, 1991). They were asked to develop six major topics to be covered by middle school students. All groups gave very sophisticated answers to this assignment. One example included beginning algebra, and helping students move to more abstract thinking. Other examples were fractions and decimals with money and cooking applications; basic geometry emphasizing that shapes are everywhere; problem solving to help build reasoning skills; statistics and probability with real life applications; and number sense.

During the spring of 1999, the students presented their activities at an NCTM regional conference and received positive evaluations from their audience. Two of the elementary teachers also presented and asked that one of the students who had worked in their classrooms be allowed to assist them. We noted that the students' presentation abilities had improved not only at professional meetings but also in their other college classes. One group of the students presented a lesson in the geometry class, and their lesson was outstanding compared to the work of the other students.

During the spring of 1999, the students and professors also met with the project evaluator. She asked them to share their impressions of their experiences with their mentor teachers. Several of the students had worked with the same mentor teacher and were all pleased with their opportunities to work in her classroom. She was one of the teachers we judged to be modeling the pedagogy that we hoped all the mentor teachers would exhibit. Students praised other teachers and said they exemplified what we were teaching. The students had seen the Annenberg K-4 mathematics video tapes. One student said her mentor was just like the teachers on the tapes. However, students also commented that other teachers had made little progress in changing their classroom procedures.

#### MATHEMATICS LEARNING FOR ALL STUDENTS

Our final class for the mentor teachers was conducted in the summer of 1999. Since we had deliberately recruited most of the students from Title I schools, the topic chosen was mathematics learning for all students. We had the teachers formulate plans for working with special needs students. One special part of the class was to have each of the teachers do a self-evaluation and to formulate a plan to improve his/her teaching. The mentoring part of the class involved having the teachers plan specific tasks for the preservice teachers who would be in their classrooms. Finally, we introduced the teachers to working with cognitively guided instruction (Carpenter et al, 1999) by allowing them to investigate cognitive levels of children and strategies for their use to enhance children's learning.

#### OVERVIEW OF THE PROJECT

The student portion of the PRIME Project has been made sustainable by having a consistent recruiting plan: as each group of approximately eight seniors graduates, they are replaced by an incoming group of sophomores who have been recruited. The PRIME courses, along with existing mathematics courses in technology, geometry, history of mathematics, statistics, and finite mathematics, make up a mathematics concentration that reflects the spirit of PRIME reform.

#### LESSONS WE HAVE LEARNED

We learned that we should have given the mentor teachers more support during the school year while they had students in their classrooms so that their concerns could be addressed in a timely fashion. It might have been helpful to "audition" the teachers in the first summer classes just as we did the students. There were several teachers whom we found would not be good mentors for our students. Some had no understanding of their peers who did not have mathematics backgrounds as strong as theirs, and felt the same way about the college students.

We should have started giving the preservice teachers more responsibility for selecting topics and approaches in the first class on applications of mathematics. We found that they showed greater improvement when we allowed them to give more input in their learning.

#### CONCLUSION

We believe that the partnership among the classroom teachers, college students, and professors has created a beneficial learning experience for all of us. Each group complements the others and increases the learning opportunity of both the college students and the elementary children. As the college students graduate, they are being employed as elementary teachers. As they gain experience, we expect them to become peer leaders in the area of mathematics. Moreover, we look forward to the prospect of their becoming mentors for future generations of college students in the project.

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## True Prime


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In the dark invisible crevises of the night
a prime number sleuthed
Searching the lifeless coordinates for clues
to the unsolved, unresolved equation.

Greater than or equal to the task
the prime number trudged on,
Dodging villainous vectors, untangling taloned tangents,
and uncovering unnacountable sets.

Into both the positive and negative bounds of the infinite,
the prime number prodded forth.
While exponents powered, derivatives differentiated,
and integrals disintegrated all about.

But as the first foggy rays of sunrise broke through,
the prime number proved potent.
Unveiling the sinister and silent silhouette
of the ever-vacuous empty set.

Alas in the tabloids and periodicals of the dewy morning news
the prime number was sainted
For discovering and recovering the imaginative
and illusively vacant solution set.