Discovering the Needs Assessment of Qualified STEM Teachers for the High-Need Schools in South Texas

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Abstract

Concerns are arising in the United States that a majority of secondary school students fail to achieve mathematics and science proficiency due to teachers who lack adequate knowledge of the subjects. The concerns over shortages of mathematics and science teachers have also reached new heights. In Texas high schools, the teaching areas in mathematics and science have persisted as being among the most critical shortage areas. For these reasons a needs assessment was conducted in the spring and fall semesters of 2013 for decision making purposes in preparing highly qualified STEM teachers for high-need school districts in South Texas. Student and Teacher surveys were utilized to collect data.

Of the 56% of student participants that showed interest in becoming a teacher, 72% of them indicated that they would like to teach STEM subjects and 99.9% were willing to teach in high-need schools. Financial assistance was needed by 99.8% of the students to complete the educator preparation program.

About 50% of teacher participants from the Teacher survey thought that the funding designated for K-12 STEM education was insufficient. 40% of them also believed that K-8 STEM education was inadequate and professional development for STEM teachers was insufficient. Teacher participants would like universities to provide training or professional development for teachers such as the implementation of vertical curriculum alignment and the establishment of partnerships between universities and school districts.

Keywords: STEM Education, Science, Technology, Engineering, Mathematics, Computer Science, Physics, South Texas

1. Background

1.1 South Texas and Texas A&M University-Kingsville

According to the 2010 census and the Texas Population Projections 2010 to 2050 (Potter and Hogue, 2013), South Texas is the home to over one-third of 9.4 million Texans of Hispanic origin. Moreover, it has been estimated that the Hispanic population will increase to 12 million by 2020 and likely surpass the white population. In percentage terms the South Texas region is the fastest growing in the state with between 145-198% growth rate projected from 2010 to 2050. From 2002 to 2007, the South Texas region's population increased at 2.1% annually, as compared to the state's 1.9% annual increase. The region, which is 81% Hispanic with a young population, is growing faster than the rest of the state.

Capacity-wise, South Texas is in transition from a historically under-served region to one where major efforts are being concerted to build an educational and economic infrastructure that provides full and equitable access for the predominately young and poor population. According to the Texas Comptroller of Public Accounts (2008), among the 12 economic regions in Texas South Texas possesses a high potential for economic prosperity based on the premise that economic growth begins with an educated work force. Its higher education institutions are increasing enrollment and the number of degrees they award. However, school districts in this area are ranked below the state level as a whole based on accountability ratings.

Texas A&M University-Kingsville (TAMUK), located in South Texas, is one of several campuses in the Texas A&M University System. As of fall 2013, TAMUK had an enrollment of 7,730 students. It is primarily an undergraduate institution; 82% of students are undergraduates. Most of TAMUK students come from South Texas, but there is wide diversity in the population with students from more than 35 states and 43 countries. The student body is split almost equally between men (53%) and women (47%). Ethnically, the campus reflects the demographics of the area, with 62% Hispanic, 27% white, and 5% African American. About 6% of the student population is international.

1.2 Shortage of Certified STEM Teachers in South Texas

The report for Congress (Kuenzi, 2008) stated that concerns are rising in the United States that a vast majority of secondary school students fail to achieve math and science proficiency due to teachers who lack adequate knowledge of these subjects. Ingersoll and Perda (2009) asserted that the concern over shortages of mathematics and science teachers has reached new heights. Various high-profile reports from national organizations have directly tied the quality of academic performances of students to mathematics and science teacher shortages and, in turn, to the future well-being of the U.S. economy and the security of the nation. Therefore, inability of schools to adequately staff classrooms with qualified teachers has emerged as a major educational problem and has been the focus of numerous educational reforms and policy initiatives.

