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Improving Gender Disparity in Scholarship Programs for Secondary-Level Mathematics Teachers

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Abstract

Gender disparity in STEM Education has been a topic of much discussion among college faculty and administrators lately. Several remedies have been proposed and carried out with little to no positive impact to the situation.

This paper will give a glimpse into a scholarship program funded by the National Science Foundation (NSF) geared towards producing secondary school teachers in mathematics at Texas A&M International University (TAMIU), Laredo, Texas. This multifaceted program, the Robert Noyce Mathematics Teacher Scholarship Program (TAMIU-NMTSP), has seen improvements in female participation in all its components and is geared towards addressing the scarcity of qualified secondary-level mathematics teachers in today's high school classrooms to serve high-need schools. The primary accomplishment in the second year is that all project components were implemented for the first time. This included mandatory mentoring for all scholars, Texas Examinations of Educator Standards (TExES) review sessions, boot camp activities, two separate orientation forums for both new and returning scholars, summer internships, conferences, and participation in other related forums. One indication of the success of the program is that our first graduate, a new female scholar, secured her first teaching position as a fully certified secondary high school mathematics teacher immediately upon graduation in the Fall of 2015.

1. Preliminaries

Many factors affecting female participation in higher education have been studied. Yet the numbers of females entering the field of mathematics remains low. Female students seek majors other than mathematics, but a new trend is happening. While the gender gap seems widespread both across U.S. schools and in international comparisons, the high-achieving girls are concentrated in schools with elite mathematics programs (Ellison & Swanson, 2010). Factors associated with this trend were examined through field visits in seven developing countries: Bangladesh, Cameroon, India, Jamaica, Seychelles, Sierra Leone, and Vanuatu (Brock & Cammish, 1997). A fundamental cultural bias that is in favor of males and economic factors appears to be the biggest obstacles to female participation in higher education in developing countries. Religious and legal factors had only indirect effects in addition to other growing needs. Significant initiatives aimed at addressing all aspects of the problem of female participation in higher education were carried out and they can be replicated in most other developing countries; however, the political desire to implement those initiatives, a conducive environments and policy consideration is largely lacking. In developed countries, the conditions, motivations, and gender equality make it possible for females to seek these opportunities in the field of education, particularly mathematics.

2. Literature Review

According to the American Association of University Women (AAUW), the gap between girls and boys in science, technology, engineering and mathematics (STEM) fields has been decreasing over the past 50 years. Several studies show that even though the number of girls in STEM fields is small compared to that of boys, girls tend to have better grades in these degrees (AAUW, 2015). According to the United Nations Division for the Advancement of Women (DAW, part of UN Women) and the United Nations Educational, Scientific and Cultural Organization (UNESCO), the gender gap in STEM-fields results from the belief that women are supposed to study certain subjects that prepare them in raising a family, while men are supposed to study a STEM degree (Grace Masanja, 2015). The first volume of the Forum for African Women Educationalists (FAWE) Research Series, asserts that one of the most common responses given by boys was that "female students are too lazy to think and work hard…"; they also mentioned the women are not able to understand, have no passion for science, and that they do not know mathematics (Jones, 2015). According to the report of *Education from a Gender Equality Perspective* from the USAID (U.S. Agency International Development), teachers may sometimes give to male students harder tasks to complete than those given to females. Also, girls are less likely to earn a degree and pursue a career in some countries because they are supposed to maintain the house (USAID, 2015). A UNESCO paper titled *Girls in Science and Technology Education: A Study on Access, Participation, and Performance of Girls in Nepal* shows that at early school years, girls are more able to learn than boys. However, as they grow older, society expects them to spend more time completing chores than on their education (Koirala & Acharya, 2015). Many academic leaders have agreed to reach the goal of increasing the number of females and minorities in STEM programs, but that goal has not been successful. The 2012 American STEM Workforce study suggests that to increase the percentage of participants in STEM fields, and it is necessary to focus on introducing and encouraging females as well as minorities into the STEM workforce by improving the academic culture in undergraduate STEM fields to have certain groups of students, specifically females, change their field of study (American STEM Workforce, 2012). It proposes that the STEM academic culture should be more accessible, affordable, and encouraging to students so as to have them stay focused in their field of study (Suchman, 2014). Xie, Fang, & Shauman (2015) reviewed the current research on STEM education in the United States and propose there are two major components of STEM education, non-STEM general education requirements and the requisite STEM specific courses. They asserted that different social factors such as cognitive and social-psychological characteristics including family, neighborhood, school, and broader cultural levels can affect these two major components of STEM education.

