Promoting More Future Math Teachers

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§1. Introduction

The secondary school years, grades 7-12, are an especially important period in which to promote the growth of young people in mathematics and the sciences. It is a time when the intellectual capacity of the students expands rapidly and student's images of future careers are developing. The decisions students make during these years about what courses to pursue have a large impact on their future goals. In large urban schools this is particularly true. There the demand is great for teachers with both a strong mathematical background and the ability to use that knowledge effectively in the classroom. There is growing awareness nationally that both of these skills are necessary in order to promote student achievement (Ball & Bass, 2000 and Ball, 2002).

In Utah, two recent trends in public education have produced a critical need for increasing the numbers of secondary teachers who are strong in mathematics and well prepared to work effectively with highly diverse groups of students. According to the 2000 Census, Utah experienced a growth rate of 29.6% over the previous ten years, and this growth rate is expected to be the same over the next decade according to the Utah Education Supply and Demand Study 2004-05. (Utah State University, 2005) Moreover, there is a rapid change in the demographics found in Utah. Since 2000, 40 percent of the population growth in Utah came from minority populations. In a recent study on demographic trends within metropolitan cities, Salt Lake City was cited as one of the nation's leading destinations for immigrants (Singer, 2004). The Salt Lake City School District serves a wide range of students with varying social, cultural, and economic backgrounds. The Salt Lake Tribune, a local newspaper, reported on March 6, 2006, that the enrollment in the district is 23,700 students with the following percentages among

ethnic groups: 46% White; 36% Latino; 5% Pacific Islander; 4.5% Black; 4.5% Asian; 2% American Indian; 2% other.

At the same time, traditional teacher preparation programs have found it difficult to increase the number of applicants, minority or otherwise, to its programs in mathematics. One reason proposed is that students with a bachelor's degree in mathematics have many different career paths available to them after graduation. While this may be true, we believe another reason plays an important role in students' decisions about a teaching career.

In Utah, many undergraduates are married and raising children as they pursue their education. At the University of Utah, the mean age at graduation for students receiving a bachelor's degree is 26.5 years in contrast to the national mean of 24.5 years. Moreover, institutional research indicates that approximately 52% of the undergraduates are married and 25% have a child (Dr. G. Levy, Office of Institutional Analysis, personal communication, 2006). As a result, these students experience a need to complete their bachelor's degree quickly in order to enter the work force and support their families. Students at the University of Utah generally require five years to complete a teaching major and a licensure program that includes student teaching. After this five-year commitment, graduates enter the teaching profession at the lowest level of employment, having only a bachelor's degree with a typical starting salary in the Salt Lake School District of $31,308. Recently more mathematics majors at the University of Utah have been inquiring about secondary mathematics teaching as a career. Yet when faced with the time commitment and a low beginning salary, students often hesitate to follow their initial interest.

The Promoting More Future Math Teachers project (PMFMT) plans to encourage these students, as well as others, to choose secondary mathematics teaching as a career by providing financial support for the last two years of a streamlined five-year program leading to a bachelor's as a mathematics teaching major, a Master's of Arts in Teaching degree (MAT), and a secondary mathematics teaching license. We believe that graduates

of this program will begin their teaching career certainly better prepared, but in addition, they will enter their profession at a higher beginning salary and with stronger credentials to advance in their career.

The program will be developed through the close collaboration of faculty in the Departments of Mathematics and of Teaching and Learning and, in consultation with the Salt Lake School District, will provide early classroom experiences for students in the program and mentoring support to graduates during their first year of teaching. Thus the project plans to develop a cadre of teachers who have strongly integrated mathematical and pedagogical skills, along with the ability to work effectively with diverse students developed through extensive classroom experiences in urban settings. We believe that the financial support for their professional development and a better focused program of induction into the teaching will encourage more mathematically talented students to consider a career as a secondary mathematics teacher.