The shortage of high school mathematics and science teachers and the national problem of retaining qualified teachers add up to a critical situation. Given the demographic trends within the state, unless and until teacher supply and related retention issues are satisfactorily addressed, Texas will continue to experience long-term shortages of highly or even adequately qualified mathematics and science teachers within its high schools (Sid W. Richardson Foundation Forum, 2012).

According to the U.S. Department of Education document "Teacher Shortage Areas Nationwide Listing 1990-91 through 2011-12;" there has been a demand for certified mathematics, science, and technology application teachers in Texas since 1993. In addition, the school districts in South Texas meet the criteria for high-need local educational agencies whose schools have a high proportion of economically disadvantaged students from families with incomes below the poverty line. In addition, the percentage of students who 'Met State Standard' in Mathematics and Science in this region are far below the state average based on the Texas Assessment of Knowledge and Skills (TAKS: standardized test used in Texas to access student's knowledge and achievement at each grade level) assessments. Compared to the other subjects such as Reading, English Language Arts, and Social Studies, the Mathematics and Science subject areas need to be reinforced to provide more quality education and to improve students' academic performance.

One of the STEM fields is Computer Science. In 2007, the Computer Science Teachers Association (CSTA) conducted a questionnaire survey to gather information on current certification requirements for K-12 teachers in Computer Science. The Association believes that addressing some issues in teaching certification is a key require-

ment for ensuring that K-12 students are prepared to pursue a career in the field of Computer Science (Khoury, 2007). The findings suggested that many Computer Science teachers are not appropriately prepared to teach the subject in K-12 schools and the certification requirements may not be sufficiently restrictive in many states. Nationally, the number of schools that offer an Advanced Placement Computer Science (APCS) course has declined significantly in the last six years and only 27% of schools surveyed in 2009 offered APCS according to a survey by the CSTA. Most of the Computer Science (CS) undergraduate students in the Computer Science program at TAMUK did not have the availability of CS courses at their high schools.

1.3 Needs Assessment in STEM Education in South Texas

A qualified STEM teacher is a crucial factor that influences students' learning, and could be a great asset to an educational program. Based on the evidence of a study of teachers about how fully certified teachers effectively contribute to enhance students' achievement, Darling-Hammond (2010) suggested all schools require highly qualified teachers. Another study conducted in North Carolina with high school students also found that students' achievement was significantly increased if they were taught by certified teachers (Clotfelter, 2007). However, according to Ingersoll (2003), students keep facing inexperienced teachers with high teacher attrition and turnover rates. Laine (2008) also pointed out that teachers often leave positions at low-performing at-risk schools due to a lack of preparation to teach in challenging environments as well as a lack of support in those environments. Hiring difficulties in finding qualified STEM teachers in secondary schools is another serious factor (Ingersoll and Perda, 2009).

A need can be referred to as a discrepancy between an existing condition and a desired condition. Gall et al. (2003) and McCawley (2009) defined needs assessment as a systematic approach to investigate the knowledge, interest, or attitude of a defined group involving a particular topic. Such an assessment is conducted in order to allow the target audience to verify its own level of knowledge and skill as well as its opinions. Through analyzing the data collected from a needs assessment, the investigator will be able to find the gap or discrepancy between what exists and what is needed.

A needs assessment is one type of decision-oriented evaluation study (Alkin, 1969; Stufflebeam, 2001). In his classic work of evaluation theory development, Alkin (1969) stated that decision-oriented evaluation is the process of determining the kinds of decisions that have to be made. A decision-oriented study, such as a needs assessment, provides vital information for decision-makers to identify the appropriate decision alternatives, which in turn assist in program planning.

Stufflebeam (2001) maintained that the basic purpose of decision-oriented studies is to provide knowledge and help guide program planners to develop, implement, and provide cost-effective services or programs. Moreover, decision-oriented studies "help program personnel make and defend decisions keyed to meeting beneficiaries' needs" (Stufflebeam, 2001). He stressed that a main advantage of a decision-oriented approach is that it encourages program planners to use findings from the studies to systematically plan and implement programs that meet specific needs. It helps decision making at all program levels and emphasizes improvement. In addition, it presents a framework of information that helps program personnel be accountable for their program decisions and actions. Furthermore, decision-oriented studies involve the full range of stakeholders to ensure all stakeholder needs are well addressed and to encourage and support them to make effective use of the findings.

