

Preparing Qualified Middle School Mathematics Teachers

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Abstract

According to the National Council of Teachers of Mathematics, in a 1999 study conducted by the Council of Chief State School Officers, it was revealed that nearly 30 percent of the 300,000 middle school and high school math teachers in the United States neither majored nor minored in mathematics. In low-income schools, students have less than a 50 percent chance of having a math or science teacher who holds both certification and a degree in mathematics or science. In order to meet the need for qualified middle school math teachers the Department of Mathematics at Texas State University-San Marcos, through an NSF grant, created a Master of Education with a major in Middle School Mathematics Teaching degree in 2003. The Department of Mathematics, with a grant from the Instructional Technology Department at Texas State, began preparing the courses as online distance learning courses. Offering the degree as a distance education program provides current teachers with the opportunity to gain the knowledge and expertise to be qualified middle school mathematics teachers and still remain in their teaching positions.

Introduction

There is an acute shortage nationally of qualified mathematics teachers specifically in middle schools. According to the National Council of Teachers of Mathematics, in a 1999 study conducted by the Council of Chief State School Officers, it was revealed that nearly 30 percent of the 300,000 middle school and high school math teachers in the United States neither majored nor minored in mathematics. Over half of the mathematics teachers in low income or low performing school are not qualified to be teaching mathematics or science or are uncertified teachers. Some of these teachers are working for certification using alternate certification routes since they already have a college degree although not necessarily in math or science. Some teachers who are certified in one discipline may take the Texas Test for teacher certification and become certified to teach mathematics even though they have not had any courses which help them with teaching mathematics. Over 50% of new math teachers leave the profession within 5 years. The problem is even more acute in rural and urban areas with high minority populations. There is a great need to prepare qualified middle school mathematics teachers.

Preparing Middle School Mathematics Teachers

Texas State University received two grants from the National Science Foundation (NSF) to address the problem of the shortage of middle school mathematics teachers. One grant focused on preparing pre-service teachers for teaching middle school mathematics and the other on preparing or strengthening in-service teachers for teaching middle school mathematics. As a result of the first grant Texas State University has a strong undergraduate middle school mathematics certification program in place.

The second grant was used in collaboration with Sam Houston State University and Stephen F. Austin University to create the Texas Middle School Math Project. This project led to the establishment of a new thirty-six hour Master of Education with a Major in Middle School Mathematics Teaching degree at Texas State University. The focal point of this program is to improve mathematics education in the critical 4th - 8th grade levels by providing already certified teachers with peer support and a clear understanding of instructional practices and content knowledge for middle school mathematics. Additionally, this degree incorporates a

leadership/mentoring component with the goal of developing 4th- 8th grade mathematics specialists from a group of middle school or elementary trained non-math specialists who have shown leadership potential. In the spring of 2004 there were 29 students who graduated from this program with their master's degree in middle school mathematics teaching.

As a result of this new masters program in Middle School Mathematics Teaching, Texas State University has been certified to prepare teachers for taking the Master Mathematics Teacher Exam. The Master Math Teacher is to serve in a leadership capacity and to mentor other teachers in their school district. School districts are encouraged to designate a Master Math Teacher who will serve in this capacity for several years. There are monetary stipends designated for the Master Math Teacher.

Most of the students the master's program are teaching fulltime in a school as well as taking classes. The students also come from the far corners of Texas. Some travel as far as 600 miles to attend classes. For the first group of 29 students, NSF funds paid for the student's travel, their lodging and substitutes in their classrooms when they needed to come to campus for classes. They would come 4 weekends during each semester on a Friday and Saturday. The school districts helped pay for their tuition. A second cohort of 9 students began this program in spring 2004 without grant support. It became clear as a second class of students began the program that it would be increasingly difficult to sustain this masters program if the students had to be attending classes on the Texas State campus at least 3-4 times each semester for almost three years and still continue teaching without the monetary support from a grant source. With an extension of the NSF grant and the promise of some funding, the second cohort grew to 15. In order for a program, which has been created using grant funding, to be institutionalized and to continue, it must become self sustaining. Travel and time away from home for students who had full time jobs as teachers were two factors that were preventing students from applying for the program. In order to try to make the program more accessible to students, The Department of Mathematics at Texas State University, with a grant from the Instructional Technology Department at Texas State University began preparing the courses as online distance learning courses. Putting courses online would allow students to take courses without having to make as many trips to campus and thus making the program more feasible for students who live a great distance from campus. It also allows the students to do the coursework on their schedule as long as they meet the necessary deadlines imposed by each course. With the prospect of some online courses the second cohort grew to 20 students. These students graduated in the spring and summer of 2006.

In the fall of 2006 a third cohort of 20 students began the master's program. These students applied without the prospect of any funding. They were drawn to the program because of the classes offered in the program, and also because as they progress through the program the classes would be ready for them as online distance learning courses.

The Department of Technology at Texas State University offers funding to departments that wanted to create online courses. The original grant for the master's in middle school mathematics teaching was written to create one course, the Geometry and Measurement course, for the master's degree. Because of the success of the master's program, not only did they fund the creation of the geometry course for online delivery, but also they funded all eight math courses for the masters program. The courses include Quantitative Reasoning, Algebraic Reasoning, Geometry and Measurement, Math Modeling, Calculus Concepts, Probability and Statistics, Logic and Foundations of Mathematics and History of Mathematics. There are also four courses in the Curriculum and Instruction Department which are a part of this degree and are already online.