The PI for this project will be Aaron Bertram, Chair, Department of Mathematics. Professor Bertram has played a lead role in the development of the Foundations of Algebra course that is a requirement for all mathematics teaching majors. In addition to his interest in mathematics education, Professor Bertram is an eminent researcher in Algebraic Geometry, and serves on the steering committee of the department's National Science Foundation's VIGRE grant. Co-PIs on the project will be Marilyn Keir, Mary Burbank, and Anne Roberts each of whom has been involved in mathematics education and teacher preparation over many years.

Marilyn Keir is an Associate Instructor in the Department of Mathematics and Chair of the department's Mathematics Education Committee. Before joining the department in 1999, she had been a high school mathematics teacher for many years in the Granite School District where she received many awards for her teaching. Ms. Keir has an MAT degree from Stanford University.

Mary Burbank is a Clinical Instructor in the Department of Teaching and Learning and she is the Director of Program Evaluation and the Secondary Education Program. Her research interests include action research teaming between preservice and inservice teachers; urban education and instruction for multilingual students; the historical and theoretical underpinnings of preservice teacher supervision.

Anne Roberts is a Professor/Lecturer in the Department of Mathematics and has been involved in the design of mathematics courses for prospective teachers for many years. She was co-director of the project, Elementary Mathematics through Teacher Partnerships, supported by the National Science Foundation, and is the author of a manuscript detailing the project work (Roberts, 1996).

§2. Description of the PMFMT Project

The PMFMT Project will be based on two programs developed recently at the University of Utah, the new mathematics teaching major (non-licensure program) in the Department of Mathematics, and the new MAT Program in the Department of Teaching and Learning. The connecting link between these programs will be a Mathematics Teaching Seminar developed jointly by faculty from both departments that will place the focus on the mathematical and pedagogical issues that arise in diverse classrooms. The PMFMT project will have close connections to the Salt Lake City School District through the teacher education schools already established by the Department of Teaching and Learning. Mathematics curriculum specialists from the Salt Lake City School District will take part in the seminar and help design the project support for the new teachers during their first year in the profession. The above two programs, the seminar, and the structure of the PMFMT Project are described in the following paragraphs.

Mathematics Teaching major without licensure: This new mathematics teaching major program in the Department of Mathematics was designed to address two problems. Developing sufficient mathematical knowledge, pedagogical understanding, and student-teaching experiences in a four-year undergraduate program is very difficult

and often leaves students with too little preparation in either area to be an effective teacher. In addition, students frequently do not see much connection between their education coursework and their mathematics coursework. This disconnect seems to exist despite the fact that they take a mathematics teaching methods class and spend a semester in student teaching. For this reason, the Department of Mathematics recently developed the mathematics teaching major program without licensure. (The course requirements for this program are described in the Appendix, page 12.) As undergraduates in this new program, the students will place the primary focus on their mathematics coursework. In the fall of their fourth year as an undergraduate, in addition to their mathematics courses, they will enroll in a teaching internship. During the internship they will be a teaching assistant in a university Intermediate Algebra or Pre-Calculus class where they will work closely with the professor, leading weekly problem sessions for small groups of students and assisting in designing and grading tests, Each week these prospective teachers will meet together with a mathematics faculty member involved in mathematics education in order to discuss the various mathematical and pedagogical issues that have arisen in their classes that week. The purpose of these meetings will be to place the pedagogical teaching issues within a mathematical context with the goal of developing the pedagogical content knowledge that is so necessary to become an effective mathematics teacher in secondary school (Cuoco, A. 2001; The Mathematical Education of Teachers, 2001).

Although students who graduate from the new mathematics teaching major program will not receive a teaching license with their undergraduate degree as do the current teaching majors, these new graduates will have a stronger mathematical background and will be well-prepared to obtain a teaching license as a part of graduate work.