Educational program planners conduct a needs assessment as an attempt to measure a perceived need by collecting data to document a challenge that exists (RMC Research Corporation, 2008). Data can be collected through survey, interviews, focus groups, and working groups (McCawley, 2009). For federal funding programs, the No Child Left Behind (NCLB) Act has created specific requirements for conducting a needs assessment (RMC Research Corporation, 2008).

Both NCLB and state laws have legislated a requirement for schools to conduct comprehensive needs assessment (CNA) as part of their planning and decision- making process (Texas Education Agency, 2015). The purpose of CNA is to identify a school campus's educational strengths and areas that need improvement. This will help school program planners to prioritize the areas that most affect student achievement and guide the development of their campus improvement plan.

2. Methods

A needs assessment based on the decision-oriented approach was conducted in the spring and fall semesters of 2013 to collect data to support decision making in preparing highly qualified STEM teachers for high-need school districts in South Texas. It was expected that appropriate decision alternatives would be identified through analyzing the data, which would assist in program planning. Two sets of needs assessment survey questionnaires were developed: Teacher Survey and Student Survey. A website, Future STEM Teachers in South Texas (http://southtexas-stemteachers.org/survey.php), was built to introduce the initiatives and to collect data for the needs assessment.

The Student Survey was conducted in the spring and fall semesters of 2013. The survey questionnaire was distributed to any freshman or sophomore students in STEM courses who wished to participate in the survey whether or not they had an interest in becoming a STEM teacher. For the purpose of the needs assessment, if they stated that they were interested in teaching they were also asked which subjects and grade levels they would prefer to teach, if they were willing to teach in a high need school, and if they needed financial aid to enroll in the teacher preparation program. If they indicated they had no interest in becoming a STEM teacher, they were prompted to give their reason(s). The students from the College of Arts and Sciences and the College of Engineering at TAMUK were invited to participate. Site visits were also administrated to contact the students with STEM majors in the community colleges (Del Mar College, South Texas College). During the visits, the students were asked to complete the survey questionnaire.

Student participants made the decision to participate in the survey by reading the information provided, consenting to participate in the study, and certifying that they were 18 years of age or older. As participants, the students had been informed that any information obtained in this study would be de-identified so as to protect their privacy and confidentiality. Under this condition, and as there was no personal risk or discomfort directly involved with this research, they agreed that any information obtained from this research could be used in any way thought best for education and academic publications.

As for the Teacher Survey, district instructional directors and grant directors of high-need school districts (Kingsville ISD, Pharr-San Juan-Alamo ISD, and Corpus Christi ISD) were contacted in the fall semester of 2013 to invite their teachers to complete the online survey questionnaire. For the purpose of the needs assessment, the teachers were asked questions on STEM education in the schools. Did the schools have enough math and science teachers? Did the math and science teachers have degrees in the fields that they were teaching? Did their curriculum include discussions or introductions to careers in engineering and technology? They were also asked to give comments related to the challenges facing STEM education in their school and how higher education institutions can better support their efforts to implement effective STEM programs. The participants of the needs assessment involved faculties from elementary, middle, and high schools. Teachers at all grade levels were invited as an interest in STEM needs to begin in the early years. The specific rationale was that in order to develop a robust pipeline for STEM education, instruction should begin at the elementary level (Murphy, 2011). In addition, there should be a vertical alignment of STEM curricula from pre-K through the first years of higher education (National Science Board, 2007).

