

PMET IMPACT ON CURRICULUM IMPROVEMENT

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INTRODUCTION

The proposal “Development of MATH 3053 “*Mathematics for elementary teachers*” and revision of MATH 4003 “*Mathematical modelling*”” submitted by Prairie View A&M University (PVAMU) was granted by the NSF-PMET program in 2005. In this paper-report we summarize the outcomes of two-year activities under the PMET program, its benefits to PVAMU, and impact of the program on mathematical education.

The first section shows the importance, necessity, and justification of the proposed work. Its goals and outcomes and some non-standard teaching ideas that improve understanding of mathematics are presented in the following two sections. The last section provides a brief summary.

THE NECESSITY OF CHANGES

According to the “No Child Left Behind Act” of 2001, our nation’s education goal is to have a qualified teacher in every classroom by the year 2006. Despite all efforts this goal remains unfulfilled for schools with a high percentage of low socio-economic minority students. Studies using state and national data show that the effort to attract a necessary number of qualified teachers from certain groups and subject areas continues to fail. There is an ongoing disparity between the number of minority students in American public schools and the number of minority teachers. According to a 2003 National Commission on Teaching and America's Future report, individuals of African American, Hispanic and Latino, Asian, and Native American descent make up 14% of K–12 teachers, while 36% of students are from such backgrounds. As the number of minority students grows there is an urgent need for the increase of the number of minority teachers especially in the areas of science and mathematics from elementary grades to high school.

As a historically black institution in the State of Texas, PVAMU plays an important role in enrollment and education of future African American teachers. The university efforts are dedicated to enhancing the success of African American students and increasing the number of minorities who attend college and want to become a teacher. The provided under PMET program work contribute to reaching this goal.

There is a proven relation between effective teaching and students’ achievement. It is necessary to have a strong mathematics background in order to be a proficient mathematics teacher. Therefore in order to produce high achieving mathematics teachers, especially in the public school system, pre-service teachers have to be presented specifically sequenced and structured mathematics material that will prepare them to meet challenges of teaching. The level of courses they take have to be sufficiently much higher than the level of courses they are going to teach. Otherwise they will be unprepared and incapable to teach mathematics in various ways using different techniques. For example, to teach algebra, it is not enough to know just the material related to this subject. It is important to be fluent in Geometry, Trigonometry, Calculus I, II, and II and only then classes in Algebra will be productive,

understandable, bring lots of benefits, and meet needs of all learners. The teacher have to be able to understand connections within and beyond mathematics, look at a problem from multiple perspectives, and analyze/discuss their student's work from different angles. Thus in the modification of a curriculum it is important to integrate *three aspects of the mathematical education* of teachers:

- mathematical content,
- pedagogy,
- practice.

The necessity and importance of the revision of mathematical and educational contents of the courses are determined by the following. Over the years content areas have mostly been the responsibility of the subject home department that has led to a disconnection between what is offered in the course and what students need to know to be successful in their career. Effective development of courses should involve both the subject requirements and the competencies for the teacher certification. Moreover, in Fall 2002 the State Board for Educator Certification in Texas implemented a new teacher certification examination program, called the Texas Examination of Educator Standards (TExES), which takes an important role in examination for the certification of educators in Texas. The proposed work tries to align the mathematics content in the courses with the standards for the new TExES test for teachers. The curriculum of these courses is based on recommendations provided in recent reports such as recommendations of the State Board for Educator Certification in Texas, the MET Report, CBMS guidelines, "No Child Left Behind Act" and others.

PROJECT GOALS AND OUTCOMES

The goal of the proposed (and provided) work is to assist in revision of the mathematical education program in order to prepare high quality mathematics teachers. The project has been provided in the close collaboration among the Department of Mathematics, College of Arts and Sciences, the Department of Curriculum and Instruction, College of Education, at Prairie View A&M University, PVAMU professional development schools and local school districts.

The proposed work has concentrated on three main aspects. They have been successfully implemented. The aspects and achievements are provided below.

1. Improving Mathematics Courses for Teachers. The proposed work has contributed to the development of a new mathematics course MATH 3003 "*Mathematics for elementary teachers*" and a revision of the existing course MATH 4003 "*Mathematical modelling*". The enrollment of future mathematics teachers in both courses is 100%, mostly African-American. MATH 3003 is the requirement for both K-4 and 4-8 future mathematics teachers. MATH 4003 is the requirement for all pre-service teachers. As a result of a close collaboration between Department of Mathematics and College of Education, MATH 4003 "*Mathematics for elementary teachers*" is offered in Fall 2006. Assistant Professor of Department of Mathematics with specialization in Mathematical Education, Dr. Taugamba Kadhi, is teaching this course. The current enrolment is 13 students. MATH 3053 "*Mathematics for elementary teachers*" was taken by students as an independent study course during two terms in 2005-2006 academic year. Students not only learnt the material but also provided research, prepared papers and presentations. One paper was published. This work assists the goal of increasing the number and quality of certified educators, especially African-American, in the area of mathematics available to be employed by public schools.

2. Engaging Other Faculty. Department of Mathematics of PVAMU is concerning about providing high-quality education to prospective teachers as well as to all its students, supports efforts of individual faculty working on education and encourages collaboration with College of Education. The proposed work has contributed to the further restoration of a traditional priority of education in mathematics departments and brought closer mathematicians and educators. Outstanding professors such as Dr. Frazier, Dr. Allen, and Dr. King emphasized the role of mathematical education during their presentations at the colloquium of the Department of Mathematics. On the other side, Dr. Hritonenko showed the importance of educational issues at mathematical scientific conferences.