In addition to the teaching internship in the fall, during the spring semester of their fourth year, these undergraduates will attend and assist in the Math Circles meetings held through the department's VIGRE grant. In these weekly meetings the prospective teachers will interact with the mathematics graduate students as they work with the high

school students enrolled in the program. This will provide a wonderful opportunity for the prospective teachers to develop an appreciation of the impact that challenging and sometimes complex problems can have on stimulating high school students' mathematical development (Lappan, G. 1998).

The MAT Program: Two years ago, the Department of Teaching and Learning began a master's program, which has developed into the current MAT program. This program is based on the cohort model and takes place over four semesters beginning during summer semester. The program includes a 33 credit hour master's degree with nine additional hours of clinical experiences. (The course requirements for this program are described in the Appendix, page 13.) Graduates leave the program with a recommendation for the Utah Level One teaching license and must have passed the Praxis II content knowledge test and pedagogical examinations that make them "highly qualified" according to the "No Child Left Behind" law. The program has a focus on urban education for diverse populations. The students in the PMFMT project will be assigned to teach in urban schools with an emphasis on issues of diversity in the classroom.

The PMFMT Project Structure: The PMFMT Project will invite students to apply to the program as they begin their upper division mathematics course work. Those students who are accepted will be designated as Noyce Scholars. These scholars will enter the program in their last undergraduate year and will begin the MAT program in the summer semester after they receive their bachelor's degree as a mathematics teaching major (without licensure). The Noyce Scholars will receive a scholarship of $7,500 for the last year of their undergraduate work and, assuming satisfactory progress, they will receive a stipend of $8,500 for their post-baccalaureate year in the MAT Program. Currently, the University of Utah graduates an average of eight mathematics teaching majors each year. The PMFMT project expects to increase this number, by enrolling seven to eight students per year during the three years of the project. We expect to produce an additional twenty-one to twenty-four secondary mathematics teachers over the four-year period from the start of the project.

During the two-year period of their university coursework, and their first year of full time teaching, the Noyce Scholars will take part in the Mathematics Teaching Seminar to be held during the spring semester of each year. This seminar will be developed jointly by faculty from the Departments of Mathematics and of Teaching and Learning. The seminar's focus will be on the necessary interaction between the mathematical content and the pedagogical skill teachers need to promote the mathematical growth of students (Roberts, 1995). Traditionally the preparation of secondary mathematics teachers has been separated into two components, the first being mathematical content and the second, education coursework. The goal of the Mathematics Teaching Seminar will be to help students forge a connection between these two areas, one that is especially needed in diverse classrooms (National Council of Teachers of Mathematics, 2000). The seminar discussions will be led by Marilyn Keir, Mary Burbank, CO-PI's on the project in consultation with Anne Roberts, Aaron Bertram, project PI and mathematics curriculum specialists from the Salt Lake School District. Through this seminar, beginning teachers will continue their growth in both subject matter and pedagogy, an important opportunity as they develop their teaching practice (Feiman-Nemser, S., 1983). Prospective teachers can begin to gain insight into the issues they must consider in their classroom practice as they interact with teachers in the field and with curriculum specialists from the Salt Lake School District (Heikkinen, H., McDevitt, T., Stone, B., 1992). We view this seminar as providing both the impetus and the opportunity for a rich dialogue among university faculty and school district personnel involved in the preparation and support of beginning secondary mathematics teachers. Given the attrition rate for beginning teachers (over half leave in the first five years, Deseret Morning News, 2006) and the changing demographics in the secondary mathematics classrooms in which they teach, such interaction seems imperative.

§3. Recruitment Plans

Currently the Department of Mathematics has two specific recruitment efforts that will be fully utilized by the **PMFMT Project**. These include:

- During the fall semester, a luncheon is scheduled for all students interested in mathematics. At this luncheon, mathematics faculty members from various specialties including education present the features of their areas and meet with groups of students to answer questions.

- During the spring semester the department hosts a career day at which speakers from various professions describe their work and how it relates to their undergraduate mathematics degree.