Teacher participants also made the decision to participate in the survey by reading the information provided, consenting to participate in the study, and certifying that they were 18 years of age or older. Any information obtained in this study would be de-identified to protect their

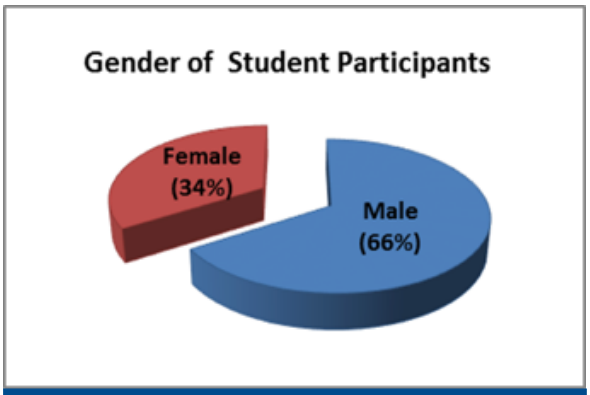

Figure 1. Gender of student participants

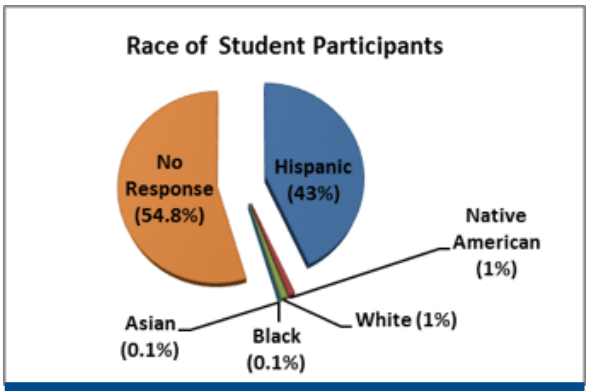

Figure 2. Race of student participants

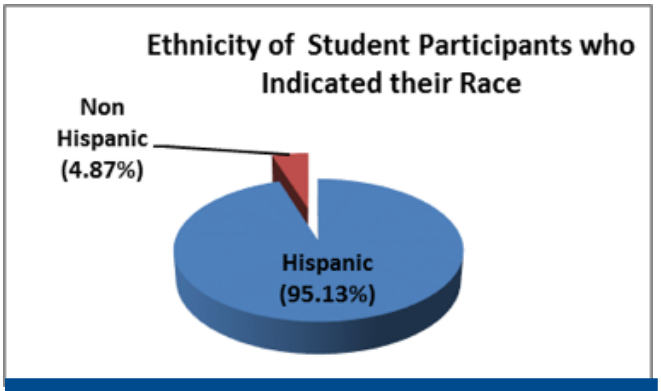

Figure 3. Ethnicity of student participants who indicated their race

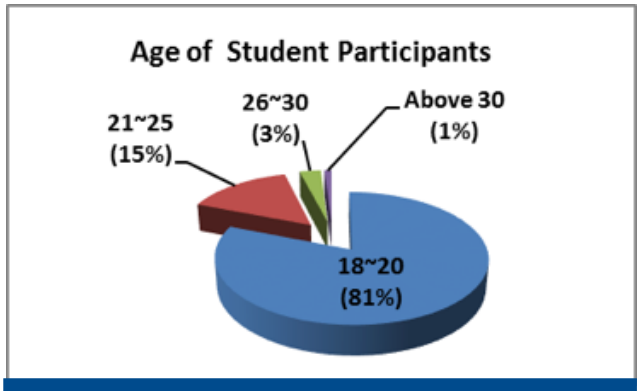

Figure 4. Age of student participants

privacy and confidentiality and would be used for education and academic publications.

3. Results and Discussions

3.1 Student Survey

520 students participated in the Student Survey. The demographics indicated that 66% were male, 34% female (Figure 1). On average 54.8% of student participants did not indicate their race (Figure 2), but among the participants who indicated their race, 95.13% of them were Hispanic (Figure 3). Among the 520 respondents, the majority, 422 (81%) of respondents were between the ages of 18 and 20, and 78 of them (15%) between the ages of 21 and 25 (Figure 4).