The gender disparity among the students in STEM education may eventually result in a disparity within the faculty of STEM programs, thus exuberating the situation. One contributing social factor is the underrepresentation of women STEM faculty to serve as role models and mentors to encourage female students to choose STEM fields of study. Xu (2008) examined the underrepresentation of women faculty in STEM and compared attrition and turnover rates between genders in both research and doctoral universities. The two genders did not differ in their intentions to depart from academia, but women faculty had a significantly higher likelihood to change positions within academia. According to the study, academic culture of the STEM field provides fewer opportunities, limited support, and inequity in leadership. The study suggested that the academic STEM culture needs to change in order to attract more women into these fields and narrow the current gender gap. One approach to increasing women in these fields was proposed by You (2013), namely that school districts should include an additional mathematics or science course to be taken in high school. The article presents a study done with a sample of secondary students and demonstrated that if these students took more challenging STEM field courses, they would be more likely to enroll in college and pursue a degree in a STEM field (You, 2013). Another investigation on gender and racial/ethnic disparities in STEM fields found that the physical science and engineering majors were dominated by men, specifically white men. This study also had a similar goal to increase the availability of high school preparation courses for females and minorities, which resulted in the percentage of the females majoring in a STEM field becoming closer to the percentage of men (Riegle-Crumb & King, 2010).

While additional mathematics or science courses are ideal, in some cases there is not room in a student's schedule to accommodate more coursework, and it also raises costs for schools as they have to hire additional teachers. Enrichment programs for students in developmental education is another approach to increasing STEM content knowledge and students with poor quality skills in core subjects have been shown to improve after participating in the enrichment programs. A 2012 study involving almost 7000 students further demonstrates that enrichment programs which provide additional support to students can result in improved student outcomes (Visher et al., 2012). This provides support for the design of the TAMIU-NMTSP activities, which will help ensure student success. Summer bridge programs are also an excellent tactic colleges can implement to have a positive impact on incoming students and to assist them with building their necessary core subjects skills (Wathington et al., 2011). Improving social awareness and skills via an intervention was the approach Cerezo and McWhirter (2012) implemented with a group of Latino college students, which did aid those students to successfully build their core subject skills. This intervention can be added to the other available techniques colleges can use to assist their students to develop the skills necessary for success in STEM fields.

3. Data and analysis

The Office of Recruitment and School Relations is at the forefront of student recruitment by planning, coordinating, and implementing recruitment strategies for prospective students that aligns with the continuous enrollment growing efforts of the University and its institutional mission (http://www.tamiu.edu/enroll/). In addition, previous and on-going grant programs fund summer enrichment workshop activities to provide students with the background information necessary for them to choose STEM programs, whether at TAMIU or other schools. This includes the BA in mathematics with 7-12 certification program for those who want to become high school mathematics teachers upon graduation. Recruitment for female mathematics undergraduate students has consistently been significantly higher from 2006 to 2015 at TAMIU, and is clear that TAMIU has been successfully recruiting more females than males in 9 out of the last 10 years, but the same gender pattern, does not hold for mathematics graduate students, as depicted in Table 1.

Table 1. Students Enrolled in Mathematics Programs from 2006 to 2014 at TAMIU

Year	Undergraduate	Graduate

	Female	Male	Female	Male
Fall 2015	71	52	0	8
Fall 2014	70	42	2	7
Fall 2013	65	43	4	5
Fall 2012	52	42	4	7
Fall 2011	70	61	2	10
Fall 2010	28	45	2	12
Fall 2009	69	54	2	9
Fall 2008	49	40	3	5
Fall 2007	61	45	4	4
Fall 2006	51	41	2	2

There are three undergraduate programs in math, namely BA, BA 7-12 mathematics certification, and BS. For the graduate program, there are three tracks, which are thesis, non-thesis, and non-thesis in Mathematics Education.