3. Networking. Dr. Hritonenko and Dr. Mason have made presentations at various universities and schools, national and international conferences on education. They report the results of their research and promote the PMET program. They have networked with other mini-grant leaders, participated and presented at the PMET workshops in Bowling Green in 2005 and the PMET conference in San Francisco in 2006. These activities have provided productive environment that make the research efforts more effective. The PMET program has offered many opportunities for mathematicians and educators to exchange ideas, share successes, discuss problems, coordinate efforts, and find ways of teaching prospective teachers more effectively.

NON-STANDARD TEACHING IDEAS

Working on research under the PMET grant, Dr. Hritonenko and Dr. Mason and pre-service teachers have discussed various techniques to be more effective and helpful to their students. The techniques have been used in classrooms and evaluated by students. Warm-ups and projects are among the considered methods.

Warm-ups. This activity consists of questions and simple problems related to basic rules and topics that require quick response. They have numerous benefits:

- Warm-ups are not time-consuming: they are given during the first 5-10 minutes of each class.
- Warm-ups change students' thoughts to mathematics: having several classes in a row, students thoughts are under the previous activity or they are sleepy in the morning. The activity will "awake" them.
- Warm-ups assist in reviewing basic concepts, properties, rules, and prepare students for understanding a new topic: specific questions assist in check students' background and whether they are ready for the class.
- Warm-ups make mathematics friendly: repeating and memorizing basic concepts of mathematics, students start to understand this subject and overcome their fear of mathematics.
- Warm-ups involve all students.

Depending on the topics studied and goals of the class, warm-ups can contain different questions. Examples of some of them are: Is \sin of a negative number always negative? How many solutions $\sin 2x = 2$ has? Give an example of a function symmetric about the x -axis. Can a mean, median or mode be negative? Can a mean be positive and median be negative for the same data set? Can a standard deviation be greater than the variance? Which is bigger - half a square meter or a half-meter squared. The average age of children in a room is 5 years with a standard deviation of 1 year. What happens with the average age and standard deviation if a 5-year child enters (leaves) the room?

Projects. Individual and team projects play an important role in the learning process and bring fresh spirit even to a difficult subject. They represent an important method of integrated learning, which is the mainstream of modern teaching philosophy when students listen lectures as well as work independently. The major challenge in this approach is to convince students to fully devote themselves to a project. The projects can be on various topics related to a course and can be done individually and in teams. Assigning a project, it is essential to be clear about the goals, expectations, evaluations, and completion dates. Diversification and structure of the tasks sufficiently increase effectiveness of projects.

Each team has the following requirements:

- *Prepare a poster* that reflects basic ideas and steps of a presentation. Working on a poster, students learn how to choose and organize the most important facts on the poster making it visible and accessible, understandable and helpful, informative and interesting.
- *Submit a report.* While working on the report, students learn how to work with various sources such as scientific and popular journals, monographs, and internet, and learn how to express scientific information in a written form. They have to provide collaborative research and interactive investigations. Numerous discussions during preparation of the report help students to learn more information than they would learn in class.
- *Make a presentation.* A presentation teaches students how to express their thoughts, organize their speech, provide vocal delivery, speak mathematically, answer questions and defend their opinion. Pretty often the students have found sufficiently much more material that they are able to outline only because of the lack

of the presentation experience. 15% of the students (pre-service teachers!) name “a presentation in front of class” as a negative aspect of projects.

Another important aspect of the project is its *reviewing* and *evaluation* process. Depending on the class size and the number of projects, each project is evaluated by two-four students and one discussant. They have to provide a written report that contains a brief description of the reviewed project, its positive and negative aspects, and suggestions. Approximately three quarters of peer reviews have been provided on a very high professional level. In provided questionnaires the students give positive comments about peer blind reviews and their importance.

The discussant should present a project, manage the class, and provide a summary. It is the discussant's responsibility to keep class in order. In their summary they have to mention whether reviewers' recommendations have been considered and the project has been improved. It is the greatest teaching experience for the pre-service teachers.

The *evaluation* of a presentation consists of three criteria:

- *peer's evaluation* provided by all students of a class: they grade each project, express their opinion, and write their comments and a grade;
- *evaluation within a group*, where each student evaluates their comembers; it helps to find out each student's contribution to the team project;
- *instructor evaluation*.

Presenting the pre-service teachers gain very important pedagogical experience that a presentation alone does not guarantee that the learning takes place among their students. The more listeners are involved and engaged in discussions on the topic presented the more they are likely to learn and remember. This motivation can be done through quizzes, games, puzzles, etc.

A project is an effective integration of research and training. It stimulates learning through the excitement of discovery, broadens the participation of students in an educational process, help them to understand connections in mathematics. Projects also increase the students' mathematical culture and literacy and develop analytical, social, and communication skills. They get better writing and presenting skills. At the same time the students gain more mathematical expertise by researching deeply at least two topics: one that they are presenting and the second one that they are reviewing. Mathematics teachers become more prepared for their future teaching career.

CONCLUSION

The PMET program has provided an incredible job in supporting efforts and organizing various activities to improve preparation of mathematics teachers and to bring educators and mathematicians together creating favorable conditions for their communications.

The mathematical courses MATH 3053 and MATH 4003 directly impact the mathematical instruction of pre-service teachers, increase their mathematical culture and strengthen the mathematical education of America's teachers. It is also a great asset for teachers' professional development and lead to an increase of the number and quality of certified educators, especially African-American, in the area of mathematics, available to be employed by public schools.

Meetings of faculty from different departments, colleges, and universities provided under the PMET project enhance future cooperation and collaboration.

Education methods discussed with pre-service teachers will help them in their teaching careers.