Table 1 shows the number of student participants by major (some indicated double majors). Among the 520 students, 406 (78.1%) were STEM students: including 93 (17.4%) Mathematic majors, 92(17.2%) Computer Science majors, 75(14.0%) Chemical Engineering majors, 53(9.9%) Electrical Engineering majors, 31(5.8%) Natural Gas Engineering majors.

Interest to become STEM Teacher: 56.25% of the STEM student participants indicated that they were interested in becoming a teacher and 99.9% of them were willing to teach in high-need schools. Also, 99.8% of them stated that they needed financial assistance to complete the educator preparation program. For those who were not interested in becoming a teacher, 35% stated that they were not interested in teaching; 25% expressed that they were interested in other fields; 20% claimed that their majors did not match; 12% stated that the pay was not high enough; 7% claimed that they had no ability in teaching; and 1% said that they had insufficient patience and were afraid of speaking to large crowds.

About 72% of the student participants that had indicated they were interested in teaching stated that they would like to teach STEM subjects: 31% Computer Science, 30% Mathematics, 10% Science (Physics, Biology, and Chemistry), and 1% Technology Application. Among the students who were interested in teaching STEM subject areas, 68% of them responded that they would prefer to teach middle level, grades 4-8 and 14% of them preferred high school level, grades 9-12.

Major	# of students	%	Major	# of students	%
Animal Science	3	0.6	Liberal Art	2	0.4
Architecture Engineering	1	0.2	Mathematics	93	17.4
Aviation	1	0.2	Mechanical Engineering	22	4.1
Biology & Bioscience	20	3.7	Natural Gas Engineering	31	5.8
Biomedicine	5	0.9	Nursing	20	3.7
Chemical Engineering	75	14.	Nutrition	3	0.6
Chemistry	3	0.6	Physics	3	0.6
Computer Science	92	17.0	Political Science	1	0.2
Criminology	2	0.4	Premed	2	0.4
Education & Communication	23	4.3	Psychology	5	0.9
Electrical Engineering	53	9.9	Resource Management	1	0.2
Geology	3	0.6	Science	25	4.7
History	1	0.2	Social work	1	0.2
Interdisciplinary Studies	1	0.2	Technology	12	2.2
Kinesiology	1	0.2	Others	30	5.6

Table 1. Major of student participants

Grade	# of teachers	Grade	# of teachers
K	7	7	17
1	6	8	15
2	6	9	13
3	6	10	13
4	6	11	11
5	1	12	11
6	6		

Table 2. Grade(s) teacher participants teach

In summary of the Student Survey, 81% of the student respondents were between the ages 18 to 20 and 78% of them were STEM students. 56% of the STEM students indicated that they were interested in becoming a teacher and 99.9% of these were willing to teach in high-need schools. Also, 99.8% of them stated that they needed financial assistance to complete the educator preparation program. About 72% of the student participants indicated that they would like to teach STEM subjects, and among the students who were interested in teaching STEM subject areas, 68% of them responded that they would prefer to teach middle level, grades 4-8.

3.2 Teacher Survey

There were 63 full-time teachers (23 elementary school teachers, 21 middle school teachers, and 19 high school teachers) and 10 'other' that responded to the Teacher Survey. Among the respondents, over 50% of them taught STEM subjects at least part-time at the middle or high school level at the time of the survey. The majority (83.17%) of the teachers indicated that they had been teaching for more than 6 years.