In addition to these recruitment activities, the PMFMT Project will sponsor two information meetings about the project and the secondary mathematics teaching profession. These meetings will be specifically for second and third year undergraduates in the College of Science and will be held during the fall and spring semesters. Presentations to student organizations for minorities on campus will be made by one of the CO-PIs on the project prior to these meetings in order to encourage members of the organization to attend the meetings.

Several initiatives have been developed recently at the University of Utah to promote the enrollment of minority students at the university. These include the University Neighborhood Partners (UNP), a project aimed at helping minority youth to view higher education as a personal option. The Department of Mathematics, in its application for a second VIGRE grant, is developing connections with the Mathematics, Engineering, and Science Achievement program (MESA). These plans include bringing mathematics graduate students into MESA classrooms and will provide three one-year scholarships for MESA students. Currently, as a part of their mathematics methods course work, teaching majors in the department spend between 5 and 10 hours a week in either a MESA classroom at a local middle school or in classrooms for low-achieving high school students. In addition to these efforts, and in an effort to encourage more minority students to consider becoming secondary mathematics teachers, the project team will make

presentations at the Salt Lake Community College, a feeder college for the university, on the possibilities offered through the PMFMT program.

As mentioned earlier, in the last few years the Department of Mathematics has seen an increase in the number of students declaring a mathematics major, whether for secondary teaching or otherwise. When declaring a major, students meet with the Undergraduate Advisor in the department. Students who have an interest in teaching are given a brochure on the mathematics teaching major (with and without licensure) and referred to a faculty mentor in mathematics education for further information. Having a faculty contact with whom to discuss the mathematics teaching program and the teaching profession is especially valuable for undergraduates considering their career options.

§4. Selection Process

The PMFMT project will select students based on three criteria: academic merit, teaching potential, strength of commitment. Applications for the program will be accepted during a student's third year as an undergraduate. By this point, a student will have completed several upper division mathematics courses including their first "proof" course, Foundations of Analysis I, and either Foundations of Geometry or Foundations of Algebra. The latter two courses have related practicum connecting the course topics to the secondary mathematics curriculum during which the teaching majors spend time in local classrooms. This background will provide a strong basis for making decisions about whether a student is a good candidate for the PMFMT project.

To be accepted into the program, a student must have a GPA of 3.0 overall as well as in their mathematics coursework. A student must also submit two letters of recommendation: one letter from the instructor of the mathematics methods or practicum courses that focuses on their teaching potential; the other from an instructor in one of their mathematics courses focusing on their mathematical development. Finally, a student must submit a resume and letter of purpose describing their interest in teaching and their goals in the profession. All students will have a personal interview with a committee of

three members from the project team who will make the final selection of the top seven or eight candidates for the program. Before final acceptance into the program, the students selected will be required to sign a commitment form agreeing to teach for two years in an urban school for each year of scholarship/stipend granted.

§5. Program Management

The project team will include the PI, Aaron Bertram, the CO-PI's, Marilyn Keir, Mary Burbank, and Anne Roberts. as well as one PhD candidate from the College of Education. Professor Bertram, as Chair of the Department of Mathematics, will supervise the recruitment activities, selection process, and organize the connections between the Math Circles and the PMFMT project. Marilyn Keir and Mary Burbank will develop and lead the Mathematics Teaching Seminar in consultation with Anne Roberts and Salt Lake School District mathematics specialists. (Letters of support for the program from the Salt Lake School district, and the Deans of the Colleges of Science and of Education are provided in the Supplementary Documents section.) In addition to the above faculty members, the team will include a half-time research assistant selected from among the PhD candidates in the College of Education. The graduate student's role will be to assist in recruitment efforts and in mentoring the Noyce Scholars. In addition, the graduate student will maintain the database of assessment information on the students involved in the project and will assist in the evaluation of the project results. It is expected that the graduate student's work will be a part of the student's PhD thesis.