The creation of a course is a three semester process. The first semester is dedicated to deciding on the content of the course, determining the technology to be used to deliver the course and making a prototype of one module to test the content and delivery of the course to make sure it is working as it was intended. During the second semester all the content and technology preparations are completed. The third semester is used to launch the course with students for whom the course was designed. The courses are delivered through Blackboard which affords the use of discussion boards, chat rooms, online quiz taking, and a drop box for submitting papers as well as access to all documents. Texas State University is currently migrating toward using TRACS which will be used to deliver these courses in future semesters.

It has been shown that teachers teach the way they are taught. When students see teachers exploring alternative ways of approaching tasks and posing provocative questions to the class, they are likely to experiment with alternative strategies and ask questions of themselves and their classmates. The courses for the master's degree, when taught on campus, use discovery/inquiry techniques and technology integration. The online courses are designed to be taught in the same way. Camtasia software is used to provide demonstrations on the use of the Geometer's Sketchpad, Fathom, Excel and other appropriate software, as well on the use of the Graphing Calculator, which equips the students to explore ideas using their own software or calculator. There are student versions of some of the software which make it very affordable for students. Interactive presentations have been designed to allow students to make conjectures or write their own definitions, receive feedback on their ideas and then reflect on how they could change or alter their ideas. A print out of the responses is sent to the instructor so the instructor can see how the students are progressing. Online quizzes are provided for the student to test themselves on the material they have learned. The quizzes can be setup so all students take them at the same time for a grade or they can be setup so students can take the quiz as many times as they wish until they have mastered the material. Video demonstrations are used to teach the concepts requiring the use of manipulatives such as compass and straight edge constructions, the concepts involved in volume and surface area using three dimensional figures, fraction bars to understand operations with fractions, two color chips for understanding operations with integers and many other manipulatives which provide hands-on activities to teach a concept. Videos also provide a means for demonstration of ideas as one might do on a blackboard in a classroom. Students respond to these videos through questioning and conjecture using course documents.

Students are required to exchange ideas about topics and classroom experiences through the use of the discussion board. In each course open ended questions are posed which require the students to post their ideas and then to react to posts by the other students. Students get to know others students through this experience and often will post questions of their own to other students, providing an opportunity for dialog among the students.

Texas State University contracted to use the Elluminate software which provided real time discussions with the students. Using this software all students would be on their computers at the same time and be able to talk with the instructor and the other students in real time. Texas State has subsequently bought the rights to use the Connect Software which provides the same type of interaction among students and instructor in real time. It is a less expensive software because there is a one time fee and it does not require a yearly fee for its use.

Assessment of student learning in each course is generally done through papers the students write, some problem sets and proofs that are submitted, a lesson plan project which focuses on some aspect of the material in the course which the student could use in their own classroom and a midterm and a final exam. The midterm and final exams are offered on campus or a student may make arrangements with an approved testing center to take the test off campus.

To complete the master's degree the students must take two comprehensive exams. These exams draw material from the algebraic reasoning, math modeling, geometry and measurement and the calculus concepts course. The students must also submit an electronic portfolio which showcases their mastery of the content in the courses they have taken, the implementation of the methods and content in their own classrooms and documentation of providing leadership in their schools in the area of mathematics teaching and in mentoring teachers in their schools.

After each course is completed the students are requested to fill out a rather comprehensive course perception form to ascertain their ideas and perceptions of the course. The students have been overwhelmingly satisfied with the courses in the way the material has been presented, the depth of the material and their mastery of the content. The students appreciate the discussion boards where they post ideas and questions and get responses from other students in the class. The students appreciate frequent contact with the instructor where they could ask questions or discuss ideas. Usually this contact is through email or sometimes phone calls. Through the online Gradebook students know exactly what their grades are as they progress through the course. The students like the assignments that are completions grades. These are designed to give students feedback on what they are learning on a regular basis so they can track their progress and so be responsible for the material being presented.

The question often arises as to whether a degree should be offered totally online or should there be some face to face courses on campus. In the first summer session of 2007, the algebraic reasoning course was offered as an on campus course for two weeks meeting 6 hours a day for those who could attend. Sixteen out of the 20 in the cohort came to campus. These students had taken two courses online, fall 2006 and spring 2007. The students who came really enjoyed meeting the other students and getting a chance to interact with the instructor on a daily basis. They felt they had formed relationships with others in the class so they would feel free to contact these people and work with them on projects and assignments. They also observed that two weeks was not long enough for all the reading and writing of papers that needed to be done. Extending the class for the full 5 weeks of summer school was not an option for some because it meant living in the dorm and being away from their families for too long a period since commuting was not feasible. It was decided in this class that the students would do the content work during the class time available and would read and write their papers when they returned home before the end of the summer session. When the program begins a new cohort this question of offering at least one on campus course during a summer session will be discussed again. The courses during the long semesters when the students are teaching their own classes will definitely be online.

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