Of the 73 teacher respondents 21 (29%) taught only STEM subjects at the time of the Survey: Mathematics (12), Science (6), Computer Science (1), and Technology (2). Of the respondents, 14 (19%) taught ELA; 4 (5.5%) taught Social Studies; 6 (9%) taught Special Education; and 7 (9.6%) taught other. In addition, there were 21 teachers who taught a variety of courses; it appeared that a majority of teachers who taught social studies also taught STEM courses – 21(28.8%) taught a variety of courses including STEM courses. Those who taught at the high school level tended to teach singular subjects instead of a variety of courses (Table 2). The majority of the teacher participants taught at the middle school level grades 6-8 or high school level grades 9-12 (Table 2).

Of the teacher participants, 74.59% indicated that they had been working as a teacher for 6 or more years: 28.75% for more than 20 years, 12.69% for 16-20 years, 17.46% for 11-15 years, and 15.87% for 6-10 years. A quarter (25.37%) of the teachers had experience in teaching for less than or equal to 5 years: 15.87% for 1-2 years and 9.5% for 3-5 years.

Teacher Perceptions: When asked whether "STEM Education" had been a topic of discussion in their schools, 44.4% acknowledged that this was true. According to 61.9% of the teachers, schools had insufficient math and science teachers. However, the teachers perceived that the math and science teachers at their schools had degrees in the fields that they were teaching. Only 38.1% of the teachers felt that their curriculum included discussions or introductions to careers in engineering and technology. They were also asked about the most important challenges facing STEM education. The challenge that was selected most frequently was "Funding in K-12 specifically designated for STEM education is insufficient" (47.6%) followed closely by "Professional development for STEM teachers is insufficient" (42.9%) and "STEM education in K-8 is lacking or inadequate" (41.3%) (Table 3).

The last item of the Teacher Survey was an open-ended question, which asked, "How can higher-education institutions better support your efforts to implement effective STEM programs?" The teachers were asked for their suggestions regarding the support from higher education institutions in STEM education. Three themes developed: 1) 40% of the respondents stated that they would like universities to provide training or professional development for teachers. 2) 20% of them suggested the implementation of vertical curriculum alignment. "Provide tuition for post-graduate course loads whose main effort is to design appropriate stem related curriculum." 3) 12% suggested the establishment of partnerships between universities and school districts. "A great way higher-education institutions could better support my efforts to implement effective STEM programs, is to become more involved in the early childhood learning of students. If want and interest is not there early on, it may be difficult to get the proper foundation the students need in order to be able to handle the rigor of later years in education that will benefit them when it comes to engineering, math and science." Another teacher stated, "I think the collaboration between higher education institutions can help by having tours and presentations that show the students a real world side of these areas so they can better grasp the opportunities they offer." Another perception on this theme was "Bridge programs between high schools and higher education universities and colleges would help to alleviate some of the lack of students going into STEM fields/courses."

4. Conclusion

Based on the needs assessment, decision alternatives were identified: provide financial assistance for the students to complete their teacher preparation programs, organize and conduct training or professional development for teachers, provide induction and mentoring to novice STEM teachers, implement vertical curriculum alignment, and establish partnership with the school districts. These alternatives would help guide the decision-makers in preparing qualified STEM teachers and to improve STEM education for the high-need schools in South Texas.

4.1 Provide financial assistance for the students to complete their teacher preparation programs

Findings from the needs assessment indicated that the majority of the STEM students needed financial assistance to complete the educator preparation program. Financial assistance is a key component that would attract more STEM professionals in South Texas to participate in the teacher education program. It would enable students to obtain a better means to focus on and prepare for teaching careers, thus facilitating their decision to participate in a STEM discipline.