6. Program Evaluation and Monitoring of Participants

Throughout the project data will be collected on the progress of the PMFMT participants in order to assess the results of the project and to track the participants growth as a teacher. Participants will be required to complete a survey at the end of each of their three years in the project (last undergraduate year; graduate year; first year as a teacher). These surveys will be based on: knowledge of mathematics for teaching; the role of a teacher in promoting learning; expectations of the teaching profession. In

addition, data will be collected on the participants' scores on the PRAXIS content and pedagogical tests as well as their GPA during the two years of coursework. At the end of the first year of teaching, participants will be asked to submit a portfolio that will include a letter from their principal, one or two lessons presented during that year with an analysis of the lesson results, and any other artifact of their choice. Two research questions will be of particular interest to the project team. These are: 1. Did the emphasis on the interaction between mathematical and pedagogical knowledge in the PMFMT project affect the participants' concept of their role as a teacher; 2. Did the participants gain new mathematical insights from their teaching? If so, from what experiences?

Because participants in the PMFMT project who are progressing satisfactorily will receive financial support for two years, they will be expected to commit to four years of teaching in an urban school. (In Utah, after three years of teaching, educators become eligible for a Level II license, a permanent teaching license.) Each year prior to receiving financial support, project participants will be required to update their commitment and their contact information. Upon graduation from the MAT program, participants will be asked to report their teaching assignment and to commit to returning 25% of their total financial support from the project for each year that they do not teach. Because the project graduates will spend three years participating in the Mathematics Teaching Seminar, they will establish strong ties with the seminar leaders, a connection that will be maintained over their four years of required teaching. The graduate student on the project team will maintain contact information and documentation of qualified teaching for all project participants.

Appendix

1. Courses to complete Mathematics Teaching Major Without Licensure.

Course number	Title	Hrs.
M 1210,1220	Calculus I, II, III	4,4
2210		3
M 2160	Intro to Scientific Computing	3
M 2270	Linear Algebra	4
M 2280	Differential Equations	4
M 3010	History of Mathematics	3
M 3070	Applied Statistics I	4
M 3210, 3220	Foundations of Analysis I, II	3,3
M 3100	Foundations of Geometry,	3
3105	Practicum	1
M 4030	Foundations of Algebra	3
4035	Practicum	1
M 4090	Teaching Secondary Mathematics	3
M 4910	**Teaching Seminar/Internship**	**4**
M 5700	**Capstone Course**	**3**

	Select two courses from these or other approved courses above the 4200 level:	
M 3080	**Applied Statistics II**	**3**
M 4400	**Number Theory**	**3**
M 4510	**Topology**	**3**
M 4530	**Curves and Surfaces**	**3**

Allied Physics Course

Physics 2210 Or	Physics for Scientists and Engineers I	4
Physics 3210	Physics for Scientists I	4
	Students are encouraged to complete the physics series	
	Students are encouraged to complete a teaching minor	
TL 2100 **ECS 4150**	Students must also complete **Introduction to Teaching** **Introduction to Multicultural Education**	3 3

2. Courses to complete Master of Arts in Teaching, Department of Teaching and Learning

Summer Term (15 hours)

TL 6741	*Integration of Educational Technologies	
SpEd 6011	*Inclusive Classrooms	
EdPs 6080	*Adolescent Development and Learning	
ECS 6632	*Issues & Research in Multicultural Education	
TL 6126	*Content Area Literacy Instruction	

Fall Semester (9 hours)

TL 6410	Curriculum and Assessment	
TL 6411	Instruction and Management	
TL 6490	Teaching Practices In The Public Schools	

Spring Semester (12 hours)

TL 6941	Action Research/Seminar (3 hours)	
TL 6495**	Student Teaching; Secondary (9 hours)	

Summer Term (6 hours)

TL 6XXX	2 electives in the Department of Teaching and Learning at 6000+ level	
TL 6XXX		

Total: 45-48 hours of Licensure course work

33 hours of Master's credit

12-15 hours of non-graduate credit

  * May be waived, if comparable course was taken previously at the undergraduate or graduate3 level within 5 years.

** Course does not count toward Master's Degree