Focusing on only the undergraduate enrollment numbers in mathematics education, Table 2 breaks down this profile of students as reported in Fall 2015 and there are several factors taken into consideration. Students pursuing a B.A. in mathematics degree with secondary certification should be admitted by the College of Education (COED) after their sophomore year. For matriculation, students interested in programs/majors/certifications must apply to the College of Education. Admission to the College is contingent upon meeting full admission requirements, which is a separate application process from the University's admission procedures. Acceptance to the University does not ensure acceptance into the College of Education. Students who are fully admitted to the College of Education will be eligible to enroll in 3000-4000 level education courses in their major. Full admission requirements includes: 1) Completion of all core curriculum coursework with a grade of "C" or better, 2) Completion of pre-admission courses offered by the College of Education, 3) taking two University Seminar courses (UNIV 1101 and 1102), 4) students who transfer in with 30 or more credits, 5) assessment of basic skills through exams in reading, writing, and verbal, 6) demonstration of oral and writing skills, 7) have a TAMIU GPA of 2.75, 8) Foreign language requirement, and 9) TOEFL IBT is required of all students having academic studies from a country where English is not the native language.

Table 2. Distribution of Students Based on Gender and Rank§

	Male	Female	Total
Senior	3	8	11
Junior	2	4	6
Freshman or Sophomore (Not yet Admitted to COED)	11	34	45
Total	16	46	62

§-as of Fall 2015

One of the primary recruitment tools of the TAMIU Noyce Program is a week-long Summer Boot Camp, in which participants are given stipends for attendance. The Summer Boot Camp offers students who are interested in mathematics an opportunity to participate in mathematics workshops geared towards preservice teachers, in which they complete 30 hours of activities related to mathematics, and mathematics education. The Summer Boot Camp in 2014 had 22 participants, 7 were male, while 15 were female. Of these 22 participants, 10 were our first cohort of Noyce Scholars, with the other 12 identified as potential future educators in mathematics. In the 2015 boot camp, there were 18 participants, of which 12 were TAMIU undergraduate students, three were TAMIU graduate students and three were from Laredo Community College. Of which, 8 were male participants and 10 were female participants. Students were surveyed at the end of the boot camps appreciated the benefits of the camps. The Summer Boot Camp is a first step at continuing this promising trend at TAMIU to encourage and support increasing numbers of females to becoming secondary mathematics teachers and serve as inspiration for their students to consider mathematical fields of study for their careers.

All attendees of the Summer Boot Camp and all mathematics majors are encouraged to apply for the TAMIU Noyce Program and the complete potential pool of TAMIU Noyce scholarship applicants is shown on the fourth row of Table 2, and includes those who are seeking admission, pending admission, or have been admitted to the program. The scholarship applications received and awarded appears below in Table 3, and shows that the female participation in the program is more significant than their male counterparts (Goonatilake, Lewis, Lin, & Kidd, 2014). In the first and second cohorts of the Noyce Scholarship program there were ten and six students, respectively who were awarded scholarships. Out of the first 16 awarded scholarships, 12 were female students. They have all participated in Summer Boot Camps, Fall 2015 TExES review sessions, and in the project's mentoring. When the first cohort of scholars was interviewed by the West Texas Office of Evaluation and Research in August 2015, they expressed interest in being involved in the mentoring of the new cohort of Noyce Scholars. This demonstrates the positive effects of the scholarship program on female mathematics majors. The scholars are not only personally benefiting from the program, but are also invested in helping others thrive in the program. These predominately female scholars have volunteered to be mentors, attended informal meetings to answer the new scholars' questions, and provided advice as well as helped them prepare for the content exams.

Table 3. Breakdown of Scholarship Awarded and Applications Received as of Spring 2016

	Female	Male	Total
Fall 2014	7 (11)±	3 (4)	10 (15)
Fall 2015	5 (9)	1 (3)	6 (12)
Spring 2016	3 (3)	1 (3)	4 (6)
Total	15 (23)	5 (10)	20 (23)

±- the figures in the parentheses are the number of applications received

4. Conclusions

The TAMIU Noyce Scholarship program is an ongoing effort and this paper provides a glimpse of our success in motivating female participation in the program. As the scholarship program is still in progress, its success and its long-term usefulness in increasing mathematics knowledge and increasing females choosing mathematics fields of study will require continued analysis to determine the overall effectiveness of the program. However, at this initial stage of the program, all indications are that the high rate of female participation in the program is a solid first step towards reducing the gender inequality discussed in this paper and will have a positive impact on the preparation of the teacher candidates to serve as role models for subsequent generations of students, especially female students.

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