Question	# selected	% selected
STEM education in K-8 is lacking or inadequate.	26	41.3
National set of core common standards for science is needed.	10	15.9
Number of qualified STEM education teachers is too low.	19	30.2
Funding in K-12 specifically designated for STEM education is insufficient.	30	47.6
Number of students who pursue STEM careers after graduation is too low.	18	28.6
Professional development for STEM teachers is insufficient.	27	42.9

Table 3. Challenges facing STEM education

4.2 Organize and conduct training or professional development for teachers

About 40% of teacher respondents stated that they would like universities to provide training or professional development for teachers. Universities could oversee internships or summer camps of in-service training in a variety of STEM teaching experiences in order to provide students an opportunity to observe and participate in STEM education. In addition to the internships or summer camps, field-based assignments in the public school classrooms for students could be organized. After the completion of the field-based assignments, the students would participate in teaching under a cooperating teacher in the public school system. Universities could also host seminars or workshops that would allow the teachers to share their experiences and discuss problems with their peers, education faculties and/or mentor teachers. It will be envisioned that new teachers will quickly matriculate themselves to the level of veteran teachers and will be in a position to assist others as experienced mentors in subsequent years.

4.3 Provide induction and mentoring to novice STEM teachers

A primary interaction between experienced veteran teachers and novice teachers could be established by mentoring. Mentoring could be offered by education faculty members from universities and the experienced veteran teachers from schools to help novice STEM teachers to achieve success in the classroom. Mentoring could be offered using a face-to-face meeting or virtual mentoring via the web mentoring system. Mentors and mentees could regularly meet together to review curriculum materials and to learn teaching strategies, to provide peer support, and to share experiences.

4.4 Implement vertical curriculum alignment

One of the academic weaknesses of the current computer science majors at TAMUK is a lack of background knowledge. Many freshman and sophomore students struggle in the foundation courses. This problem can be traced back to the high school curricula. Many high schools in South Texas do not offer computer science courses.

In order to help create a stronger workforce for STEM and better STEM teachers, the school districts need to add new elective courses such as computer science in their high schools. Concurrently the universities could prepare highly qualified STEM teachers who would learn the requisite knowledge and skills and be able to provide quality education to students in high schools. This would provide schools with the ability to educate high school students for more challenging, higher-level work at the next level in college. The academic weakness of the current high school and college curricula in STEM could be gradually overcome by this logically structured and sequenced teaching and learning, thus "Implement Vertical Curriculum" could be achieved.

4.5 Establish partnership with the school districts

There must be a deliberate partnership between universities, community colleges, and school districts. A coalition could be established to unite area educators, community leaders, students, and teachers to discuss STEM education needs and strategies in an effort to meet these needs. Developing partnerships with high schools is vital to increase the number of STEM majors and to improve STEM education.

The findings of the needs assessment were utilized for the proposal of National Science Foundation's Robert Noyce Teacher Scholarship Program. Under the award, TAMUK will contribute to help the area school districts reach their goal of hiring qualified STEM teachers and improving students' knowledge and performance in STEM subjects. Over the next five years, TAMUK is expected to recruit, prepare, and retain 24 new highly qualified STEM teachers for high-need schools in South Texas. This will broaden participation of underrepresented groups in STEM disciplines by preparing teachers who will strengthen teaching and learning of STEM subjects in schools that serve large numbers of minority students and students of low socioeconomic background, resulting in a direct benefit to society by bridging the gap that persists within communities that serve students underrepresented in STEM disciplines.

Based on the needs assessment, the overarching goal of the TAMUK Noyce Scholarship program was set to increase the number of qualified secondary education teachers in the STEM disciplines in high-need schools in South Texas. To fulfill this goal, the following objectives will be accomplished: 1) To recruit students who are presently majoring in STEM disciplines, including both transfer students from community colleges and students native to the institution, to the teaching profession; 2) To ensure students complete all requirements for their STEM discipline degree and teacher certification; 3) To develop procedures for tracking students after their degree completion; 4) To establish necessary connections and articulation agreements with school districts, and community colleges; 5) To support and retain students in their teaching position in high-need schools.

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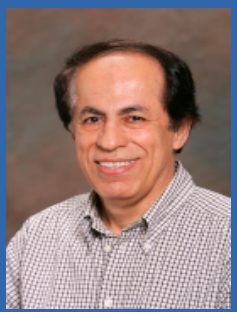

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